CHEMWATCH

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ASIA PACIFIC

Learn about our compliance monitoring program

2020-08-27

We monitor introducer compliance across each introduction category. Our compliance monitoring activities use a risk-based approach and try to minimise unnecessary burden on regulated entities.

We focus on introducers at higher risk of non-compliance as well as introductions that pose a higher risk to human health and the environment. We also modify our monitoring activities to accommodate emerging risks.

Learn more about our compliance monitoring program

Australian Industrial Chemicals Introduction Scheme, 27 August 2020

https://www.industrialchemicals.gov.au/news-and-notices/learn-about-our-compliance-monitoring-program

Our compliance monitoring activities use a risk-based approach and try to minimise unnecessary burden on regulated entities.

Variation of inventory listing following revocation of CBI approval

2020-08-28

On 26 August 2020, the Executive Director varied the terms of the Inventory listing for the industrial chemical with CAS number 2415656-58-3 because approval had been revoked for the proper name of the industrial chemical to be treated as confidential business information (CBI). The terms of the listing as varied are:

CAS Number	2415656-58-3
CAS Name	Formaldehyde, polymer with tetrapropylenephenol, magnesium salt
Molecular Formula	(C18H30O.CH2O)x.xMg

CAS Number	2415656-58-3
Specific information requirements	Obligations to provide information apply. You must tell us within 28 days if the circumstances of your importation or manufacture (introduction) are different to those in our assessment.

Australian Industrial Chemicals Introduction Scheme, 28 August 2020

https://www.industrialchemicals.gov.au/news-and-notices/variation-inventory-listing-following-revocation-cbi-approval-1

Categorisation of chemicals introduced for research and development

2020-08-26

If you're planning to introduce industrial chemicals (and products that release industrial chemicals) that are for use in research and development, see our extra guidance on this subject. It'll give you tips to help you work out your introduction category.

Read - categorisation of chemicals introduced for research and development

Australian Industrial Chemicals Introduction Scheme, 26 August 2020

https://www.industrialchemicals.gov.au/news-and-notices/categorisation-chemicals-introduced-research-and-development

If you're planning to introduce industrial chemicals (and products that release industrial chemicals) that are for use in research and development, see our extra guidance on this subject.

AMERICA

EPA announces proposal to add Chitosan to the list of active ingredients permitted in exempted minimum risk pesticide products

2020-08-21

On August 20, 2020, the U.S. Environmental Protection Agency (EPA) announced that it is seeking to add chitosan to the list of active ingredients allowed for in minimum risk pesticides exempted from pesticide registration requirements under Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Section 25(b). A minimum risk product must

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meet six specific conditions to be exempted from pesticide registration. One of those conditions is that the active ingredient in the minimum risk pesticide be one that is **listed** specifically by EPA. If added to the list of minimum risk pesticide active ingredients, pesticide products containing chitosan could qualify as minimum risk pesticides provided the other conditions are also satisfied (*e.g.*, using inert ingredients approved by EPA for use in minimum risk pesticides, not making any public health claims).

Chitosan is a naturally occurring polymer that is derived from the shells of crustaceans. It is currently registered as a fungicide, antimicrobial agent, and plant growth regulator that boosts the ability of plants to defend against fungal infections. For uses as a plant growth regulator, chitosan is applied to treat field crops, ornamentals, turf, home gardens, and nurseries. Target pests include early and late blight, downy and powdery mildew, and gray mold. As an antimicrobial agent, chitosan is used on textiles to protection the fabric from bacterial and fungal growth. Chitosan is exempt from the requirement for a pesticide tolerance.

Full Article

Pesticide Law and Policy blog, 21 August 2020

http://pesticideblog.lawbc.com/entry/epa-announces-proposal-to-add-chitosan-to-the-list-of-active-ingredients-pe

EPA finalizes rollback of Obama-era methane emissions regulations

2020-08-20

On August 13, 2020 the U.S. Environmental Protection Agency (EPA) issued two final rules, completing the rollback of Obama-era methane emissions regulations in the New Source Performance Standards (NSPS) for the Oil and Gas Industry. Issued in response to the March 2017 Executive Order on Promoting Energy Independence and Economic Growth, the EPA's new rules relax methane gas emissions requirements applicable to various segments of the oil and gas industry. Methane, the primary component of natural gas, is a greenhouse gas.

Key Changes

The two rules include policy and technical amendments to the NSPS for the Oil and Gas Industry:

The final **policy amendments** to the 2012 and 2016 NSPS:

Methane, the primary component of natural gas, is a greenhouse gas.

Remove the NSPS requirements for the transmission and storage segment of the oil and gas industry altogether, including rescinding both volatile organic compounds (VOC) and methane emissions standards for transmission and storage sources. This final rule concludes that the oil and natural gas production source category only includes the production and processing segments of the industry. The policy amendments state that under section 111 of the Clean Air Act (CAA), the Obama-era EPA could have listed the transportation and storage segment for regulation only if it first found that emissions from the segment cause or significantly contribute to air pollution that may be reasonably anticipated to endanger public health or welfare. EPA never made such a cause-or-contribute-significantly and endangerment finding, and therefore regulation of the transmission and storage segment under the NSPS is improper.

Rescind the methane emission standards for the production and processing segment of the oil and gas industry. The production and processing segment will still be required to meet smog-forming VOC emissions limits, which EPA contends will also reduce methane emissions, making separate methane requirements unnecessary.

Finalize an interpretation of the CAA section 111 for newly regulating any air pollutant that EPA did not consider when listing or initially regulating a source category. The final rule states that in order to newly regulate such an air pollutant, in this case methane, EPA must make a finding that emissions of that air pollutant from the source category cause or contribute significantly to air pollution which may reasonably be anticipated to endanger public health or welfare.

Full Article

Lexology, 20 August 2020

https://www.lexology.com/library/detail.aspx?g=43278af0-7112-4827-98fa-fba30d56268e

Thousands allowed to bypass environmental rules in pandemic

2020-08-24

Thousands of oil and gas operations, government facilities and other sites won permission to stop monitoring for hazardous emissions or otherwise bypass rules intended to protect health and the environment because of the coronavirus outbreak, The Associated Press has found.

Hundreds of requests were approved for oil and gas companies.

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The result: approval for less environmental monitoring at some Texas refineries and at an army depot dismantling warheads armed with nerve gas in Kentucky, manure piling up and the mass disposal of livestock carcasses at farms in Iowa and Minnesota, and other risks to communities as governments eased enforcement over smokestacks, medical waste shipments, sewage plants, oilfields and chemical plants.

The Trump administration paved the way for the reduced monitoring on March 26 after being pressured by the oil and gas industry, which said lockdowns and social distancing during the pandemic made it difficult to comply with anti-pollution rules. States are responsible for much of the oversight of federal environmental laws, and many followed with leniency policies of their own.

AP's two-month review found that waivers were granted in more than 3,000 cases, representing the overwhelming majority of requests citing the outbreak. Hundreds of requests were approved for oil and gas companies. AP reached out to all 50 states citing open-records laws; all but one, New York, provided at least partial information, reporting the data in differing ways and with varying level of detail.

Almost all those requesting waivers told regulators they did so to minimize risks for workers and the public during a pandemic — although a handful reported they were trying to cut costs.

The Environmental Protection Agency says the waivers do not authorize recipients to exceed pollution limits. Regulators will continue pursuing those who "did not act responsibly under the circumstances," EPA spokesman James Hewitt said in an email.

But environmentalists and public health experts say it may be impossible to fully determine the impact of the country's first extended, national environmental enforcement clemency because monitoring oversight was relaxed. "The harm from this policy is already done," said Cynthia Giles, EPA's former assistant administrator under the Obama administration.

Full Article

Star Tribune, 24 August 2020

https://www.startribune.com/thousands-allowed-to-bypass-environmental-rules-in-pandemic/572202332/?refresh=true

EUROPE

Comments on GRACIOUS framework due August 31

2020-08-21

The European Union's (EU) Horizon 2020 project GRACIOUS has launched its stakeholder engagement platform and started an open consultation on the GRACIOUS Framework. The GRACIOUS project invites stakeholders from industry, regulators, policy makers, consultants, non-governmental organizations (NGO), and academia to use the platform to provide their opinions on the progress within the project, including whether the structure of the GRACIOUS Framework is "clear and appropriate" for all stakeholders. The Framework is intended to streamline the process for assessing the risk of nanomaterials by logically grouping them, thereby allowing extrapolation between (read-across) nanomaterials and reducing the need to assess exposure to and toxicity on a case-by-case basis. Comments are due **August 31, 2020**. The project will use all feedback to refine the Framework further for its official launch in **2021**.

Nano and Other Emerging Chemical Technologies blog, 21 August 2020

https://nanotech.lawbc.com/2020/08/comments-on-gracious-framework-due-august-31/

INTERNATIONAL

US plastics pact aims to ignite further change toward circular economy for plastic

2020-08-26

60+ brands, retailers, government agencies, and NGOs collaborate to advance all plastic packaging to become reusable, recyclable or compostable by 2025.

Today, The Recycling Partnership and World Wildlife Fund (WWF) launch the US Plastics Pact — an ambitious initiative to unify diverse public-private stakeholders across the plastics value chain to rethink the way we design, use, and reuse plastics; to create a path toward a circular economy for plastic in the United States. The initiative is being launched as part of the Ellen MacArthur Foundation's global Plastics Pact network.

Expanding on the work done to eliminate plastic waste from corporate value chains by the UK Plastics Pact — launched in 2018 with a number of

The European Union's (EU) Horizon 2020 project GRACIOUS has launched its stake-holder engagement platform and started an open consultation on the GRACIOUS Framework.

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the same players — and WWF's work on the same through its ReSource: Plastics platform, the US Plastics Pact brings together companies, government entities, NGOs, researchers, and other stakeholders in a pre-competitive platform for industry-led innovation. It will drive collaborative action and deliver a significant system change toward a circular economy for plastic, enabling companies and governments in the US to collectively meet impactful goals by 2025 that they could not otherwise meet on their own.

A new partnership, also launched today, between US Plastic Pact "Activators" The Clorox Company and Colgate-Palmolive with Chilean startup Algramo — to scale up the zero-waste distribution of common household cleaning and personal care products to the US market — is an excellent example of this kind of collaboration already in progress.

"Plastic pollution is a global crisis that needs local solutions, and the United States is one of biggest opportunities where regional interventions can result in transformative change around the world," said Erin Simon, Head of Plastic Waste and Business at WWF. "To do this, WWF sees the US Plastics Pact as the linchpin for uniting the critical stakeholders — industry leaders, waste management systems, and policymakers — under a common vision and action plan for meaningful, measurable impact."

Full Article

Sustainable Brands, 26 August 2020

https://sustainablebrands.com/read/collaboration-cocreation/us-plastics-pact-aims-to-ignite-further-change-toward-circular-economy-for-plastic?utm_source=newsletter&utm_medium=email&utm_campaign=nl_200827

Major EU project develops REACH-compatible nano read-across framework

2020-08-20

JCR, RIVM, BfR and BASF directly involved, with Echa on advisory board

An EU project involving Echa in an advisory capacity has developed a framework for grouping nanomaterials that is designed to be compatible with REACH, in addition to established safe-by-design processes.

In 2018, the EU made changes to the REACH annexes to increase the amount of nanomaterials data in registration dossiers, with the aim of ensuring that the data was sufficient to demonstrate safe use of all nanoforms covered. The new requirements came into force on 1 January.

While Echa has published REACH guidance on nanomaterials risk assessment – and on grouping and read-across – one of the developers of the framework said new tools are needed to bridge the gap between what this guidance says and the specific challenges facing registrants.

One of the framework's aims is to reduce the administrative burden on companies required to submit nanomaterials data under REACH by facilitating read-across. Echa says it offers a "valuable scientific contribution" to the discussion on grouping and read-across for nanoforms, but alone would not be sufficient for constructing a dossier for nanomaterials.

The framework, which is described in a paper published in *Nano Today* on 8 August, is an output of the GRACIOUS project, which the EU launched in 2018 and will run until 30 June 2021.

The 22 authors of the paper include scientists at various organisations, including:

the European Commission's Joint Research Centre (JRC);

the Dutch National Institute for Public Health and the Environment (RIVM);

the German Federal Institute for Risk Assessment (BfR); and

chemical company BASF.

The first named and corresponding author is Vicki Stone at Heriot-Watt University in Edinburgh.

The new requirements came into force on 1 January.

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The framework is built around a set of grouping hypotheses, each of which comprises one or more statements about toxicology and physicochemical properties.

For example, one hypothesis is that "non-flexible nanoforms of more than 5 nm in length ... following dermal application will not penetrate (in their particle form) to viable layers of the skin above 1% of the applied dose".

In the first step, users collect basic information about a nanomaterial, which guides selection of a hypothesis. They then test whether or not the hypothesis applies using the integrated approaches to testing and assessment (Iata) concept, which is supported by the OECD.

Iata describes how test data from multiple sources can be combined in an iterative way to answer a specific scientific question about hazard.

If the available data supports the hypothesis, with sufficient certainty for the particular decision context, read-across from similar nanomaterials to fill data gaps may be possible.

'Scope for interpretation'

Professor Stone says that Echa guidance does not specify the "exact methods" that should be used to make read-across predictions, "so there's lots of scope for interpretation within that guidance".

Furthermore, the frameworks previously developed by scientists have been limited in scope by, for example, focusing on just one route of exposure.

The GRACIOUS framework builds on these, with a scope that includes "all relevant exposure routes for humans and all compartments in the environment".

The project is developing a software application based on the framework and the aim is to share that with stakeholders for feedback by the end of the year.

Professor Stone says that the framework should be sustainable beyond the end of the project because developers of other risk-assessment and decision-support software are free to integrate it into their products and update the content as needed.

However, further work will be needed on the test methods for generating the required data.

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"There will be varying levels of confidence in some of the answers," she says. "What we'll do is identify where there's less confidence and that will help people to identify the method development that's required in future."

Full Article

Chemical Watch, 20 August 2020

https://chemicalwatch.com/146322

REACH consultations

2020-08-28

Applications for authorisation

Consultations: 11

Start date: 12/08/2020

Deadline: 07/10/2020

Restrictions

Consultations on SEAC draft opinion: 1

Start date: 01/07/2020

Deadline: 01/09/2020

Restriction proposals: 1

Start date: 25/03/2020

Deadline: 25/09/2020

Testing proposals

Testing proposals: 6

Start date: 24/08/2020

Deadline: 08/10/2020

ECHA, 28 August 2020

https://echa.europa.eu/

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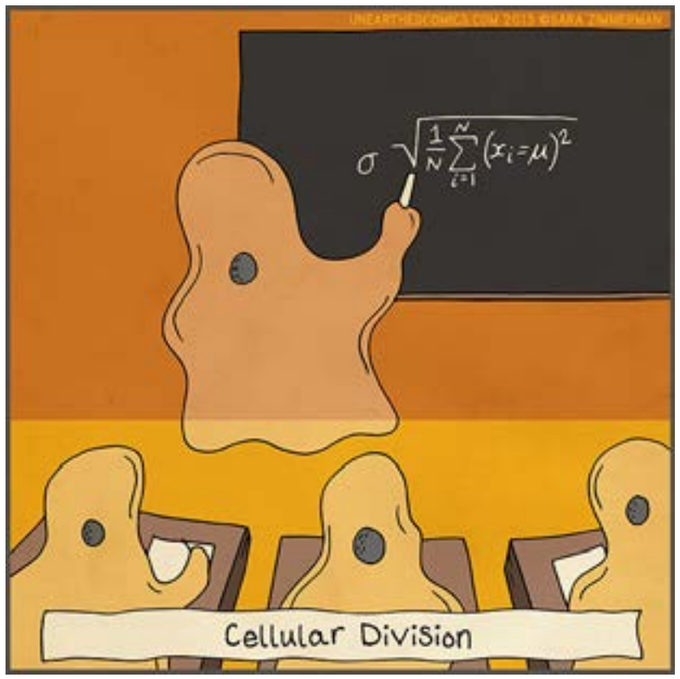
Cellular Division

2020-09-04



http://unearthedcomics.com/comics/cellular-division/

Oxalic Acid

2020-09-04

Oxalic acid (aka ethanedioic acid or oxalate) is an organic compound, with the chemical formula of $C_2H_2O_4$. In its solid state, the acid forms white crystals, and when combined with water, creates a colourless solution. It is naturally occurring in many vegetables. The compound is classified as the simplest dicarboxylic acid. [1,2]

USES [1]

Oxalic acid is used in a range of chemical applications. Its primary use is as an ingredient in cleaning agents. Its corrosive nature means it is used in a range of bleaches, detergents, cleaning products, and as a rust remover. The acid is also used across the board as a sterilising agent, including in corporate and medical industries. Oxalic acid is used as a bleach in textile mills and factories and in mineral processing.

ROUTES OF EXPOSURE [1]

- Oxalic acid is naturally occurring in a range of vegetables, including potatoes, leafy greens, broccoli, and sprouts.
- Leafy greens, such as spinach, are the most concentrated source of oxalates (in regards to vegetables).
- Vegetables that are high in the acid are not dangerous in small doses.
- More dangerous routes of exposure are from the cleaning products where oxalic acid is included as an ingredient.

HEALTH EFFECTS

Oxalic acid poisoning affects a range of systems, including the urinary and integumentary systems.

Acute Effects [1,3]

Severity of symptoms depend on the level and type of exposure.

Acute doses of oxalic acid can occur if large quantities of the acid are accidentally ingested—as a pure substance, or through vegetables that are highly concentrated. High levels of ingestion can cause death. Oxalic acid crystals can cause chemical burns, and acute exposure to the vapour can result in internal chemical burns.

Oxalic acid (aka ethanedioic acid or oxalate) is an organic compound, with the chemical formula of C2H2O4.

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Chronic Effects [1,3]

Chronic exposure to oxalic acid is toxic to multiple body systems. Long term exposure to the acid can corrode tissue throughout the body. This includes on the mucosa of the mouth, the oesophagus, and the stomach. It can also cause great thirst, bloody vomit, convulsions, coma, and death. Over time, oxalate crystals can break down in the body, forming kidney stones. This can cause various gastrointestinal complications and/or kidney failure. People who consume a lot of vitamin C are also in the higher risk category, as when the vitamin is broken down, it releases oxalic acid, which can, again, result in kidney stones.

SAFETY

First Aid Measures [4]

- Ingestion: DO NOT INDUCED VOMITING. If spontaneous vomiting occurs, place the victim's head below their hips to prevent the acid moving into their lungs. Get immediate medical attention.
- Skin contact: Remove all contaminated clothing, footwear and accessories. Do not re-wear clothing until it has been thoroughly decontaminated. Immediately rinse affected areas with plenty of water. If symptoms persist, contact a doctor immediately.
- Eye contact: Flush eyes (including under the eyelids), with water for several minutes. Check for, and remove, any contact lenses (if easy to do so). Continue rinsing. If irritation persists, contact a medical professional.
- Inhalation: Take victim to the nearest fresh air source and monitor their breathing. Keep the victim warm. If the victim is not breathing, and you are qualified, you may perform CPR with a one-way valve or protective mask. Immediately contact a medical professional.
- General: Never administer anything by mouth to an unconscious, exposed person.

Exposure Controls/Personal Protection [4]

- Engineering controls: Emergency eyewash fountains and quick-drench areas should be accessible in the immediate area of the potential exposure. Ensure there is adequate ventilation. Use a local exhaust ventilation or process enclosure, to limit the amount of acid in the air.
- Personal protection: Safety glasses, protective and dustproof clothing, gloves, an apron and an appropriate mask or dusk respirator. Wear

impervious shoes. Do not wear contact lenses. For specifications regarding other PPE, Follow the guidelines set in your jurisdiction.

REGULATION [4]

United States:

The Occupational Safety and Health Administration (OSHA) has set an 8-hour time weighted average (TWA) concentration limit for oxalic acid of 1mg/m^3.

Australia [5]

Safe Work Australia has set an 8-hour time TWA for oxalic acid of 1mg/m^3.

REFERENCES

1. http://acidpedia.org/oxalic_acid/
2. https://en.wikipedia.org/wiki/Oxalic_acid
3. https://medical-dictionary.thefreedictionary.com/oxalic+acid+poisoning
4. https://www.statlab.com/pdfs/sds/Oxalic_Acid_2_Safety_Data_Sheet.pdf
5. https://diggersaustralia.com.au/wp-content/uploads/sds/Rust%20and%20Stain%20Cleaner%20%28Oxalic%20Acid%29%20v4.pdf

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Culling dingoes with poison may be making them bigger

2020-08-19

Australia's dingoes are getting bigger, and it may be because of humans. New research suggests the change is happening only in places where the wild canine's populations are controlled with poison.

The findings could illustrate for the first time that, when targeted with pesticides, changes to the physical traits of "pest" species can occur in bigger animals, not just insects and rodents.

Scientists had noticed an increase in the size of some dingoes, but that there hasn't been much understanding of what was causing it, says Michael Letnic, an ecologist at the University of New South Wales in Sydney. He wondered if it was the consequence of decades of the dingoes' status as a livestock pest.

Dingoes (*Canis lupus dingo*) have long had an uneasy relationship with farmers and ranchers in rural Australia. The predators can attack livestock, usually sheep. Shooting and fencing have been used to control dingo populations and protect livestock. But in the 1960s and 1970s, a new tool was also employed in western and southern Australia: a poison called sodium monofluoroacetate, or 1080. Odorless and tasteless, the powder could be mixed into bits of meat and scattered across the landscape as deadly bait for dingoes to snatch up.

Odorless and tasteless, the powder could be mixed into bits of meat and scattered across the landscape as deadly bait for dingoes to snatch up.

Bottom of Form

A dose's effectiveness is dependent on a dingo's mass, which led Letnic to test the idea that 1080 use might be related to dingoes' size change. He and Mathew Crowther, an ecologist at the University of Sydney, delved into museum collections of dingo skulls, collected from across three areas that have been exposed to 1080 for about 50 to 60 years, and one region where baiting is banned. The skulls date from 1930 to the present day, so by measuring their length (a proxy for a dingo's body size), the researchers could compare the sizes of the animals before and after poisoning began.

After examining more than 500 skulls, the team found that in baited regions, female dingoes' skulls have grown 4.5 millimeters longer, on average, in the era after 1080 was introduced. Male skulls are 3.6 millimeters longer than they were. These changes equate to a roughly 6 and 9 percent jump in body mass in males and females, respectively, or about a one kilogram increase on average, the team reports July 31 in

the *Biological Journal of the Linnean Society*. In contrast, skulls from dingoes in the unbaited region did not significantly change in length over the same time period.

Dingoes are top predators whose appetites send ripple effects through the food web *(SN: 1/13/14)*. Kangaroo numbers increase when dingo populations are controlled, so the combination of extra prey availability and reduced competition may make it easier for dingoes that aren't killed by the poison to find food and grow. "By reducing the dingo population, [1080 is] changing the environment that dingoes are growing up in," Letnic says. Bigger dingoes may then, in turn, be more tolerant of the poison's effects, their body size outpacing a relatively constant dosage over the years.

"We've known for a long time that if we spray our fields with pesticides, then the insects that we're trying to kill change and develop resistance" to the pesticides, Letnic says. "This work suggests that when we use pesticides on big animals, we can produce comparable changes."

Still, the study is based on correlations rather than experimental manipulation of dingo populations, so pinning down precisely what's causing the change is tricky. But the team's search for possible alternative explanations for the size increase came up short. Climate change can cause size shifts, but animals tend to get smaller as temperatures rise, not bigger. Interbreeding with domesticated dogs might make the dingoes bigger, but the skulls all came from areas of Australia with negligible rates of dog-dingo hybrids.

Kiyoko Gotanda, an evolutionary biologist at the University of Cambridge not involved with the research, says that while the effects of hunting on animal traits are often investigated, she's "unaware of studies looking at how using poisoning as a control method for vertebrates might also induce [physical or behavioral] change… I would also be interested to learn if changes to body size occur once you stop using poison control on the predators," she says.

If dingoes are growing in size in response to 1080 exposure, there could be ecological implications down the line. Bigger dingoes can hunt bigger prey, notes Letnic, which could have unknown impacts on Australian ecosystems. And dingoes aren't the only worry. The poison is also used to control other "pests," including invasive red foxes, which devour many

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threatened animals. If the foxes become tolerant of 1080, the conservation consequences could be harsh, Letnic says.

sciencenews.org, 19 August 2020

https://www.sciencenews.org

CVOID-19 has the potential to be as deadly as the 1918 flu

2020-08-20

The COVID-19 pandemic has the potential to become more deadly than the 1918 flu pandemic, a new study suggests.

Remembered as the deadliest pandemic in recent history, the 1918 influenza pandemic infected one-third of the world›s population and killed at least 50 million people, 675,000 of them in the U.S., according to the Centers for Disease Control and Prevention (CDC). At the time, there were no vaccines and no antibiotics to treat secondary infections that inevitably popped up in flu patients. However, society employed measures like the ones being used today to curb the spread, such as imposing quarantines and endorsing good personal hygiene, according to the CDC.

Over a century later, the world has found itself in the grip of another pandemic, this one caused by the coronavirus SARS-CoV-2 — and it›s still not clear just how deadly it is. The virus has now infected at least 22.2 million people and has claimed at least 783,525 lives worldwide, according to the Johns Hopkins dashboard.

To compare the current pandemic with last century's, a group of researchers focused on a sliver of the world that was hard hit by both viruses. In the spring, SARS-CoV-2 hammered New York City, causing more than 19,000 known deaths — and more than 4,600 probable deaths or those that were likely caused by COVID-19 but there aren't positive laboratory tests to confirm, according to the NYC Department of Health and Mental Hygiene.

Using data from the CDC, the New York Department of Health and Mental Hygiene and the U.S. Census Bureau, the researchers compared the mortality rate in New York City during the early COVID-19 outbreak with the mortality rate during the peak of the 1918 H1N1 influenza pandemic.

The researchers specifically analyzed deaths from all causes in New York City in October and November of 1918 — the peak of the influenza pandemic in the city — and compared them with all-cause deaths in the

The virus has now infected at least 22.2 million people and has claimed at least 783,525 lives worldwide, according to the Johns Hopkins dashboard.

same months since 1914. They then calculated all-cause deaths for March 11 to May 11 of this year in New York City, when the COVID-19 outbreak peaked and subsided in New York. The time periods they compared were each 61 days long.

The researchers chose to compare the early outbreak in NYC with the peak of the 1918 flu, rather than with the milder influenza wave that hit in the spring of 1918, so that "people can get context for how serious," this modern outbreak is, said lead author Dr. Jeremy Faust, an emergency physician at the Brigham and Women's Hospital in Boston and instructor at Harvard Medical School.

They found that during the peak of the 1918 influenza outbreak in New York City, a total of 31,589 all-cause deaths (this included death from any cause) occurred among the 5.5 million residents that lived there at the time. The all-cause mortality in the peak of the influenza pandemic in 1918 was 2.8 times higher than during the same months in previous years.

In contrast, for the early 2020 COVID-19 outbreak in New York City, they found that 33,465 deaths from all causes occurred among 8.28 million residents between March 11 and May 11. The all-cause mortality in those months of 2020 were 4.15 times higher than those months between 2017 and 2019.

That means that in the peak of the 1918 influenza pandemic in NYC about 287 per 100,000 people died a month from any cause in NYC, whereas during the early COVID-19 outbreak, about 202 per 100,000 people died a month in the city. So the all-cause mortality during the spring of 2020 was 70% of the all cause mortality during the fall of 1918. "When we do that, we see that COVID-19 really does have the potential and has already unfortunately caused per capita death rates that were in the same ballpark," Faust told Live Science.

But there's another way to look at the deaths related to each pandemic: comparing deaths during a pandemic to the baseline that you'd expect during a particular time. There were more "excess deaths" during the 1918 flu than the early COVID-19 outbreak. But in relative terms, the COVID-19 outbreak in the spring actually looks worse, because the numbers quadrupled from pre-pandemic times (from a baseline of around 50 deaths per 100,000 people per month), whereas in the peak of the 1918 flu, the numbers less than tripled (from a baseline of around 100 deaths per 100,000 people per month).

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"Its a bigger shock to our system, but that's a little bit unfair because we started off at a lower death rate," than there was in 1918, due to advances in hygiene, medicine, public health and safety, Faust said. Really, we don't yet know if the 1918 pandemic or the COVID-19 pandemic is more deadly, he added. Maybe what happened in New York in the spring was a "freak thing," before interventions such as masks and shutdowns took hold; or maybe the numbers will slowly creep up to match the death tolls seen in the 1918 flu until an effective vaccine is found.

One limitation of the study is that it's not possible to directly compare how infectious and harmful the two viruses are to people and it's unknown how many deaths from SARS-CoV-2 were prevented because of modern interventions that weren't available a century ago, the authors wrote.

"All we know is that in this little slice of time that we looked at, there are certainly enough resemblances that it can't be just shrugged off," Faust said. "We've asked the question how did this compare to the worst pandemic in modern history, and we've given the first possible window into that and I think that further research will give us more answers as to whether it's not as bad, similar or worse."

In the meantime, the take-home message is that shutting down hard-hit places, social distancing, quarantining and wearing masks are critical. «Unlike any other pandemic we›ve ever confronted, flattening the curve can actually do more than just slow down the death rate ... it can actually buy us time to get a vaccine,» Faust said. «If you don›t do these things, mayhem of historic proportions is actually possible. It›s not guaranteed, but it›s possible.»

livescience.com, 20 August 2020

https://www.livescience.com

The worst animal in the world

2020-08-20

For about a week this past September, I adopted a wellness routine that—at the time—felt like neurotic overkill. I didn't bother with masks or hand sanitizer; back then, the virus we now know as SARS-CoV-2 was still presumably nestled in the warm body of an unknown animal. Instead, each morning, I spritzed my arms and legs with picaridin, a chemical repellent meant to ward off parasitic bugs. Then I covered myself with one of several increasingly crusty sets of khaki pants and long-sleeved shirts

In 2019, when the World Health Organization compiled a list of threats to global health, dengue got a whole slot to itself.

that I had infused with the insecticide permethrin. Only then, force field up, would I venture outside.

I had come to Dakar, Senegal, to get close—but not too close—to *Aedes aegypti*, a globally invasive mosquito that is arguably the worst animal in the world. The species carries yellow fever and dengue, both of which can cause more severe disease in young adults than SARS-CoV-2; Zika virus, which can lead to birth defects; and chikungunya virus, which can leave victims with debilitating joint pain.

Unlike viruses that travel person-to-person, most of these pathogens can spread only in places where mosquitoes live. Then again, *aegypti*'s range is immense. All told, her bites—and only females bite—cause an estimated 400 million infections each year, which means that several dozen people have been infected in the time it took you to read this sentence. In 2019, when the World Health Organization compiled a list of threats to global health, dengue got a whole slot to itself. Zika showed up in another slot, sharing billing with Ebola, SARS, and "disease X," the prospect of some then-unknown pathogen with epidemic potential.

In Senegal, my own illusion of invulnerability lasted until I met Mawlouth Diallo, a medical entomologist from the Pasteur Institute in Dakar. Wearing a matching blue kaftan set, he sat with me in my hotel lobby for more than an hour, earnestly explaining his team's mosquito research in smooth, French-accented English. Finally, I had to ask a nagging, basic question.

"Sitting here, right here," I said, gesturing to the air-conditioned lobby, "where is the nearest *Aedes aegypti*?"

Diallo seemed confused at the question. "Where?"

"Like, could we go find some of them outside right now?"

"No, it is inside," he said, then laughed out loud at the expression on my face. "For sure, *aegypti* is inside the hotel." When dengue broke out in Dakar in 2009, the city's Lebanese population was hit the hardest. One reason, Diallo said, was that mosquitoes and wealthy foreigners are both drawn to luxury indoor environments. In this lobby, he said, the best place to find *Aedes aegypti* would be the flowerpots.

I laughed with him, albeit less easily. Of the 3,000-plus mosquito species alive, most are fairly harmless. Only a handful are a concern for public-health officials. But *Aedes aegypti* is different. Whether in Rio de Janeiro, New Delhi, or Miami-Dade County, it will breed in clean water supplies, it will come indoors, it will make a beeline toward human odor, and it will

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bite when the sun is up, circumventing bed nets that protect at night. Masks to prevent the spread of COVID-19 won't make a difference. Neither will staying at home, unless you live in a closed, air-conditioned house. No other mosquito is so perfectly suited to live with, and on, human beings.

The problem will get worse. Beyond the tropics and subtropics, the species has strongholds in Florida, Texas, California, and Arizona, and at least one population has managed to survive multiple winters in Washington, D.C. One recent study projected that by 2050, thanks to the climate crisis, the North American range of *Aedes aegypti* will extend to Chicago; in China, its range will go as far north as Shanghai.

In response, the world is readying an arsenal of shiny new biological tools. But as scientists and policy makers plan to subvert the species' evolutionary future, it's especially important to grapple with its origins, the kind of processes that begin long before once-obscure pathogens emerge from clear-cut rainforests or animal markets. In tropical Africa, especially Senegal, researchers are uncovering the shared history of *aegypti* and its favorite host, learning how environmental change, slavery, and colonialism turned a local mosquito into a global menace.

After chatting in the hotel lobby, Diallo agreed to find me some mosquitoes. Outdoors, we walked half a block and poked around a construction site, looking for standing water in buckets and concrete blocks before fending off a nervous manager. Then Diallo saw a tire leaning against a wall. Reaching inside with a discarded coffee cup, he scooped out a little water—in which he pointed out at least a dozen larvae.

Cup in hand, Diallo hailed us a cab and negotiated a fare to the Pasteur Institute. In his lab, he led me into a room full of mesh cages of *aegypti* from all over the country. The mosquitoes looked, in my paranoid imagination, very eager to get out.

That afternoon, when I returned to my hotel, I walked over to the pool. I waited until nobody was watching, then bent to look into the wet, shaded basin under one of the large flowerpots. The shadows wriggled, and I recoiled. The next morning, despite all my defenses, I noticed the first bites on my arm.

Aedes aegypti, whatever else you want to say about it, is a good-looking animal. Entomologists have described it to me as "elegant," "quite attractive," and even "beautiful." Photographs often show it perched delicately on pink skin, displaying long limbs with black-and-white jailbird

stripes. That pretty pattern belies an ugly disposition; the name of its scientific genus is derived from the Greek for "unpleasant."

Fair enough. But *aegypti* wasn't always unpleasant. Within the past few thousand years, somewhere in Senegal or farther down the continent in modern-day Angola, biologists suspect that *aegypti* took its first step toward world domination.

Early hints of this story surfaced in the 1960s, when medical entomologists in the Rabai region of Kenya saw the species breeding in earthenware pots of water and feasting on their human hosts. "Every house they'd go into would just be teeming with these mosquitoes," says the Princeton evolutionary biologist Lindy McBride, who has revisited the same sites.

No surprise so far. This was the familiar, human-obsessed *aegypti*. But outside the Rabai houses, researchers spotted another form of *aegypti*. This variant laid its eggs in holes in the trunks of trees, not pots of water; it preferred to bite animals, not people. Yet it wasn't a new species. It was a trace of the ancestral *aegypti*, a relic of a more innocent time.

Scientists have since found undomesticated populations of the species across tropical Africa. They hope to understand not just how the domesticated form picked up its particularly nightmarish set of skills, but how other species might be bending the same way under the same forces. "If we can understand where [*aegypti*] comes from and how it works, the hope is, we can figure out how to stop it," says Noah Rose, a postdoc in McBride's lab at Princeton.

Senegal, especially, might be the key. Starting in 2017, Rose went on a series of road trips across sub-Saharan African countries. In Senegal, Rose teamed up with the ecologist Massamba Sylla, who had already discovered something unique about the country's mosquitoes.

After an hour-and-a-half-long cab ride inland from Dakar, during which I watched the scenery change from very dusty to extremely dusty, I met Sylla in a café in the city of Thiès. Over croissants and café au lait, we flipped through photos from his expeditions on his laptop as he described his lifelong, wife-vexing passion for field entomology. "Once it catches you, you put all your time into doing it," he said.

During his travels, Sylla discovered a pattern. Senegal's climate ranges from desert in the northwest to tropical rainforest in the southeast; as these habitats blend into one another, so do the parasites. In dry cities on the coast such as Saint Louis and Dakar, Sylla and collaborators found only

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domesticated mosquitoes. But in towns in the far southeast, they collected almost exclusively undomesticated mosquitoes, breeding in tree holes or in the husks of fallen fruit. Between the two extremes, Sylla found a continuum of domesticated and undomesticated *aegypti*.

When Rose came to the country in August of 2018, he and Sylla drove along the same gradient, from dry Dakar in the south to where the countryside flushes green and rivers block the roads. The trip was not without risk: A decade earlier, another American researcher working in the southeast with Sylla flew back home before developing flu-like symptoms—Zika, it turned out, which he then transmitted to his wife through sex.

This time, though, no one got sick, and the collection process they followed was alarmingly easy. They collected the eggs in oviposition traps lined with filter paper, upon which the eggs can survive dormant for months. Once back in New Jersey, Rose submerged the eggs in water; most hatched overnight. "You've suddenly just transferred a whole population of mosquitoes between continents," he told me, "with almost no effort expended."

Rose tested mosquitoes from across the Senegal transect and other countries, imprisoning them in plexiglass cages and presenting them with two olfactory options. They could fly down a tube that led to his own arm, or down another that led to a hapless guinea pig. Screens shielded both Rose and the guinea pig from actual bites.

These tests, recently summarized in the study, show that places in northern Senegal near Dakar — with severe dry seasons but crawling with people, who come with their own water supply — host the most human-craving mosquitoes Rose harvested anywhere in Africa. But the country also contains the widest range of *aegypti* behaviors, from almost exclusive animal-biting in the southeast to exclusive human-biting in the northwest. This diversity suggests that Senegal could be where the transformation happened.

Scientists still don't know the specific reasons for the change. But here's one plausible scenario of *aegypti* evolution, described to me by the biologist Jeffrey Powell at Yale University. Imagine a city near or encroaching on the forest. The climate slides into a drought, and animals are scarce. But human communities still offer warm-blooded bodies to drink from and cisterns of clean water to lay eggs in, enough to support *aegypti* until the rains return. Now imagine *aegypti*, over several generations, adapting to this new, more reliable lifestyle.

Some 500 years ago, after our domesticated *aegypti* had evolved in dry coastal cities in Senegal, Angola, and elsewhere on the African continent, European ships arrived on the Atlantic coast and began to carry away human beings. As the global tragedy of slavery unfolded, *aegypti* unleashed itself on the wider world.

Dakar, a French- and Wolof-speaking city clogged with determined street vendors, honking cabs, and clomping horse-drawn carts, was once the administrative center of French West Africa. Now it's Senegal's capital. The larger metropolitan area, home to some 3 million people, is still trying to cram itself onto the Cape Verde peninsula, which curls out into the Atlantic from the westernmost point of Africa like an arm bent at the elbow.

When the Portuguese sailed into the peninsula's enclosed harbor in 1444, the city of Dakar did not exist. For societies living between the Senegal and Gambia Rivers, the Atlantic was a dead end. Trade came instead from the Muslim world to the east. But after Europeans arrived, the slave-trading outposts they built along the African coast began to exert their own gravity.

To meet the European demand for enslaved people, some societies launched massive manhunts against neighbors. Normal economies collapsed. Famines struck, leaving victims so hungry that they offered themselves up to enslavers. "This predatory business, which reduced the producer to an export commodity, pushed Senegambian societies into a state of regression," writes the West African historian Boubacar Barry. "Violence became the dominant motive force of their history."

At staging grounds such as Goree Island, enslavers conducted invasive physical examinations to screen out unhealthy people. After loading their captives on boats, though, they locked many inside the hold in rank, appalling conditions rather than risk having them revolt or jump overboard. Disease and death were rampant. For the crew and a profitable percentage of the captives to survive the two-to-four-month journey across the ocean, the ships also needed to carry dozens of water barrels. The concentrated humanity combined with the abundant standing water offered domesticated *aegypti* everything it needed to stow along.

Meanwhile, the same bottomless avarice that brought enslaved people and *aegypti* to the Caribbean had terraformed their destination. After uprooting indigenous populations, enslavers cleared large areas for sugarcane, then razed even more forest for the fuel they needed to reduce cane juice to crystals. Clearing the dense, moist stands, they assumed,

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would also eliminate the noxious miasmas that they believed to be the ultimate source of disease.

They were wrong. With forests gone, invasive species replaced insect-eating birds. Erosion caused flash floods. Loose sediments collected into marshland, creating new breeding grounds for mosquitoes. Native *Anopheles* mosquitoes ingested the malaria parasite from the blood of incoming West Africans and spread malaria throughout the islands. As for the arriving *aegypti*, it found the Caribbean's ports and sugar plantations teeming with human victims, standing water, and pure cane juice—which the species will also drink in a pinch. By the 1640s, *aegypti* had made itself at home in the islands, and was quietly setting the stage for something worse.

Around this time, the yellow-fever virus must have also made the trip over from Africa, likely volleying between mosquitoes and infected enslaved people or sailors during the long voyage. Yellow fever wreaks special havoc on adult immune systems that have never encountered it before. First victims get flu-like fever and aches for a few days, then appear to recover. Typically this recovery sticks. Otherwise, they get sick again, this time with jaundice—hence the "yellow"—and start vomiting up blood, hence the disease's Spanish name, *vomito negro*.

An early outbreak hit Barbados in 1647, leaving 6,000 people dead before rippling through the rest of the Caribbean. Yellow fever then sloshed from port to port for centuries, borne on silent wings. Ships, ports, and cities formed an invisible circulatory system. In summertime, the yellow-fever virus could materialize far outside its normal range—as in 1793, when one of America's foundational disease outbreaks killed one in 10 Philadelphians and abated only once fall brought frost.

Here *aegypti*, itself shaped by history, began to shape history back. Once established in the Americas, as the historian J. R. McNeill argues in his 2010 book, *Mosquito Empires*, endemic malaria and especially yellow fever gave local populations an advantage against foreign powers, whose soldiers would show up to fight with less seasoned immune systems. All locals had to do was survive outright confrontation—and wait. Yellow fever helped Spain defend its holdings against European competitors; malaria weakened British forces during the American Revolution. When Toussaint L'Ouverture fought to liberate Haiti, yellow fever may have been his staunchest ally.

The domesticated *aegypti* had established itself quickly across the Atlantic, altering the history of the Americas in the process. In 2018, Powell at

Yale published a landmark study showing that mosquito genomes and epidemiological records reflected the historical timeline. "The histories of the slave trade, the mosquito populations, and the disease outbreaks are all telling the same story," he said.

And then *aegypti* kept going. After ships crossed from Africa to the Americas, they headed back to Europe laden with goods such as sugar. Soon, a few mosquitoes likely hitched a ride on this leg of the trip too. In 1801, Spain's queen consort, Maria Luisa de Parma, suffered from a disease she called dengue. Around then, *aegypti* was making itself comfortable in the Mediterranean, and would go on to cause outbreaks of yellow fever and dengue there for decades. When the Suez Canal opened in 1869, it offered the species a back way out of the Mediterranean into the Pacific. Before that century's end, the first clear outbreaks of chikungunya and dengue had appeared in Asia.

Meanwhile, yellow fever kept burning through the tropics. Nobody even knew what carried it until the 1880s, when a Cuban doctor named Carlos Finlay made a then-preposterous proposal: Maybe mosquitoes caused these outbreaks. The U.S. Army pathologist Walter Reed proved Finlay's theory in 1900, finally giving humans a chance to slow the spread of the disease by putting up screens and getting rid of standing water. Between then and now, though, the sun still hasn't set on *aegypti*'s empire.

Yellow fever itself has been mostly brought to heel. The breakthrough came in 1928, when competing American, French, and English research teams across Africa convened in Dakar to discuss the tragic case of one Adrian Stokes.

After France had abolished slavery in Senegal, in 1848, the colonial government conquered inland states and set up peanut farms, devising new systems to profit from African labor that soon expanded into other colonies. "Senegal was a laboratory for the European powers," says Mor Ndao, a historian of tropical medicine at Dakar's Cheikh Anta Diop University.

Disease stood in their way. Yellow fever "was an obstacle for the exploitation of the African continent," Ndao told me. Senegal's coastal cities had long been gripped by their own yellow-fever outbreaks, which public officials and even scientists invoked to justify race- and class-based "sanitary" segregation long after the mosquito hypothesis had proved what really carried the disease. But the death of Stokes, an Irish pathologist, offered a new way forward.

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The year before, in 1927, Stokes had contracted yellow fever while helping isolate the virus from the blood of a Ghanaian man named Asibi. The pathologist demanded that his colleagues draw his blood and let mosquitoes bite him. Injections of that blood and bites from those mosquitoes both caused fatal yellow-fever cases in monkeys, proving that the team really had captured the infectious substance itself. Stokes died four days after contracting the virus, and was buried in Lagos. He was the first author on the pivotal scientific paper.

Upon hearing of this success, the French team at the Pasteur Institute isolated their own strain from a local patient named Francois Mayali. After sharing their findings in the Dakar meeting, multiple groups of scientists started working on vaccines. Mass vaccination campaigns began in the following decades, pushing yellow fever and its bloodsucking vector out of mind and making the tropics less scary for Ndao's would-be exploiters. Today, virtually every yellow-fever vaccine, including the one I got before visiting Dakar, bears a hint of these colonial beginnings: They still use a watered-down version of the strain taken from Asibi.

With the world's attention diverted, this win soured. During the past century, similar viruses emerged from forests in Africa and Asia. Reaching urban areas, they all found *aegypti* ready to ferry them from person to person. First came dengue, which leaked out into a bigger global problem as southeast Asia urbanized after World War II. Then in 2006, more than a million people in India may have caught chikungunya. This past decade, Zika emerged on a similar scale in the Americas. Even yellow fever—still the only *aegypti*-carried disease with a safe, publicly available vaccine—has staged a comeback: two African outbreaks in 2016.

All this, remember, wrought by what were once inoffensive forest insects.

Rose's study projects that Africa's milder, wilder populations of *aegypti* may crank up their own appetite for humans by 2050, as dense cities spring up across the continent. In response to that alarming forecast, a new collaboration of scientists from across the Sahel, the semiarid region south of the Sahara, is collecting more local eggs—but that research has gotten off to a slow start thanks to COVID-19 and extremist groups in the region, Rose says.

Perhaps a deeper worry is that thousands of other mosquito species out there have their own capacity to change. During the Second World War, when Londoners hid in the city's Underground tunnels to escape bombing during the Blitz, they were swarmed by a form of the mosquito *Culex pipiens* that had already adapted to the world's oldest subway system.

That same pest now haunts subterranean Manhattan. And just in the past four decades, *Aedes albopictus*, an *aegypti* cousin from Southeast Asia that carries many of the same diseases, has exploded its range through Europe, Africa, and the Americas.

Not to mention unknown others. "We could be missing the tip of the iceberg here," says Scott Weaver, who directs the Institute for Human Infections and Immunity at the University of Texas. "I think understanding *aegypti*, as a first step, will be very important."

As we approached the island, a crumbling stone fort with grass growing on top came into view, then a few buildings painted in fading pastels. Then a dock next to a small beach. The ferry engine kicked into reverse, sending a deep rumble through the deck.

This is Goree Island. Within sight of Dakar, it's the kind of place where *aegypti* likely hitched a ride across the Atlantic. A UNESCO World Heritage Site, the island is already steeped in the global memory of slavery. First established as a coastal base by the Portuguese, Goree was controlled by the Dutch, the British, and the French until Senegal achieved independence in 1960.

After disembarking and buying admission to Goree, I headed southeast, passing a massive baobab tree and a few lounging stray kittens on my way to a museum called the House of Slaves. Since the 1990s, historians have argued that Goree was a relatively minor location in the overall slave trade—that perhaps "only" 33,000 captive human beings came through the island—and that the role of this specific house might have been mostly symbolic.

But memory, once established, doesn't work that way. The three U.S. presidents before the current one came here, and when Nelson Mandela visited, the story is that he sat by himself for five minutes in a cramped chamber marked for "recalcitrant" captives—and then came out shaken, his eyes red.

After the entrance, visitors pass through a pink courtyard. The ground floor under the house is divided by stone walls into various dim holding chambers, each room labeled by the museum with a sign in French: "women," "children," "the sick." Running your hand along the wall, you can feel the occasional seashell embedded in the stone.

Behind the house, visitors paused for selfies in the Door of No Return, an empty frame backlit by the sky and ocean. I waited my own turn. The

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conceit here is that anyone kept under this house and then led through that door never came back. Their world was forever altered. The wider world was also altered, both by the tragedy of slavery and by its still-unfolding consequences, among them 400 million annual infections.

For this insect problem, at least, fixes are in the works. By asking questions about where *aegypti* came from, scientists such as Diallo and Sylla in Senegal and their overseas colleagues hope to save lives too. Understanding *aegypti*'s evolution on its home turf might also help us anticipate and counter copycat trends in other mosquitoes or disease-vector species. And unraveling why *aegypti* and its viruses are so good at parasitizing us could also help us fight them.

For example, if McBride can pinpoint the genes and neurological systems that control the domesticated *aegypti*'s fixation on people, hijacking that system to find new chemical repellents could be easier. So would crafting new kinds of bait, which would manipulate *aegypti* to avoid populated areas and head elsewhere. "We might be able to design a super-stimulus that would be more attractive than humans, that would pull them into traps," she says.

But the limiting factors in 2020 are focus and funding, especially with another virus falling on the world like an anvil. "I'm optimistic that people are finally understanding we can't continue this boom-and-bust funding cycle," Weaver says, "where a new outbreak occurs and we put a lot of resources into that virus—whether it be chikungunya, or Zika, now SARS-CoV-2—and we do that by taking away resources from other diseases."

For now, though, public-health systems across the Global South have also been diverted to coronavirus work, scientists say, leaving papers unpublished and mosquitoes uncollected. And whereas vaccines for Zika and chikungunya have been in development for many years, the fact that the outbreaks of those diseases are unpredictable and their victims clustered in poorer countries—unlike those of the more widespread COVID-19—means that the vaccines are difficult to test and less lucrative for the pharmaceutical industry, and thus still haven't made it to market.

As for engineering options to target the mosquitoes themselves, new technologies are already out in the world, aiming to reshape this little critter at the nexus of so much suffering.

One option is a bacterium called *Wolbachia,* bred into laboratory *aegypti* and then into wild populations. A greedy pathogen itself, the bacteria competes with the viruses that want to piggyback on

the mosquito's life cycle. Tested in Indonesia, Malaysia, and even in Fresno, California, it reduces the mosquito's ability to spread disease.

An even more formidable option might be the gene drive, a type of genetic modification that would spread altered genes from a few sterile or disease-free mosquitoes throughout entire wild populations. The method is undergoing preliminary testing in Burkina Faso and elsewhere, and *aegypti* is high on the list of potential targets.

Meanwhile, less fancy kinds of genetically altered *aegypti* are already out in the wild. From 2013 to 2015, for example, one mosquito-control program released millions of modified male mosquitoes designed by a British company called Oxitec in the city of Jacobina, Brazil. The idea was that when they mated with wild females, the resulting offspring would die in infancy, causing populations to plummet—which they did.

Apparently, though, not all those doomed offspring actually died. Some found a way to live and breed, passing on little bits of themselves. As Powell and other researchers pointed out in an eyebrow-raising study this past September, the wild *aegypti* population near Jacobina now contains a sprinkling of mosquito genes from Mexico and Cuba, where the Oxitec mosquitoes' ancestors were harvested.

This crossbreeding might have actually strengthened the Jacobina *aegypti*, the study suggested—sparking a media firestorm, a fierce response from Oxitec, and concern from several of Powell's Brazilian co-authors. "I thought I was pretty conservative," Powell said, "but it seems like that got blown out of hand." This summer, both the U.S. Environmental Protection Agency and the state of Florida granted Oxitec permits to begin releasing a version of the same technology in the Florida Keys, although there are still regulatory hurdles to clear.

As we continue to influence its evolution, *aegypti,* as it always does, is beginning to respond. Standing on Goree Island, though, I didn't think much about the wizardry of all these fixes in the works, or the engineering required, or the consideration of known and unknown consequences. Instead, I took a moment to dwell on what has already happened.

And maybe with this past in mind, or maybe because of a simpler superstition, I didn't walk through the threshold of the Door of No Return

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when I got to it. I just stood there, blinking in the light, looking out at the turquoise waves.

theatlantic.com, 20 August 2020

https://www.theatlantic.com

Earth has lost 28 trillion tonnes of ice in less than 30 years

2020-08-23

A total of 28 trillion tonnes of ice have disappeared from the surface of the Earth since 1994. That is stunning conclusion of UK scientists who have analysed satellite surveys of the planet's poles, mountains and glaciers to measure how much ice coverage lost because of global heating triggered by rising greenhouse gas emissions.

The scientists – based at Leeds and Edinburgh universities and University College London – describe the level of ice loss as "staggering" and warn that their analysis indicates that sea level rises, triggered by melting glaciers and ice sheets, could reach a metre by the end of the century.

"To put that in context, every centimetre of sea level rise means about a million people will be displaced from their low-lying homelands," said Professor Andy Shepherd, director of Leeds University's Centre for Polar Observation and Modelling.

The scientists also warn that the melting of ice in these quantities is now seriously reducing the planet's ability to reflect solar radiation back into space. White ice is disappearing and the dark sea or soil exposed beneath it is absorbing more and more heat, further increasing the warming of the planet.

In addition, cold fresh water pouring from melting glaciers and ice sheets is causing major disruptions to the biological health of Arctic and Antarctic waters, while loss of glaciers in mountain ranges threatens to wipe out sources of fresh water on which local communities depend.

"In the past researchers have studied individual areas – such as the Antarctic or Greenland – where ice is melting. But this is the first time anyone has looked at all the ice that is disappearing from the entire planet," said Shepherd. "What we have found has stunned us."

The researchers' conclusion is that all the regions have suffered devastating reductions in ice cover in the past three decades and these losses are continuing.

The level of ice loss revealed by the group matches the worst-case-scenario predictions outlined by the Intergovernmental Panel on Climate Change (IPCC), he added.

The group studied satellite surveys of glaciers in South America, Asia, Canada and other regions; sea ice in the Arctic and Antarctic; ice sheets that cover the ground in Antarctica and Greenland; and ice shelves thatprotrude from the Antarctic mainland into the sea. The study covered the years 1994 to 2017.

The researchers' conclusion is that all the regions have suffered devastating reductions in ice cover in the past three decades and these losses are continuing.

"To put the losses we've already experienced into context, 28 trillion tonnes of ice would cover the entire surface of the UK with a sheet of frozen water that is 100 metres thick," added group member Tom Slater from Leeds University. "It's just mind-blowing."

As to the cause of these staggering losses, the group is adamant: "There can be little doubt that the vast majority of Earth's ice loss is a direct consequence of climate warming," they state in their review paper, which is published in the online journal *Cryosphere Discussions*.

"On average, the planetary surface temperature has risen by 0.85C since 1880, and this signal has been amplified in the polar regions," they state. Both sea and atmospheric temperatures have risen as a result and the resulting double whammy has triggered the catastrophic ice losses uncovered by the group.

In the case of the melting ice sheet in Antarctica, rising sea temperatures have been the main driver while increasing atmospheric temperatures have been the cause of ice loss from inland glaciers such as those in the Himalayas. In Greenland, ice loss has been triggered by a combination of both sea and atmospheric temperatures increasing.

The team stressed that not all the ice that was lost over that period would have contributed to sea level rises. "A total of 54% of the lost ice was from sea ice and from ice shelves," said Leeds University researcher Isobel Lawrence. "These float on water and their melting would not have contributed to sea level rises. The other 46% of meltwater came from glaciers and ice sheets on the ground, and they would have added to sea level rise."

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The group's results were published 30 years after the first assessment report of the IPCC was published, at the end of August 1990. This outlined, in stark terms, that global warming was real and was being triggered by increasing emissions of greenhouse gases from the burning of fossil fuels.

Despite warnings from scientists, these emissions have continued to rise as global temperatures continued to soar. According to figures released by the Met Office last week, there was a 0.14C increase in global temperatures between the decade 1980-89 and the decade 1990-1999, then a 0.2C increase between each of the following decades. This rate of increase is expected to rise, possibly to around 0.3C a decade, as carbon emissions continue on their upward trajectory.

theguardian.com, 23 August 2020

https://www.theguardian.com

Nano-diamond self-charging batteries could disrupt energy as we know it

2020-08-25

California company NDB says its nano-diamond batteries will absolutely upend the energy equation, acting like tiny nuclear generators. They will blow any energy density comparison out of the water, lasting anywhere from a decade to 28,000 years without ever needing a charge. They will offer higher power density than lithium-ion. They will be nigh-on indestructible and totally safe in an electric car crash. And in some applications, like electric cars, they stand to be considerably cheaper than current lithium-ion packs despite their huge advantages.

The heart of each cell is a small piece of recycled nuclear waste. NDB uses graphite nuclear reactor parts that have absorbed radiation from nuclear fuel rods and have themselves become radioactive. Untreated, it's high-grade nuclear waste: dangerous, difficult and expensive to store, with a very long half-life.

This graphite is rich in the carbon-14 radioisotope, which undergoes beta decay into nitrogen, releasing an anti-neutrino and a beta decay electron in the process. NDB takes this graphite, purifies it and uses it to create tiny carbon-14 diamonds. The diamond structure acts as a semiconductor and heat sink, collecting the charge and transporting it out. Completely encasing the radioactive carbon-14 diamond is a layer of cheap, non-radioactive, lab-created carbon-12 diamond, which contains the energetic

They will blow any energy density comparison out of the water, lasting anywhere from a decade to 28,000 years without ever needing a charge.

particles, prevents radiation leaks and acts as a super-hard protective and tamper-proof layer.

To create a battery cell, several layers of this nano-diamond material are stacked up and stored with a tiny integrated circuit board and a small supercapacitor to collect, store and instantly distribute the charge. NDB says it'll conform to any shape or standard, including AA, AAA, 18650, 2170 or all manner of custom sizes.

And so what you get is a tiny miniature power generator in the shape of a battery that never needs charging – and that NDB says will be cost-competitive with, and sometimes significantly less expensive than – current lithium batteries. That equation is helped along by the fact that some of the suppliers of the original nuclear waste will pay NDB to take it off their hands.

Radiation levels from a cell, NDB tells us, will be less than the radiation levels produced by the human body itself, making it totally safe for use in a variety of applications. At the small scale, these could include things like pacemaker batteries and other electronic implants, where their long lifespan will save the wearer from replacement surgeries. They could also be placed directly onto circuit boards, delivering power for the lifespan of a device.

In a consumer electronics application, NDB's Neel Naicker gives us an example of just how different these devices would be: "Think of it in an iPhone. With the same size battery, it would charge your battery from zero to full, five times an hour. Imagine that. Imagine a world where you wouldn't have to charge your battery at all for the day. Now imagine for the week, for the month… How about for decades? That's what we're able to do with this technology."

And it can scale up to electric vehicle sizes and beyond, offering superb power density in a battery pack that is projected to last as long as 90 years in that application – something that could be pulled out of your old car and put into a new one. If part of a cell fails, the active nano diamond part can be recycled into another cell, and once they reach the end of their lifespan – which could be up to 28,000 years for a low-powered sensor that might, for example, be used on a satellite – they leave nothing but "harmless byproducts."

In the words of Dr. John Shawe-Taylor, UNESCO Chair and University College London Professor: "NDB has the potential to solve the major global issue of carbon emissions in one stroke without the expensive

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infrastructure projects, energy transportation costs, or negative environmental impacts associated with alternate solutions such as carbon capture at fossil fuel power stations, hydroelectric plants, turbines, or nuclear power stations. Their technology's ability to deliver energy over very long periods of time without the need for recharging, refueling, or servicing puts them in an ideal position to tackle the world's energy requirements through a distributed solution with close to zero environmental impact and energy transportation costs."

Indeed, the NDB battery offers an outstanding 24-hour energy proposition for off-grid living, and the NDB team is adamant that it wishes to devote a percentage of its time to providing it to needy remote communities as a charity service with the support of some of the company's business customers.

Should the company chew right through the world's full supply of carbon-14 nuclear waste – a prospect that would take some extremely serious volume – NDB says it can create its own carbon-14 raw material simply and cost-effectively.

The company claims to have completed a proof of concept, and is ready to begin building its commercial prototype once its labs reopen after COVID shutdown. A low-powered commercial version is expected to hit the market in less than two years, and the high-powered version is projected for five years' time. NDB says it's well ahead of its competition with patents pending on its technology and manufacturing processes.

Should this pan out as promised, it's hard to see how this won't be a revolutionary power source. Such a long-life battery would fundamentally challenge the disposable ethos of many modern technologies, or lead to battery packs that consumers carry with them from phone to phone, car to car, laptop to laptop across decades. NDB-equipped homes can be grid-connected or not. Each battery is its own near-inexhaustible green energy source, quietly turning nuclear waste into useful energy.

Sounds like remarkable news to us!

newatlas.com, 15 August 2020

https://www.newatlas.com

The record is a fifth faster than the previous one set by researchers in Japan, and it shows how close we are to even faster, more affordable internet access.

Researchers found a way to download Netflix's entire catalog in less than a second

2020-08-26

Researchers at University College London (UCL) published a paper in the September issue of *IEEE* showing how they set the new world record for the fastest internet, according to *Gizmodo*. At a speed of 178 terabits or 178,000,000 megabits per second, their new fiber optics broadband can transfer 222 Ultra HD Blu-rays in a second. The record is a fifth faster than the previous one set by researchers in Japan, and it shows how close we are to even faster, more affordable internet access.

HOW DID THEY DO IT? — Compared to the fiber optics in use around the world, the new record doubles capacity by using a wider range of wavelengths and optimizing the overall transmission process, including noise reduction.

Fibers with rare-Earth elements were inserted into the glass core of an optical cable to increase the light's ability to travel long distances. Meanwhile, discrete Raman amplifier technology improves the power of the signal sent through the fiber optic lines. As a result, the data can move more efficiently with a decreased need for repeaters.

WHAT THIS MEANS FOR YOUR INTERNET — Replacing fiber optics infrastructure is extraordinarily more expensive than simply updating the amplifiers within existing cables. Following *Gizmodo's* exchange rate of the researchers calculations, new cables would cost approximately $594,000 per 0.62 miles while upgrading amplifiers every 25-62 miles would only cost $21,100. Comparatively, Google's Faster cable connecting Japan and the U.S.'s West Coast is nearly three times slower and cost $300 million to build.

The ability to perform these cost-effective upgrades would help networks, from cell networks to your home's broadband, make huge leaps in speed in a short amount of time. Though it's not clear when this technology might be implemented, the pandemic has put a spotlight on internet infrastructure around the world.

"Independent of the COVID-19 crisis, internet traffic has increased exponentially over the last 10 years and this whole growth in data demand is related to the cost per bit going down," said lead author Dr. Lidia Galdino, UCL lecturer and Royal Academy of Engineering research fellow, to UCL. "The development of new technologies is crucial to maintaining this trend towards lower costs while meeting future data rate demands

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that will continue to increase, with as yet unthought-of applications that will transform people's lives."

inputmag.com, 26 August 2020

https://www.inputmag.com

Remdesivir disappoints. Again.

2020-08-24

On Wednesday April 29th the Dow Jones Industrial Average rose 532 points on news that Gilead's remdesivir demonstrated a "clear-cut positive effect» in treating COVID. The effect may have been clear-cut, but that didn›t mean that the magnitude of the effect was sufficient to take the steam out of the pandemic.

Indeed, on April 30 I pointed out (See Remdesivir 1st Controlled Trial Is No Cause For Celebration) that although the drug did provide a modest decrease in the hospital stay of the patients who received it **(1)**, we were hardly witnessing a "Jonas Salk moment."

It was not unreasonable to expect that patients with less severe disease would stand to benefit more.

Perhaps we were expecting too much in that case. After all, the patients who received the drug were very ill and it's not clear whether their condition was due to the virus, the body's deadly immune response, or both. It was not unreasonable to expect that patients with less severe disease would stand to benefit more.

Such an assumption may be reasonable but that doesn't mean that it would be correct. And based on a new JAMA paper it seems clear that patients with moderate disease received little or no benefit from the drug. Disappointing? Yes. Surprising? No. The drug did little or nothing. Here are the details.

An 11-day randomized Phase 3 trial of almost 600 patients, all with moderate COVID, was conducted to compare the clinical status **(2)** of three groups (~200 patients each) on day 11:

patients who received remdesivir for 5 days

patients who received remdesivir for 10 days

patients who received standard care

The findings were a bit strange. On day 11, patients who had received five days of remdesivir showed a *statistically significant* improvement compared to those who received standard care but not a *clinically*

significant difference. And the patients who received a 10-day course **(3)** of the drug experienced no difference, either statistically or clinically.

The conclusion, as stated by the authors, is rather obvious:

Among patients with moderate COVID-19, those randomized to a 10-day course of remdesivir did not have a statistically significant difference in clinical status compared with standard care at 11 days after initiation of treatment. Patients randomized to a 5-day course of remdesivir had a statistically significant difference in clinical status compared with standard care, but the difference was of uncertain clinical importance.

D. Brainard, MD, et.al., JAMA. Published online August 21, 2020. doi:10.1001/jama.2020.16349

NOW, WHAT?

Two clinical trials involving more than 1,600 patients have shown effects ranging from none to modest. It is difficult to imagine that the hopes of remdesivir being a silver bullet to conquer COVID will ever be realized, at least not as an IV treatment for hospitalized patients. But it is still possible that the drug hasn't been given a fair shake. As a direct-acting antiviral, early administration is important and no patients in either of these trials were given the drug until they were already hospitalized and quite ill. It is possible (perhaps even likely) that no antiviral drug, no matter how potent, will be able to alter the course of COVID when given days/weeks after the start of the infection. Perhaps the best shot for remdesivir would be very early administration, perhaps as in inhaled powder after a rapid diagnostic saliva test. (Gilead is working on a dry powder formulation.)

Or, more likely, as is the case in drug discovery, the first drug to treat a condition or infection is *rarely* the best. The first HIV/AIDS drug, AZT, did little or nothing to prolong the lives of AIDS patients after one year of therapy. The first direct-acting hepatitis C drugs, boceprevir and telaprevir (2011) were relegated to the antiviral scrap heap within a couple of years as they were replaced by the much superior Sovaldi, which itself has been replaced by more potent drug combinations. Such is the nature of drug discovery,

If a game-changing COVID antiviral drug is *ever* found, it is quite possible that it doesn›t exist yet.

acsh.org, 24 August 2020

https://www.acsh.org

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Dust can spread influenza among guinea pigs, raising coronavirus questions

2020-08-18

Spewing virus-laden droplets may not be the only way animals can spread some viruses through the air. Viruses like influenza might also hitch a ride on dust and other microscopic particles, a study in guinea pigs suggests.

People can transmit respiratory viruses, like the ones that cause flu and COVID-19, just by talking, coughing and sneezing (*SN: 4/2/20*). Virus-contaminated surfaces, called fomites, can also cause infection when people touch the surface and then their nose or mouth. Now new research suggests that dust particles kicked up from those contaminated surfaces, called aerosolized fomites, may also spread such respiratory viruses.

"Our work suggests that there is a mode of [virus] transmission that is underappreciated" for influenza, says William Ristenpart, a chemical engineer at the University of California, Davis. "It's not on [scientists'] radar."

Viruses like influenza might also hitch a ride on dust and other microscopic particles, a study in guinea pigs suggests.

Though the study, published August 18 in *Nature Communications*, did not include the new coronavirus, or SARS-CoV-2, the finding could have implications for that virus too, Ristenpart says. Researchers are still figuring out all the ways the coronavirus spreads, including debating how much smaller respiratory droplets that remain in the air, called aerosols, might contribute to transmission (*SN: 7/7/20*). Hantavirus, which causes a deadly respiratory disease, can also be transmitted through kicked up dust that is contaminated with rodent droppings. But that virus doesn't pass from person-to-person.

In the new study, Ristenpart and his colleagues infected guinea pigs with influenza virus. Two days later, the team found infectious influenza viruses in cages as well as on guinea pig fur, ears and paws. Infected guinea pigs don't cough or sneeze like people do, so the virus may have spread when the rodents groomed, rubbed their noses or moved around the cage.

The researchers then used a paintbrush to coat virus on animals that had already been infected and were immune. Each virus-covered rodent was put in a cage separate from, but attached to, a cage housing an uninfected companion. The setup ensured that the only way to spread the virus from one animal to another was through the air.

Although the flu-covered immune rodents were not breathing virus into the air, the flu still spread among three of 12 guinea pig pairs. The newly

infected animals may have gotten infected from aerosolized fomites in dust kicked up from bedding or fur, the study suggests.

Airborne dust

Some common items people use could be potential vehicles to spread respiratory viruses via aerosolized fomites, or dust kicked up from contaminated surfaces. The graph shows the number of particles emitted per second over time when rubbing together pieces of toilet paper (blue), paper towel (red) and lab wipes (black) to produce dust.

"It's not that all dust is infectious," Ristenpart says, but "dust liberated from a virus-laden surface" may be.

In human settings, that dust might come from used tissues, sheets or blankets. Or perhaps from a doctor's personal protective equipment or a cloth mask. In a preliminary study that has not yet been reviewed by other researchers, Ristenpart and his team found that homemade cotton masks can shed minuscule particles when people breathe, making them a potential source for aerosolized fomites.

It's unclear what the results might mean for respiratory virus transmission among humans. While it is possible that aerosolized fomites might spread influenza, people would still need to breathe the virus in to get infected, says Julian Tang, a virologist and fluid dynamicist at the University of Leicester in England who was not involved in the work. Dust from guinea pig bedding may be aerosolized much more easily than from a medical professional's personal protective equipment or bed sheets. So compared with airborne influenza virus — or SARS-CoV-2 — in exhaled breath, "I'm really not convinced that in humans, this aerosolized fomite route will play any [major] role," Tang says.

sciencenews.org, 18 August 2020

https://www.sciencenews.org

How 'elite controllers' tame HIV without drugs

2020-08-26

A tiny fraction of the 38 million HIV-infected people in the world have what seems like a superpower. Without the help of antiretroviral (ARV) drugs, they keep the AIDS virus at undetectable levels in their blood, sometimes for many years, even though they still have HIV genes woven into their chromosomes. Now, the most in-depth genomic analysis of these rare individuals, who account for less than 0.5% of all HIV infections,

All but one of the 64 "elite controllers" analyzed in the new research have abundant and intact HIV genomes, so-called proviruses, integrated in their cells

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reveals a clue to their success, which scientists hope will ultimately lead to new strategies to corral the virus in others.

All but one of the 64 "elite controllers" analyzed in the new research have abundant and intact HIV genomes, so-called proviruses, integrated in their cells. But compared with people who have to take ARVs, elite controllers have far more proviruses in chromosome regions where little gene activity occurs, the study finds. Somehow these people have eliminated infected cells with proviruses parked in areas where they more readily co-opt the cellular machinery needed to copy themselves. As a result, elite controllers' immune systems can handle for prolonged periods—decades in some cases—the low levels of HIV they presumably do produce.

The "comprehensive and elegant study" provides "nature's proof of principle of how a functional cure [for HIV] is possible," says Beatrice Hahn, a virologist at the University of Pennsylvania. The challenge now is to identify how to translate this elite controller trick to the far larger HIV-infected population, but the new study "gives us a blueprint," says Mathias Lichterfeld, an infectious disease physician at Brigham and Women's Hospital and a co-author of the work, published today in *Nature*.

When people on ARVs stop the drugs, HIV typically floods their blood within weeks, as "reservoirs" of proviruses in various cells and tissues spring into action. As a result, HIV cure researchers long have attempted to reduce the size of these reservoirs. But the *Nature* study, led by immunologist Xu Yu of the Ragon Institute of MGH, MIT and Harvard, suggests the size of a reservoir may be less important than limiting proviruses to quiescent chromosome homes.

HIV typically splices its provirus into a cell's genes, which make up only 1% of the human genome. That helps the virus co-opt the gene transcription machinery needed to churn out new HIVs. But when Yu and colleagues pinpointed the location of nearly 4000 proviruses in cells from the elite controllers and 42 people on ARVs, they found a striking difference. In elite controllers, 45% of the proviruses reside in "gene deserts," regions of chromosomes where little transcription occurs. In people on ARVs, the number was 17%.

Studies probing how elite controllers manage HIV often are more intriguing than convincing because they rarely include more than a handful from that group. The fact that dozens were examined in the new work impresses Hahn. "Whoever decided to make a concerted effort to compile this cohort is a genius," she says.

One member of the cohort presents an extreme case: what amounts to a natural cure. The woman, Loreen Willenberg, who was diagnosed as HIV positive in 1992 yet remains healthy without ARVs, had the lowest levels of proviruses of anyone in the study. What's more, the only proviruses found among the billions of her cells studied were incapable of producing new HIVs. "We did not do integration site analysis on [her] samples, because there's no intact provirus, and even the defective proviruses were so rare in her genome," Yu says. (The only other widely accepted HIV cures involve two infected men whose immune systems were destroyed—to treat cancer—and who then received immune cells resistant to the virus.)

Willenberg has a seemingly unharmed immune system despite her untreated HIV infection. She has had her blood levels of HIV monitored for 24 years and has only had one detectable burst of viral replication, when she had a bad bout of the flu. Intensively studied by many HIV scientists, Willenberg nearly 15 years ago established a foundation that helps elite controllers, some of whom joined this clinical study. "If there were some way that this unique state of natural control of HIV infection could be somehow understood and then translated to individuals who did not spontaneously control HIV infection, then that's what I had to do," she says.

Previous studies of Willenberg and other elite controllers suggest they frequently have a genetic predisposition to mount stronger immune responses against the virus. Yu and her co-authors suspect this response selectively targeted cells with the most fit proviruses, tilting controllers' reservoirs toward their hamstrung relatives. A better understanding of this evolutionary immune process might be key to interventions that, in effect, create more elite controllers.

HIV cure studies to date have largely attempted to prod latent proviruses into making new viruses, theoretically setting up those cells for elimination and steadily reducing the size of the reservoir. But this "shock and kill" strategy has had little success, and Lichterfeld would now like to assess cure interventions by quantifying how much they shift the proviral reservoir from gene regions to gene deserts.

Steven Deeks of the University of California, San Francisco, another author on the paper, says the new findings could help the elite controllers. Because of worry that they may suffer chronic inflammation from low levels of HIV replication, many doctors advise this group to still take ARVs. If they have a relatively high level of proviruses in gene deserts, it may be safe for them to stop treatment. "A lot of them now are getting medication they don't need," Deeks says.

sciencemag.org, 26 August 2020

https://www.sciencemag.org

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Improved three-week weather forecasts could save lives from disaster

2020-08-27

Weather forecasters in the Philippines got the tip-off in the second week of November 2019. A precipitation forecast that peered further into the future than usual warned that the islands faced torrential rains more than three weeks away. The meteorologists alerted local and national governments, which sprang into action. Mobile phone and broadcast alerts advised people to prepare to evacuate.

By the time the Category 4 Typhoon Kammuri lashed the Philippines with heavy rains in early December, the damage was much less than it could have been. Having so much time to prepare was key, says Andrew Robertson, a climate scientist at Columbia University's International Research Institute for Climate and Society in Palisades, N.Y. "It's a great example of how far we've come" in weather forecasting, he says. "But we still need to go further."

Such efforts, known as "subseasonal forecasting," aim to fill a crucial gap in weather prediction. The approach fits between short-term forecasts that are good out to about 10 days in the future and seasonal forecasts that look months ahead.

A subseasonal forecast predicts average weather conditions three to four weeks away. Each day of additional warning gives emergency managers that much more time to prepare for incoming heat waves, cold snaps, tornadoes or other wild weather. Groups such as the Red Cross are starting to use subseasonal forecasts to strategize for weather disasters, such as figuring out where to move emergency supplies when it looks like a tropical cyclone might hit a region. Farmers look to subseasonal forecasts to better plan when to plant and irrigate crops. And operators of dams and hydropower plants could use the information to get ready for extra water that may soon tax the systems.

Subseasonal forecasting is improving slowly but steadily, thanks to better computer models and new insights about the atmospheric and oceanic

The approach fits between short-term forecasts that are good out to about 10 days in the future and seasonal forecasts that look months ahead.

patterns that drive weather over the long term. "This is a new frontier," says Frédéric Vitart, a meteorologist at the European Centre for Medium-Range Weather Forecasts in Reading, England.

On target

A forecast made in the second week of November (top) foresaw heavy rains coming more than three weeks later over the Philippines, which did indeed arrive as Typhoon Kammuri (actual path shown, bottom).

Weather forecasters are always pushing to do better. They feed weather observations from around the world into the latest computer models, then wait to see what the models spit out as the most likely weather in the coming days. Then the researchers tweak the model and feed it more data, repeating the process again and again until the forecasts improve.

But anyone who tells you it will be 73° Fahrenheit and sunny at 3 p.m. four weeks from Monday is lying. That's just too far out in time to be accurate. Short-term forecasts like those in your smartphone's weather app are based on the observations that feed into them, such as whether it is currently rainy in Northern California or whether there are strong winds over central Alaska. For forecasting further into the future, what the rain or winds were like many days ago becomes less and less relevant. Most operational weather forecasts are good to about 10 to 14 days but no further.

A few times a year, forecasters draw up seasonal predictions, which rely on very different types of information than the current weather conditions that feed short-term forecasts. The long-term seasonal outlooks predict whether it will be hotter or colder, or wetter or drier, than normal over the next three months. Those broad-brush perspectives on how regional climate is expected to vary are based on slowly evolving planetary patterns that drive weather over the scale of months. Such patterns include the intermittent oceanic warming known as El Niño, the extent of sea ice in the Arctic Ocean and the amounts of moisture in soils across the continents.

Between short-term and seasonal prediction lies the realm of subseasonal prediction. Making such forecasts is hard because the initial information that drives short-term forecasts is no longer useful, but the longer-term trends that drive seasonal forecasts have not yet become apparent. "That's one of the reasons there's so much work on this right now," says Emily Becker, a climate scientist at the University of Miami in Florida. "We just ignored it for decades because it was so difficult."

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Room to improve

Short-term weather predictions and longer-term seasonal forecasts are relatively good. People need something in between, so researchers are trying to improve subseasonal forecasts, which look ahead a few weeks, using information from many sources, including predictable weather systems.

Part of the challenge stems from the fact that many patterns influence weather on the subseasonal scale — and some of them aren't predictable. One pattern that scientists have been targeting lately, hoping to improve predictions of it, is a phenomenon known as the Madden-Julian Oscillation, or MJO.

The MJO isn't as well-known as El Niño, but it is just as important in driving global weather. A belt of thunderstorms that typically starts in the Indian Ocean and travels eastward, the MJO can happen several times a year. An active MJO influences weather around the globe, including storminess in North America and Europe. Subseasonal forecasts are more likely to be accurate when an MJO is happening because there is a major global weather pattern that will affect weather elsewhere in the coming weeks.

But there's still a lot of room for prediction improvement. The computer models that simulate weather and climate aren't very good at capturing all aspects of an MJO. In particular, models have a hard time reproducing what happens to an MJO when it hits Southeast Asia's mix of islands and ocean known as the Maritime Continent. This realm — which includes Indonesia, the Philippines and New Guinea — is a complex interplay of land and sea that meteorologists struggle to understand. Models typically show an MJO stalling out there rather than continuing to travel eastward, when in reality, the storms usually keep going.

Distant effects

The Madden-Julian Oscillation is a pattern of storms that usually forms several times a year in tropical latitudes and can have weather repercussions around the globe. The MJO travels eastward along the equator as winds push warm, wet air high into the atmosphere, where the air dries out, cools and descends back toward the surface.

At Stony Brook University in New York, meteorologist Hyemi Kim has been trying to understand why models fail around the Maritime Continent. Many of the models simulate too much light precipitation in the tropics, she found. That light drizzle dries out the lower atmosphere, contributing

to the overly dry conditions favored in these models. As a result, when the MJO reaches the Maritime Continent, the dryness of most models prevents the system from marching eastward, Kim and colleagues reported in August 2019 in the *Journal of Geophysical Research: Atmospheres*. In real life, that rain doesn't happen. With this better understanding of the difference between models and observations in this region, researchers hope to build better forecasts for how a particular MJO might influence weather around the world.

"If you can predict the MJO better, then you can predict the weather better," Becker says. Fortunately, scientists are already making those tweaks, by developing finer-grained computer models that do a better job capturing how the atmosphere churns in real life.

Meteorologist Victor Gensini of Northern Illinois University in DeKalb led a recent project to use the MJO, among other factors, to forecast tornado outbreaks in the central and eastern United States two to three weeks in advance. As the MJO moves across and out of the Maritime Continent, it triggers stronger circulation patterns that push air toward higher latitudes. The jet stream strengthens over the Pacific Ocean, setting up long-range patterns that are ultimately conducive to tornadoes east of the Rocky Mountains. In the June *Bulletin of the American Meteorological Society*, Gensini's team showed that it can predict broad patterns of U.S. tornado activity two to three weeks ahead of time.

Another weather pattern that might help improve subseasonal forecasts is a quick rise in temperature in the stratosphere, a layer of the upper atmosphere, above the Arctic or Antarctic. These "sudden stratospheric warming" events happen once every couple of years in the Northern Hemisphere and much less often in the Southern Hemisphere. But when one shows up, it affects weather worldwide. Shortly after a northern stratosphere warming, for instance, extreme storms often arrive in the United States.

In August 2019, one of these rare southern warmings, the largest in 17 years, began over the South Pole. Temperatures soared by nearly 40 degrees Celsius, and wind speeds dropped dramatically. This event shifted lower-level winds around Antarctica toward the north, where they raised temperatures and dried out parts of eastern Australia. That helped set up the tinder-dry conditions that led to the devastating heat and fires across Australia in late 2019 and early 2020 (*SN: 2/1/20, p. 8*).

Thanks to advanced computer models, forecasters at Australia's Bureau of Meteorology in Melbourne saw the stratospheric warming coming

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nearly three weeks in advance. That allowed them to predict warm and dry conditions that were conducive to fire, says Harry Hendon, a meteorologist at the bureau.

Stratospheric warming events last for several months. As with an MJO, a subseasonal forecast made while one of them is happening tends to be more accurate, because the stratospheric warming affects weather on the timescale of weeks to months. Meteorologists call such periods "forecasts of opportunity," because they represent times when forecasts are likely to be more skillful. It's like how it's easier to predict your favorite baseball team's chances for the season if you know they've just hired the best free agent around.

Now, researchers are pushing wherever they can to eke out improvements in subseasonal forecasts. The European forecast center where Vitart is based has been issuing subseasonal predictions since 2004, which have been improving with time. The U.S. National Oceanic and Atmospheric Administration began issuing similar predictions in 2017; they are not as accurate as the European forecasts, but have been getting better over time. Meanwhile, scientists have launched two big efforts to compare the various forecasts.

Vitart and Robertson lead one such project, under the auspices of the World Meteorological Organization in Geneva. Known as S2S, the meteorological shorthand for "subseasonal to seasonal," the project collects subseasonal forecasts from 11 weather prediction agencies around the world, including the European center and NOAA. The forecasts go into an enormous database that researchers can study to see which ones performed well and why. Kim, for instance, used the database, among others, to understand why models have a hard time capturing the MJO's march across the Maritime Continent.

The second effort, known as SubX, for the Subseasonal Experiment, uses forecasts from seven models produced by U.S. and Canadian research groups. Unlike S2S, SubX operates in nearly real time, allowing forecasters to see how their subseasonal predictions pan out as weather develops.

That proved useful in early 2019, when SubX forecasts foresaw, weeks before it happened, the severe cold snap that hit the United States in late January and early February. Temperatures dropped to the lowest in more than two decades in some places, and more than 20 people died in Wisconsin, Michigan and elsewhere.

Cold calculations

Using a collection of forecasts known as SubX, scientists were able to predict an early 2019 cold snap descending on North America (left, turquoise) several weeks ahead of time (actual event, center, blue).

Having an extra week's heads-up that extreme weather is coming can be huge, Robertson says. It gives decision makers the time they need to assess what to do — whether that's watering crops, moving emergency supplies into place or prepping for disease outbreaks.

In just one example, Robertson and colleagues recently developed detailed subseasonal forecasts of monsoon rains over northern India. He and Nachiketa Acharya, a climate scientist at Columbia University, described the work in January in the *Journal of Geophysical Research: Atmospheres*.

In 2018, the scientists focused on the Indian state of Bihar, where the regions north of the Ganges River are flood-prone and the regions to the south are drought-prone. Every week from June through September, the team worked with the India Meteorology Department in New Delhi to produce subseasonal rainfall forecasts for each of Bihar's regions. The forecasts went to the state's agricultural universities for distribution to local farmers. So when the summer monsoon rains arrived nearly 16 days later than usual, farmers were able to delay planting their rice and other crops until closer to the time of the monsoon, Acharya says. Such subseasonal forecasts can save farmers both time and money, since they don't need to pay for irrigation when it's not needed.

Acharya is now working with meteorologists in Bangladesh to develop similar subseasonal forecasts for that country. There the monsoon rains typically start around the second week in June but can fluctuate — creating uncertainty for farmers trying to decide when to plant. "If we can predict the monsoon onset by around the mid or end of May, it will be huge," Acharya says.

Subseasonal forecasts can also help farmers improve productivity in regions such as western Africa, says Shraddhanand Shukla, a climate scientist at the University of California, Santa Barbara. He leads a new NASA-funded project that is kicking off to help farmers better time their crop planting and watering. The effort will combine satellite images of agricultural regions with subseasonal forecasts out to 45 days. If farmers in Senegal had such information in hand back in 2002, Shukla says, they could have better managed their plantings in the run-up to a drought that killed many crops.

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As global temperatures rise and climate changes, meteorologists need to keep pushing their models to predict weather as accurately as possible as far in advance as possible, Vitart says. He thinks that researchers may eventually be able to issue forecasts 45 to 50 days in the future — but it may take a decade or more to get to that point. New techniques, such as machine learning that can quickly winnow through multiple forecasts and pinpoint the most accurate one, may be able to accelerate that timeline.

"There's no single breakthrough," Becker says. "But there are a lot of little breakthroughs to be made, all of which are going to help."

sciencenews.org, 27 August 2020

https://www.sciencenews.org

Eliminating the concept of waste from the economy

2020-08-19

Can pollution and climate change be addressed and solved as if they were design problems? For architect William McDonough, the answer is a straightforward "yes." But the solution involves getting rid of the idea of waste as an end product in our society and economy.

"The way I put it is, eliminate the concept of waste," McDonough told "Marketplace Morning Report" host David Brancaccio. "Because once you realize that something is not waste, it's food for something else. So you honor all the materials as they go through the system. And you don't design for the end of life."

While it may seem like a far-fetched idea, McDonough has developed systems of renewal in building design and clothing production that run on the concept of a "circular economy."

"What we're saying is, materials and things, you can take them from nature," McDonough said. "But when we're finished with the use of it, we can start to imagine what its next use is and design it for its next use. And once you do that, then you want to design for next use. And that's what's so much fun. And then you end up with a circular economy. So it's for intergenerational benefit."

The following is an edited transcript of McDonough's conversation with "Marketplace Morning Report" host David Brancaccio about how to create a 100% renewable energy system, how a circular economy can also foster meaningful job growth and more.

David Brancaccio: You see what needs to change to stop ruining the Earth as really a design problem, right?

William McDonough: I do, because design is the first signal of intention. And if we're destroying the Earth, we have to ask ourselves, is this is our intention? And if it's not, perhaps we need a new design.

Brancaccio: I mean, essentially you want to do away with the word "waste." You don't want us to be wasting because stuff we consider waste doesn't necessarily have to be.

McDonough: Right. The way I put it is, eliminate the concept of waste. Because once you realize that something is not waste, it's food for something else. So you honor all the materials as they go through the system. And you don't design for the end of life. So it's time for us to

But the solution involves getting rid of the idea of waste as an end product in our society and economy.

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realize the way has gone away, and it's time for us to to enjoy the prospect of being connected to things that are local and beneficial everywhere, instead of benefiting somewhere while destroying somewhere else.

Brancaccio: What should people understand about what you're calling the "circular economy"?

McDonough: What we've been doing is take, make, waste. That's a linear economy. And that's why it's known as "cradle to grave." What we're saying is, materials and things, you can take them from nature, and then we make things with them. But when we're finished with the use of it, we can start to imagine what its next use is and design it for its next use. And once you do that, then you want to design for next use. And that's what's so much fun. And then you end up with a circular economy. So it's for intergenerational benefit. But other things are really part of what we call the "technosphere." So if you think about it, in the last 5,000 years, humans ever since we started banging on metal, have created things that are what we call products as a service. What you want to do is have the use of the sword, or the plowshare, or the loom, or the car, or whatever — you want the use of it, not necessarily the ownership. So it's a beautiful system of regeneration at every use. And it's good for the economy because you get to do it again.

Brancaccio: And we're getting practiced at this, right? The notion of instead of buying a chunk of equipment that you might use some and then it goes into a closet or who knows where it goes, you might buy or rent or lease the service. And so that piece of equipment could be used down the road for someone else once you're done.

McDonough: Well, we've been effectively doing this for a long time. Think about a television set. If you say, "I want to buy a television set," but you asked for the materials, instead of the service, you'd be saying "I'd like to buy a house object in a plastic housing with 4,360 chemicals, you know, some of which are highly toxic. And I'd like to bring it home and give it to my children, encourage them to play with it." You know, that's not what you're doing. You went to buy a television, what you want to do is watch TV. So that's the service. So why can't we design a television set that, when you finish with it, it can go back and become another television set, or it can go back and be a television set for someone else, sell it on eBay? Or you can actually take it apart and get the materials back in the industry. And we can use them again to make other things, so that's how we design things. And it's very effective business, it's very good. Think about it, like a car. If you buy a car, whatever it is, if you bought a Tesla would you say,

"I want to buy electric motors and windings and PVC wrapping and this and that," or do you want a car? And when you finish with the use of it, it's nice to know that that car can be back to aluminum, and the motors can be used again and again, the copper is still valuable and it's not just being thrown in a hole in the ground.

Brancaccio: Now, I think of you as an architect with buildings and I've seen one of your buildings at Oberlin College in Ohio that is an expression of this, but you've thought a lot about apparel that could really have this almost infinite cycle. Tell me a little bit more about that.

McDonough: Well, for textiles I created with the C&A Foundation, something called Fashion for Good in Amsterdam. So, in 1994, we did our first textile for Steelcase Corporation here in the States, a furniture company. And we designed with them a fabric that is so clean, you could eat it. We did it out of wool and ramie. Ramie is a fiber. And then all of the dyes and the mordants and the rinses are all so clean that the water coming out of the factory is as clean as Swiss drinking water, which is what it is. So you're not polluting. The trimmings of the balsa cloth, which used to be hazardous waste, had to be shipped to Spain, from Switzerland, because you couldn't burn it or bury it in Switzerland. So that's a cost to the business. And so we got rid of that. So all the materials are clean enough that the trimmings of the cloth become mulch for the local garden club. So you can give it as a gift to the local people who grow strawberries, and then the water coming out is clean enough to drink. So you'd rather use that then the undefined incoming water. So guess what? You turn right around and now you don't need water anymore, and you're not polluting the local lake or having inspectors to worry about it, which saves money because there's nothing to inspect. So the whole thing becomes quite beautiful and you end up with a company still in Switzerland. And, by the way, a lot of people have sat on that fabric; it's in the Airbus [planes]. So it's the most comfortable fabric for sitting on because it keeps you one temperature and wicks away moisture. So it keeps you perfect for sitting. Anyway, just a much better product and the world gets better because you're using that instead of something else. It's very cost effective. It reduces regulation. What's not to like?

So that's where we started in textiles, and then as we moved into clothing last year, C&A, the European clothing company, announced the first perfect blue jean. And when we'd gone to the factories in India and Pakistan, one of the first factories we went to said, "We're here to help with the cotton to be you know, organic" — check — "and all the dyes and everything checked, so they're just perfect" — check. And we need it to be

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renewably powered because we have to move toward 100% renewably powered clean energy. And they said, "Oh, yes, we've been waiting for you. We've done it already." There's two factories, one wind-powered, one solar-powered. Great. "And then we have to make the water clean enough to drink. That's where we need your help, with all the dyes and everything. But we don't want to release water, if we can help it, because it's clean enough." By the time we were done, the only water leaving this factory was by evaporation. So this is like that building in Oberlin. It's a building like a tree. A tree collects more energy from solar energy than it requires to live. It actually accrues and grows. Amazing. And it purifies water, provides habitat, it can make fuel. So if you think about a tree, it's fecund. It gives more and grows like a living thing. So that's why we want to design systems that are like that; they're regenerative. And they work from solar income. They take carbon from the atmosphere and bring it down to the ground. And the world is better for it. So let's do it like that — factories that are water purification systems, safe places to work, dignified products without poisons. Why not? We can do this.

Brancaccio: So if this pandemic is some kind of opportunity to embrace what policymakers had deemed unthinkable before, because there's a lot of new thinking — at least I'm told that — how do you want us to dive further into this once we get out of this pandemic phase?

McDonough: I think it's clear now that energy has to be clean. Because right behind this one, we have climate change, and so on. We can address this. We should, we can. And we should do it in ways that give jobs to everybody. There is so much to do, and that should be a signal. Discover the obvious. There's so much to do in renewable power, there is so little to do in coal. So, focus: This is job creation. How do we mean meaningfully engage with the world today and have great work for people to do? And safety and health, first, then the economy. That's why with "cradle to cradle," the first thing we do is make sure all the materials are safe for humans and ecosystems. Then, we look for the circular economy and the sharing economy. It's much more efficient. And then we do renewable energy, clean water and then social fairness — all five are critical. So you can do this, we can do them all at once. And it can be very highly profitable.

Brancaccio: I mean, it sounds like the circular economy isn't painful in the sense of austere because in addition to not burning up the planet, you think it will create more livelihoods for people?

McDonough: Definitely. I was asked to be the chair of the circular economy at Davos in the World Economic Forum, we created a meta-council. And, you know, it was so beautiful to be able to talk to people who are in the world of making things and the economy and explain that what we're talking about here is the celebration of abundance. A lot of people started out saying, "Oh, we need the circular economy because we're running out of everything, and so we need to use it all again." And then my point was, "Be careful, because if we make products that are not even safe" — let's call them "bads." We're supposed to be making goods and services, but what if we made bads and services?" Whoops. Then if we had a circular economy of bads, it would be worse, because we're doing it again. So let's have goods first. And then let's recirculate them. That's a celebration of abundance. Can we use them over and over again? We get more value and utility from things. … But, you know, that kind of work, will be taking things that we made yesterday and reforming them into things for tomorrow. That's fine. Those are jobs.

marketplace.org, 19 August 2020

https://www.marketplace.org

Inside the incredibly slow race to reinvent time

2020-08-19

ANDREW LUDLOW'S is no ordinary ticker. An intricate tangle of tubes, cables and lasers occupying an entire room at his lab in Boulder, Colorado, it is one of the best timekeeping devices ever made. "It's the Lamborghini of atomic clocks," he says.

That isn't to say it is fast. But Yb-2, as the clock is known, is precision engineered. In fact, it should measure out each passing second so precisely that it wouldn't miss a beat for around 20 billion years – more than the age of the universe.

This is the stunning frontier of precision at which timekeeping now finds itself. Clocks such as Ludlow's could spur on as yet unheard-of technological innovations. They could transform our understanding of the universe, revealing wrinkles in established laws of physics and variations in the fundamental constants of nature that would otherwise be impossible to detect. But for metrologists like Ludlow, they raise an even more fundamental question: is it time once again to redefine time?

That might like seem an odd thing to consider for what is a fundamental property of the universe. The flow of time is an enigma; many physicists

But Earth isn't a dependable metronome.

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even suggest it is just an illusion. But clock time is our own invention. We define its basic units – the hours, minutes and seconds that break up the day. They started out as subdivisions of the time it takes Earth to rotate around its axis. Indeed, when astronomer Christiaan Huygens invented the pendulum clock in the 17th century, a second became firmly established as 1/86,400 of a solar day, a factor derived from the division of the day into 24 hours, then 60 minutes per hour and finally 60 seconds per minute.

But Earth isn't a dependable metronome. The duration of its rotation varies by microseconds daily and progressively slows ever so slightly, meaning a second gradually gets longer. That became a problem in the early 20th century, when experimental verification of quantum mechanics and the emergence of radio broadcasting required a steadier, more precise unit of time. It eventually arrived with the microwave atomic clock: a timepiece that ticks in harmony with the frequency of microwave radiation emitted from the rapid oscillations inside caesium atoms, where electrons hop back and forth between closely spaced energy levels.

The first microwave atomic clock was unveiled at the National Physical Laboratory (NPL) in Teddington, UK, in 1955. It was accurate to 1 second every 300 years, meaning two such clocks would fall out of sync by just one second every three centuries. It wasn't long before such precision transformed the way we measure the basic unit of time. In 1967, representatives at the 13th General Conference on Weights and Measures in Paris officially redefined the second as "the duration of 9,192,631,770 periods of the radiation corresponding to the transition between the two hyperfine levels of the ground state of the caesium-133 atom".

The new second was no longer or shorter than the old one. But the change did provide a much more precise definition of that duration, dramatically improving the extent to which we can be sure each second is the same as the next, and the one after that too.

It is a time standard that persists today, even if the accuracy of microwave atomic clocks has improved to the point that the best caesium clocks now keep time with an accuracy of 1 second in roughly 300 million years. And it is a measure that has served us well. The steady backbeat of the caesium atom's vibration underpins all manner of modern technologies, from GPS and smartphones to the internet and electricity grids, all of which require exquisitely precise synchronisation.

But it is no longer the best we can do – not by a long way. Ludlow, a physicist at the National Institute of Standards and Technology's (NIST) Physical Measurement Lab, is one of many researchers working on optical

atomic clocks, a new generation of timepieces that promise to once again dramatically improve the precision with which we can measure time passing.

We have known for a long time that other atoms oscillate much faster than caesium. Strontium and ytterbium stand out because the electrons surrounding their nuclei have stable excited states, relatively unperturbed by potentially disruptive outside forces like temperature and electric and magnetic fields. The problem was always that their electrons transition between energy levels so fast that there was no easy way to count them.

That wrinkle was smoothed out in 1999 with a device called an optical frequency comb, which essentially translates the atomic oscillations measured in the optical range into microwave frequencies. For the first time, the rates at which optical clocks "tick" could be calibrated against one another and the standard set by the caesium atom.

"The current definition of a second is no longer the best we can do"

The technique sparked something of an arms race, with labs around the world competing to create ever more precise optical clocks. Currently, top contenders include not only Ludlow's ytterbium clock at NIST, but also a similar device at the RIKEN Quantum Metrology Lab in Tokyo and strontium clocks at NIST and the National Metrology Institute of Germany in Braunschweig.

These optical clocks have already achieved a level of certainty nearly two orders of magnitude higher than caesium-based clocks, to the point that most would lose a second only once over the course of the entire history of the universe.

That might seem like overkill. Wrist watches and iPhones don't need to operate to a precision of 18 digits or more. Yet if they can be made sufficiently portable, optical atomic clocks could be used for all sorts of practical purposes, from tracking movement to detecting volcanic activity and earthquakes. They are also likely to usher in many technologies and breakthroughs that we haven't thought of yet – and that is before we even get onto the fundamental questions in physics that more accurate timepieces would help resolve (see "Clocking new physics").

"It's an 'If you make it, they will come' kind of attitude," says Anne Curtis, a metrologist at NPL. "Fifty years ago, when people were contemplating GPS satellites for the first time, no one thought we'd be walking around with handheld computers utilising GPS in real time, just to get to a restaurant."

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So what are we waiting for? If optical clocks have already achieved such record-breaking precision, why isn't the world already ticking to their superior beat? "Frankly, it is somewhat awkward to have optical clocks that are 'better' than the very definition of what a second is," says Franklyn Quinlan at NIST. The trouble is that there is a checklist of knotty problems to be addressed before they can establish a new international time standard.

For one thing, you need to pair the signals coming from optical atomic clocks with all the electronic infrastructure already in place, which is currently synchronised using microwave-based clocks. That is tricky because, as well as an optical frequency comb, it requires a separate piece of hardware called an optical-to-electrical converter to transform pulses of light into an electric signal. For a long time, it wasn't clear that it was possible to translate the exquisite timing produced by optical clocks into the microwave frequency range for use in electronics.

But earlier this year, Quinlan, Ludlow and their colleagues cracked the problem. After a decade of work, they finally demonstrated that the translation provided by optical frequency combs yields microwave signals with a 100-fold stability improvement compared with the best microwave atomic clocks. "Considering that it took 20 years of steady improvements to see the last tenfold increase in microwave signal stability, we think a sudden 100-fold increase is a significant advance," says Quinlan.

Curtis agrees. "As part of the roadmap for the redefinition of the second, it is an essential requirement to be able to connect the future optical definition back to the current microwave definition," she says. "This demonstrates this at the highest levels."

Metrologists are now discussing the idea of submitting a proposal to vote on an official redefinition at the next General Conference on Weights and Measures, scheduled for 2026.

To make that happen, the field must first negotiate a few obstacles. For starters, metrologists will have to decide on the cut-off point, a level of precision that everyone agrees is enough for redefinition. "People start getting antsy about how much better do you need to be than the [current] definition before you should redefine it," says Curtis.

Final countdown?

Once that's settled, they will have to thrash out which kind of optical atomic clock should be used to set the official redefinition. There are at

least 10 different models being developed in labs around the world, and no single candidate has yet emerged as an obvious best choice.

The clocks differ not only in the types of atoms being used, but also in their architectures. One leading design, the optical lattice clock, measures the oscillations of about 10,000 neutral atoms simultaneously to provide stable, snappy readings. NIST's Yb-2 clock is an example of this. Other candidates include the single-trapped-ion clock, which measures the transition frequency of a single isolated, charged atom in a way that can help to reduce uncertainty. The problem with single-atom clocks is that they deliver a smaller signal than lattice clocks and thus take more time to produce measurements.

Fritz Riehle, former head of optics at the National Metrology Institute of Germany, says that the diversity in clock designs is a good thing for now, because it provides different possible solutions. But eventually, one must be crowned the winner. This decision will ultimately fall to the board of representatives at the General Conference on Weights and Measures; its conclusion will be based on the recommendation reached by numerous experts, committees, working groups and subgroups. Naming a final winner will probably be more of a human problem than a scientific one, says Riehle, although one he is sure "will be solved in a competitive but respectful way".

"Nature places a fundamental limit on how well we can measure time"

Before we get to that point, though, there are still scientific hurdles to clear – not least the verification of the various measurements that the clocks produce. This process ensures consistency and replicability, and it is used to compare optical clocks with each other and the best microwave clocks. Teams in Colorado, France, Germany, the UK, Italy and Japan have already begun using optical fibres to link optical clocks to facilitate such comparisons. But labs still sometimes produce slightly different results, leaving researchers troubleshooting.

According to Curtis, this is all par for the course. "The art and science in metrology is really about assessing all the things that can go wrong," she says. "There's no reason why we can't, over the next five years, all figure out what might be going wrong with our clocks and ensure that it doesn't."

How long a new definition of the second will last is anyone's guess. Just like their microwave-based predecessors, optical atomic clocks will, at some point, be surpassed. In fact, people are already thinking about clocks based on transitions that take place inside the nucleus of an atom, rather

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than the cloud of electrons that orbit it. "We want to choose something that will last for a long period," says Patrizia Tavella, director of the time department at the International Bureau of Weights and Measures in France. "But we also understand we can't have something that will last forever."

Even future generations of atomic clocks will eventually have to grapple with the nature of time as described by Einstein's general theory of relativity, which predicts that a clock ticks ever so slightly faster for every centimetre it is elevated within Earth's gravitational field. As the precision of our best timepieces reaches into ever more digits, shifts in that field will begin to interfere. At some point, we will run up against "the fundamental limit nature places on us in how well we can measure time", says Jun Ye, another NIST physicist.

It is most likely, then, that a timeless definition of the basic unit of time, just like time itself, will always escape us.

newscientist.com, 19 August 2020

https://www.newscientist.com

New ways to turn waste PET into nanomaterial for rechargeable battery production

2020-08-20

UC Riverside engineers have developed a way to recycle plastic waste, such as soda or water bottles, into a nanomaterial useful for energy storage.

Mihri and Cengiz Ozkan and their students have been working for years on creating improved energy storage materials from sustainable sources. Their latest success could reduce plastic pollution and hasten the transition to 100% clean energy.
Making Battery Production Sustainable

The researchers describe a sustainable, straightforward process for upcycling polyethylene terephthalate plastic waste, or PET, found in soda bottles and many other consumer products, into a porous carbon nanostructure.

"*Thirty percent of the global car fleet is expected to be electric by 2040, and high cost of raw battery materials is a challenge*," said Mihri Ozkan, a

"Thirty percent of the global car fleet is expected to be electric by 2040, and high cost of raw battery materials is a challenge," said Mihri Ozkan…

professor of electrical engineering in UCR's Marlan and Rosemary Bourns College of Engineering. "*Using waste from landfill and upcycling plastic bottles could lower the total cost of batteries while making the battery production sustainable on top of eliminating plastic pollution worldwide.*"

Using Electrospinning to Process Supercapacitors

Researchers first dissolved pieces of PET plastic bottles in a solvent. Then, using a process called electrospinning, they fabricated microscopic fibers from the polymer and carbonized the plastic threads in a furnace. After mixing with a binder and a conductive agent, the material was then dried and assembled into an electric double-layer supercapacitor within a coin-cell type format.

When tested in the supercapacitor, the material contained the characteristics of both a double-layer capacitor formed by the arrangement of separated ionic and electronic charges, as well as redox reaction pseudo-capacitance that occurs when the ions are electrochemically absorbed onto surfaces of materials.

Though the new batteries don't store as much energy as lithium-ion batteries, the new supercapacitors can charge much faster, making batteries based on plastic waste a good option for many applications.

By "doping" the electrospun fibers prior to carbonization with various chemicals and minerals such as boron, nitrogen, and phosphorous, the team plans to tune the final material to have improved electrical properties.

Recycling Plastic Waste into Energy Storage

"*At UCR, we have taken the first steps toward recycling plastic waste into a rechargeable energy storage device,*" said doctoral student and first author Arash Mirjalili. *"We believe that this work has environmental and economic advantages and our approach can present opportunities for future research and development."*

The authors believe the process is scalable and marketable, and that it represents major progress toward keeping waste PET out of landfills and the oceans.

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"The upcycling of PET plastic waste for energy storage applications could be considered the holy grail for green manufacturing of electrode materials from sustainable waste sources," said mechanical engineering professor Cengiz Ozkan. *"This demonstration of a new class of electrodes in the making of supercapacitors will be followed by a new generation of Li-ion batteries in the future, so stay tuned."*

omnexus.specialchem.com, 20 August 2020

https://www.omnexus.specialchem.com

Florida is going to release 750 million mosquitos genetically engineered to decimate the mosquito population

2020-08-20

In the Florida Keys, the local mosquito control agency has just approved the release of 750 million genetically engineered mosquitoes. The test, which is likely to begin in 2021, will be the first time that mosquitoes—designed to be "self-limiting," meaning that they'll breed offspring that can't survive—will be used in the United States.

Oxitec, the U.K.-based company that engineered the mosquitoes, plans to place boxes filled with mosquito eggs in the area, releasing male mosquitoes bred with the self-limiting gene. When they breed with female mosquitoes, female offspring won't survive. Because only female mosquitoes bite humans, this can help stop the spread of disease. The species they're targeting is the *Aedes aegypti* or "yellow fever" mosquito, an invasive species that transmits diseases such as dengue, chikungunya, and Zika.

"With repeated releases over a number of weeks, the population of females gradually reduces," says Kevin Gorman, Oxitec's head of global field operations. "And we end up with vector control. It's taking away that vector that is intended to reduce the incidence of disease."

In previous tests in other countries including Brazil, the company says that the process has worked to dramatically shrink populations. "We've had multiyear programs giving over 80% control in every single year," he says. "And that far exceeds typically what people get trying to control *Aedes aegypti* with chemicals, because *aegypti* is very resistant. It's not usually present in super-high numbers. So it can be difficult to actually reach."

"We've had multiyear programs giving over 80% control in every single year," he says.

The startup also claims that it's a more environmentally friendly way to control mosquitoes, because it's possible to target only a particular species, and after around 5 to 10 generations, the modified gene will be removed from the population (since the females with the gene die, halving the number of modified bugs each generation), leaving no ecological footprint. Advocacy groups, however, argue that the technology hasn't been tested enough, and it could potentially have unintended effects.

"If they do work to reduce the number of *Aedes aegypti*, other mosquitoes might move into their niche," says Jaydee Hanson, policy director for the International Center for Technology Assessment and Center for Food Safety. "The most likely one is the Asian Tiger mosquito, which is better at carrying some illnesses like West Nile." (Oxitec says that as it has tested its mosquitoes in other areas, it hasn't seen significant increases of the Asian Tiger mosquito.)

Hanson also says that the company needs to do more lab testing to understand how the mosquitoes might impact local species that eat the insects. "Every environment is different," he says. "We would like them to mock up the Florida environment before they release three-quarters of a million mosquitoes." He argues that there's also a risk that the engineered mosquitoes could cross-breed with native species, creating hybrids that might be more resistant to insecticides. He thinks that the EPA, which gave approval to Oxitec earlier this year, didn't do due diligence.

Hanson argues that there are better solutions. A vaccine for yellow fever exists, for example, and other vaccines for mosquito-borne diseases are in development, including vaccines that target multiple diseases simultaneously. Simple control measures like getting rid of standing water can be effective. Malaria used to be common in the United States; it was eradicated by a combination of draining water, spraying, and removing breeding sites. "What I urge people not to do with new technologies is not to worship them," he says. "We need to assess them rigorously." Mosquitoes used in one place, like Florida, can also easily end up in other states that didn't choose to approve them.

Still, if the genetically engineered mosquitoes are safe and effective, they could be a powerful tool. Globally, more than a million people die each year from diseases spread by mosquitoes. As climate change extends the range of mosquitoes, the problem could get worse. Oxitec—backed by the Gates Foundation—particularly wants to target mosquitoes that spread malaria. Of the hundreds of species of mosquitoes that exist, only a handful are most responsible for disease, says Gorman. Using genetic

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engineering can reduce their populations enough that they would no longer spread those diseases. "We really want to work with the community in Florida, so that we can garner their support and demonstrate to them that this really is a technology that is benign, and it could really help," he says.

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https://www.fastcompany.com

Australia's biggest bats fly thousands of kilometres a year—farther than wildebeest and caribou journey

2020-08-20

Australia's biggest bats—known as flying foxes—are among the world's most restless nomads, according to a new study. Just how restless? The most peripatetic can journey up to 6000 kilometers per year, much farther than any land mammal and close to the distances covered by some whales and migrating birds.

This continent's flying foxes can weigh up to 1 kilogram with meter-wide wing spans. But instead of hunting like other bats, they make nightly forays to flowers in search of nectar, pollen, and seeds. By day, they roost by the thousands in trees.

Researchers had thought these bats stayed local, loyal to a particular roost. But when they put satellite transmitters on 201 bats from three species in eastern Australia, they found they were mistaken: From months of tracking each bat, they calculated that the bats wandered anywhere from 1487 to 6073 kilometers per year, they report today in *BMC Biology*.

The black flying fox (*Pteropus alecto*) had the shortest range, followed by the gray-headed flying fox (*P. poliocephalus*, above), and the little red flying fox (*P. scapulatus*). The little red flying fox averaged about 5000 kilometers per year—farther than champion mammalian migrators such as caribou, which travel 1200 kilometers per year, and wildebeest, which migrate 2900 kilometers with each trip.

Rather than following a seasonal path, flying foxes seem to wander randomly, most likely in search of newly flowering species. The little red flying fox, for example, travels 1300 kilometers north to south, but not continuously. Instead, it crisscrosses its range and settles briefly in dozens of different roosts, whose populations fluctuate based on the new

But instead of hunting like other bats, they make nightly forays to flowers in search of nectar, pollen, and seeds.

migrants. In total, bats in the study visited 755 roosts, more than half of which were previously unknown to scientists.

Because these furry fliers are key to dispersing seeds and pollen, their meanderings help "connect" forests fragmented by fire or human activity, the researchers say. But their erratic, far-flung movements also complicate conservation and disease management, which is usually under the jurisdiction of local, not national, authorities. Now that researchers know nomadism is a way of life for these bats, they can start to search for some rhyme or reason to all this meandering.

sciencemag.org, 20 August 2020

https://www.sciencemag.org

Some people can get the pandemic virus twice, a study suggests. That is no reason to panic

2020-08-24

Scientists have found the first solid evidence that people can be reinfected with the virus that causes COVID-19. A new study shows a 33-year-old man who was treated at the hospital for a mild case in March harbored the virus again when he was tested at the Hong Kong airport after returning from Europe on 15 August, less than 5 months later. He had no symptoms this time. Researchers had sequenced the virus, SARS-CoV-2, from the first infection; they did so again after the patient's second diagnosis and found numerous differences between the two, bolstering the case that the patient had been infected a second time.

"This case proves that at least some patients do not have life-long immunity," Kelvin To, a clinical microbiologist at the University of Hong Kong (HKU) and one of the authors of a paper on the case, told *Science* today.

Exactly what that finding means is unclear, however. To and his colleagues make some sweeping statements in their paper, parts of which *Science* has seen. "It is unlikely that herd immunity can eliminate SARS-CoV-2," the authors write, referring to the idea that the epidemic will peter out once enough people have been infected and become immune. "Second, vaccines may not be able to provide life-long protection against COVID-19."

But it's too early to draw those conclusions, says Columbia University virologist Angela Rasmussen. "I disagree that this has huge implications

"Second, vaccines may not be able to provide life-long protection against COVID-19."

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across the board for vaccines and immunity," she wrote in an email, because the patient described in the study may be a rare example of people not mounting a good immune response to the first infection.

Mark Slifka, a viral immunologist at Oregon Health & Science University, says his takeaway from the paper is the opposite of what the authors write: "Even though [the patient] got infected with a very different strain that's distinct from the first time around, they were protected from disease," he says. "That is good news."

Fueling the debate over the importance of the case is that the paper on it isn't public yet, which means scientists can't scrutinize its data in full. HKU put out a press release about the study today and said the paper had been accepted for publication by the journal *Clinical Infectious Diseases*. To confirmed that a few pages of the manuscript circulating online were from the paper but said he could not make the full text available. "This is why I loathe data disclosure by press release," Rasmussen wrote. "It seems designed to stoke sensationalism by leaving all these provocative questions unanswered, some of which could probably be answered by just reading the paper and examining the figures."

There have been several reports of COVID-19 patients testing positive for SARS-CoV-2 again after apparently clearing their infection, but in those cases there was less time between the tests and researchers did not have sequences of the viruses to confirm there were two different infections. Many of these cases were likely testing errors, says Jeffrey Barrett, a genomic epidemiologist at the Wellcome Sanger Institute: "I wasn't convinced by any of them."

In the current case, the press release and paper excerpts say, the HKU scientists found 24 differences between the first and second viral genome, including one in the first virus that truncates a gene known as *ORF8*. "There's sort of no chance that it's the same infection twice," Barrett says. "It is much more convincing than any other anecdotal reports that have come out so far," agrees virologist Charlotte Houldcroft of the University of Cambridge.

Even if the finding settles the question of whether people can be reinfected with the pandemic virus, it raises many additional questions: How often does this happen? Do people have milder infections, or no symptoms at all, the second time around? Can they still infect others? If natural infection does not always confer solid protection, will that be true for vaccines as well?

To says he believes reinfections are not rare—just difficult to find. "This case is very special because he was screened at the airport," he says. "Under normal circumstances, he may not even have been aware that he was infected again." If reinfections are more likely to lead to asymptomatic cases, To notes, they may be tougher to spot.

In a press conference on Monday morning, epidemiologist Maria Van Kerkhove of the World Health Organization warned against jumping to conclusions. "We need to look at this at a population level," she said. Given that there have been more than 24 million reported SARS-CoV-2 infections worldwide, a single reinfection report may signal a very rare event, Barrett says. "Biology is complicated. You always find some strange exceptions." He hopes efforts like the COVID-19 Genomics UK Consortium, which is sequencing viral samples from tens of thousands of patients, will provide data on how often reinfection occurs. Houldcroft says studies in health care workers may be key, because they are most likely to be exposed repeatedly.

There were reasons to expect that SARS-CoV-2 can reinfect at least some recovered COVID-19 patients, Houldcroft says. Experiments in the 1980s in the United Kingdom showed some people who were infected with coronaviruses that cause the common cold could be deliberately reinfected a year later. "I think most virologists were waiting for this to happen and it was more of a question of when rather than if," she says. "It's almost impossible to be protected completely from a reinfection, especially [with] upper respiratory tract viruses and bacteria," Slifka adds. "We get reinfected all the time."

In the 1980s experiments, participants who produced less robust immune responses during the first infection were most likely to be reinfected. Perhaps that happened in the Hong Kong case: The man tested negative for immunoglobulin G, the most common class of antibody, against SARS-CoV-2 10 days after his mild symptom began in the first infection, the authors write. "People with low neutralizing antibody titers will be expected to be more susceptible to reinfection," Houldcroft says. "We have no idea what it means for everyone else." But the assay used in the paper, which targets the nucleoprotein of the virus, is particularly prone to false negative results, Slifka says.

Whether reinfected people can still spread the virus may turn out to be the crucial question, Houldcroft says. "If they don't shed and they're dead ends, that's fine. If they are still infectious, that's a bit more of a problem." Whether the Hong Kong case was infectious after his second brush with

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SARS-CoV-2 is not clear; the researchers are trying to culture live virus from the patient, To says. "But viral culture takes some time, so we don't know yet." Given the experience with other respiratory viruses, Slifka says he would expect the patient to be about 10 times less infectious the second time around.

Even if reinfections turn out to be more common and to lead people to shed infectious virus, that does not mean vaccines won't work. **"**The protection given by the [human papillomavirus] jab, for instance, is more durable and better than natural infection," Houldcroft says. "It's not impossible that we will do the same for the coronavirus."

To says it was important to get the available information out as soon as possible, because recovered COVID-19 patients should keep practicing physical distancing and other measures to avoid infection. "People should not assume that once they get infected, they have life-long immunity," he says. But he stresses that the findings "shouldn't cause panic."

sciencemag.org, 24 August 2020

https://www.sciencemag.org

What are cholinesterase inhibitors, the chemical agents thought to have been used to poison Alexei Navalny?

2020-08-27

Medical tests on Alexei Navalny, the outspoken political critic of Vladimir Putin who was allegedly poisoned last week, have shed more light on his illness.

Berlin's Charite–Universitätsmedizin hospital said yesterday that Mr Navalny was being treated in intensive care and remained in a medically induced coma.

"While his condition is serious, it is not currently life-threatening," the hospital said in a statement.

Notably, the hospital said he was poisoned by «a substance from the group of cholinesterase inhibitors».

But what are these, and how can this sort of poisoning be treated?

From pesticides to weapons-grade chemicals

Cholinesterase inhibitors, also called anticholinesterases, are a broad group of chemical agents.

In this form, these chemicals are often collectively referred to as "nerve agents".

They include many everyday pesticides such as organophosphate and carbamate compounds, which the Australian Pesticides and Veterinary Medicines Authority regulates in Australia.

They also include more exotic weapons-grade chemicals such as sarin, which was deployed in Syria, and novichok, reportedly used to poison two Russian expatriates in the UK town of Salisbury in 2018.

In this form, these chemicals are often collectively referred to as "nerve agents".

First developed in Germany in the lead-up to World War II, nerve agents are several times more potent, and therefore dangerous, than organophosphate or carbamate pesticides.

They're banned under the Chemical Weapons Convention.

These chemicals can cause harm through simple contact or inhalation, in minuscule quantities. Some reports suggest Mr Navalny was poisoned via a cup of tea, which would also be effective.

It is no exaggeration to say this group represents the most lethal chemicals humans have ever created.

How do they make people sick?

Cholinesterase inhibitors work by blocking an enzyme called acetylcholinesterase.

Under normal circumstances, acetylcholinesterase regulates the amount of a neurotransmitter called acetylcholine (ACh) that crosses our nerve junctions (or synapses), converting electrical signals through the body.

ACh acts mainly on the body's autonomic (involuntary) nervous system, which controls fundamental functions such as heart rate, breathing rate, salivation and digestion. It is a crucial neurotransmitter.

Left unregulated, the effect of cholinesterase inhibitors is a little bit like blocking one of the major "off-switches" of the body. You're left with all the lights turned "on" and the body quickly runs into trouble.

A rapid build-up of ACh at the nerve junctions leads to the effects we tend to see in nerve agent toxicity, including mucus secretions from the respiratory and digestive tracts, breathing problems, and muscle dysfunction.

Ultimately, death is usually a result of respiratory failure.

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How can this poisoning be treated?

It is possible to treat nerve agent poisoning with a combination of physical and pharmacological interventions. But it is dangerous, and difficult.

Initially, decontamination is critical. Poisoning continues as long as contact with the agent continues, and there's a risk of contamination for those providing medical care.

Significant exposure will invariably require intubation and mechanical ventilation.

The German hospital reports Mr Navalny is currently being treated with atropine.

Atropine is used to bind to and blanket ACh receptors, rendering the circulating excess of these neurotransmitters less hazardous.

Identifying the poison

Health workers can detect whether or not someone has been exposed to harmful cholinesterase inhibitors by taking urine and blood samples.

But as time passes, and the toxin is secreted in the urine, it becomes more difficult to identify exactly what type of cholinesterase inhibitor is the culprit.

The "ghosts" of the poisoning — incapacitated acetylcholinesterase enzymes — are detectable for a longer time, but it can be very hard to link these in isolation to a specific agent.

Depending on the toxicity of the agent, how much was used, how long patients were exposed, and how they were exposed, enzyme levels can start to return to normal from several days to several weeks after exposure.

The person's health will improve, but often not back to normal.

An intermediate syndrome can last for weeks, and people affected describe this as very debilitating.

A history of exotic poisonings

Critics of the Russian regime and their affiliates seem to have a higher than average chance of succumbing to exotic poisons, compared with the general population.

In 2004, the then-president of Ukraine, Viktor Yushchenko, was poisoned with a chemical called TCDD-dioxin, and left with facial disfigurement.

In 2006 Alexander Litvinenko, a former FSB agent who defected to the West, was poisoned with radioactive isotope polonium-210.

The attempt on the lives of the Skripal family in Salisbury, with an agent generally assumed to be novichok, was probably the highest-profile poisoning in recent years.

In the case of Mr Navalny, it's very unlikely the specific agent used will ever be proven. But his case does share common ground with these others.

To assume all of these attempts were necessarily at the personal behest of the Russian leader is probably too long a bow to draw. But it would be reasonable to assume someone in an inner coterie was involved each time — if only to access such sophisticated weapons of assassination.

abc.net.au, 27 August 2020

https://www.abc.net.au

Green on-trend: Top fashion and food firms test ways to nurture nature

2020-08-26

BARCELONA (Thomson Reuters Foundation) - From helping Mongolia's goat herders produce cashmere more efficiently to counting insects on "biodiversity plots" planted on farms, some of the world's biggest brands are blazing a trail with innovative efforts to nurture nature.

Sustainability researchers say businesses have shown a surge of interest in limiting the harm their operations do to the planet, as scientists have outlined more clearly the threats to forests, water, soil, plants, animals, birds - and people.

"For decades we have been trying to get companies on board with this journey but in the past six to 12 months, I have never seen so much interest," said Eva Zabey, executive director of Business for Nature, a coalition lobbying for stronger government policies and more corporate action.

At least 400 firms have signed up to international commitments to protect nature, and more than 1,200 companies already are taking some steps in their operations, she added.

At least 400 firms have signed up to international commitments to protect nature, and more than 1,200 companies already are taking some steps in their operations, she added.

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Britain on Monday said it would start a consultation process on a potential new law that would force big companies to clean up their supply chains by fining them if they used products grown on illegally deforested land.

A World Economic Forum report in January estimated that $44 trillion of economic value generated around the world each year - over half of global GDP – depends on nature and its services.

Those include food crop pollination, genetic material for medicines and mangroves to reduce storm damage, said Cath Tayleur, a senior programme manager for business and nature at the Cambridge Institute for Sustainability Leadership (CISL).

"The key message is that your business can't continue to have negative impacts while still expecting to benefit from the positive aspects of biodiversity," she told a webinar on business and nature this month.

Already nature "is in a perilous state", she added.

A 2019 flagship report from the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services (IPBES) warned that up to 1 million animal and plant species out of an estimated 8 million are at risk of extinction, particularly due to industrial farming and fishing.

Numbers like these - together with greater recognition of the role forests play in absorbing planet-heating carbon - are pushing water utilities, mining companies, food manufacturers and others to address the environmental impact of how they source raw materials.

RESOURCE STEWARDS

Chris Brown, senior director of sustainable supply chains at British supermarket chain Asda, said customer surveys show more than 90% of its shoppers care about the Walmart-owned business being green.

"We are seen as stewards of the natural resources we rely on by our customers," he told the online event.

To earn their trust, Asda is transforming its supply chains, from selling fish certified by the Marine Stewardship Council to sourcing sustainably produced cocoa and palm oil, and planting trees to reach a net-zero deforestation goal.

One of its programmes works with potato growers to plant biodiversity plots on their land.

Asda sent in entomologists to identify and count the insects, and "see what we were generating other than pretty flowers and nice photos" from the project, said Brown.

He noted that 75% of global food production relies on pollinators such as bees and wasps, a key incentive to protect them.

Working out metrics to measure improvements to the soil and other benefits from eco-friendly agriculture will be one important challenge in the coming five years, he said.

Meanwhile, businesses face an "alphabet soup of initiatives" aimed at galvanising nature protection, making it hard to know which to back, he added.

Those initiatives include the New York Declaration on Forests, which strives to halve tropical deforestation by 2020 and end it by 2030 - although it is not on track to meet its goals - and the New Plastics Economy Global Commitment to reuse plastic items and reduce waste.

"There are an awful lot of pledges and commitments that companies are being asked to become signatories for - which is in my opinion both good and frustrating, because... just having a commitment doesn't necessarily mean action," said Gemma Cranston, director for business and nature at CISL.

CASHMERE AND COTTON

The University of Cambridge institute has worked with Asda, France-based luxury goods group Kering, and other companies to produce practical tools for businesses to manage their supply chain risks associated with nature and ultimately become "nature-positive", which means enriching rather than harming the natural world.

In July, Kering - which owns Gucci, Saint Laurent and Balenciaga, among other top fashion houses - published a biodiversity strategy with a series of targets to achieve what it calls a "net positive" impact by 2025.

That includes regenerating and protecting 2 million hectares - about six times the total land footprint of its supply chain - in the next five years.

Half of the target covers land in agricultural areas where the company sources its materials. It plans to restore that land through a 5-million-euro ($5.9-million) fund it has set up.

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The rest it hopes to achieve by supporting U.N.-backed and other external schemes to protect forests, reduce carbon emissions and improve local livelihoods.

Since 2014, Kering has helped herding families in Mongolia's South Gobi region boost the amount and quality of cashmere they get from their goats, while accessing meat and dairy markets.

The programme has enabled them to keep fewer animals - to reduce pressure on grasslands - and to better understand their potential role in protecting wildlife such as antelope and snow leopards, according to Kering.

"It's quite easy for people to forget about the tight connection between fashion and agriculture - all of our clothes come from farms and managed forests and so on," said Katrina ole-MoiYoi, a sustainable sourcing specialist with Kering.

But to make a wider impact on the planet, ole-MoiYoi said collaboration was needed within the fashion industry, because stopping biodiversity loss is "not something any one company can do alone".

If businesses could team up on projects to transform cotton production, for example, it could be a "big win for everybody", she said.

That is the kind of thinking behind The Fashion Pact, which brings together more than 250 brands and suppliers, representing about 35% of the industry, to work jointly on climate change, biodiversity and ocean health issues, she noted.

GLOBAL GOALS

Zabey said the companies Business for Nature works with want clearer government policy and regulation to help them expand and accelerate their efforts to protect nature.

All eyes are on a new set of global biodiversity goals governments are due to hammer out at a U.N. conference next May.

That meeting was postponed due to the coronavirus pandemic - itself an added incentive for environmental action to help lower the risks of diseases passing from wild animals to humans.

Ahead of the U.N. General Assembly in September, Business for Nature is urging companies to sign up to a collective "call for action" to reverse

nature loss this decade, with "hundreds" of firms already on board, Zabey said.

One key aim is to create momentum and reassure governments "that all of these companies do think we should be going for more ambitious policy on nature", she said.

reuters.com, 26 August 2020

<a href=" https://www.reuters.com/article/us-global-business-environment-nature-idUSKBN25L1TC

">https://www.reuters.com

Australia floats plan to better protect Great Barrier Reef

2020-08-25

Australian officials plan to redouble their efforts to save the Great Barrier Reef from the effects of global warming.

The world's largest coral reef system is under threat from rising ocean temperatures, ocean acidification and violent tropical weather. Scientists also have struggled to contain outbreaks of the crown-of-thorns starfish, a polyp-eating predator that can threaten the reef's health.

In response to these dangers, Australia's Department of Agriculture, Water and the Environment is floating a 30-year plan to protect the natural wonder.

The proposal calls for controlling surface runoff and shore-based water pollution that can harm the reef, along with improved coastal infrastructure planning. The draft also outlines rehabilitation efforts to be taken out to 2050.

The Australian and Queensland governments are planning to spend up to $2 billion over the course of a decade as part of an initial phase of reef protection and recovery efforts. The new draft plan was opened for public comments last week.

It's a revision of a plan issued in 2015. The department said the updated strategy "includes a greater focus on climate change and its impact on the Reef" and takes into account recent coral bleaching events that occurred after 2015.

The Great Barrier Reef is a major tourist draw that creates more than 64,000 jobs for the state of Queensland and about $4.6 billion in annual

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economic benefit, according to the Australian government. It is the world's largest structure built by living organisms, and it's among the most biodiverse regions of the world's oceans. The Great Barrier Reef is registered as a World Heritage Site by UNESCO.

The draft "Reef 2050 Long-Term Sustainability Plan" points to climate change as the single greatest threat to the future of the Great Barrier Reef. Getting greenhouse gas emissions under control will be critical to its future, the department argues.

"Global warming and the climate change it drives is the most serious and pervasive threat to the Reef," says the draft. "The future long-term outlook is critically dependent on limiting global temperature rise to the maximum extent possible."

And yet the draft plan acknowledges there is little Australia itself can do to limit or reverse global warming or halt the rise in ocean temperatures—a prime factor in recent mass coral bleaching events.

"Global warming and the climate change it drives is the most serious and pervasive threat to the Reef," says the draft.

Corals grow through a symbiotic relationship between animal coral polyps that build the hard calcium carbonate skeletons of the reefs and single-celled organisms that survive via photosynthesis and feed the polyps nutrients. Higher water temperatures cause polyps to expel these single-celled zooxanthellae and turn corals white, thus the term "bleaching." This increases coral mortality.

Harmful bleaching episodes at the Great Barrier Reef occurred in 2016 and 2017. The most recent bleaching event happened earlier this year during the Southern Hemisphere summer. Its impact is still being assessed.

"In 2020, severe bleaching was more widespread than in previous bleaching events in 2016 and 2017," the draft plan notes. "While major tourism areas of the Reef mostly had negligible or moderate bleaching in 2020, areas in the southern part of the Reef that escaped much of the impact in 2016 and 2017 were severely affected by this third event."

A new study by the Australian Institute of Marine Science (AIMS) showed that the Great Barrier Reef has recovered slightly from the previous two coral bleaching events, but it cautioned that scientists won't know the full impact of the 2020 bleaching until later this year.

The AIMS annual report, published Friday, found that two-thirds of 86 separate reef structures surveyed showed "slightly increased coral cover," with coral cover in the southern portion of the Great Barrier Reef having recovered the most.

The institute noted that the corals of the Great Barrier Reef have largely bounced back from the 2016 and 2017 events; "however, the third mass coral bleaching event in five years will likely be a setback to their recovery."

The government's plan says Australia must accelerate domestic efforts to lower greenhouse gas emissions and do everything necessary to convince other governments to do the same.

It also proposes stricter regulation of land- and water-based activities in and around the reef. And it recommends involving Aboriginal communities more in Great Barrier Reef management.

Stricter regulation of tourism may be forthcoming, as well.

Graeme Cumming, a professor and researcher at the ARC Centre of Excellence for Coral Reef Studies at James Cook University, says there's been an exponential increase in government permits issued for Great Barrier Reef operations since 2000. The rise in permitting is revealed by data he uncovered during a study on conservation management.

The permitting spike reflects an increase in international tourism, but he said he doubts this has had major negative effects on the health of the reefs—as the permits were mostly for "generally low-impact" activities like tour boat access and moorings.

The management plan emphasizes the necessity of minimizing pollution from coastal surface runoff. This means reducing fertilizer use for agriculture and ensuring the survival of coastal habitats that mitigate water quality issues, such as coastal wetlands and mangrove forests.

Runoff from coastal agriculture is "the main source of water pollution in the Reef catchment and is therefore a major focus for action and funding under the Plan," says the draft.

The authors want new measures to control water pollution from urban runoff and more cleanup operations to remove marine litter around the reefs, in particular marine plastic waste.

They want Queensland to better manage and control coastal development, and for the national government to enact stricter enforcement against illegal fishing activity.

The population of towns and cities along Queensland's coast is projected to steadily increase, "which will intensify impacts from the associated use of the Reef if not managed appropriately," the draft says.

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The plan also calls for greater protections for sea grass communities. Sea grass is critical to the survival of endangered dugongs, a cousin species to Florida's manatees.

Money also would be directed at controlling future crown-of-thorns starfish outbreaks and the spread of invasive species.

The plan promises future initiatives to replace or replenish corals that are damaged or destroyed by storms or other impacts, citing past coral experiments in reseeding and relocating corals that proved successful.

The Australian government aims to spend big on devising strategies to help the Great Barrier Reef adapt to higher ocean temperatures, including "on-reef experimental trials of selected techniques" launched within two years of the start of the recovery and protection plan.

Cumming called the new plan "useful" but warned that it wouldn't resolve direct impacts from climate change. He also expressed doubt about the government's spending plan for water pollution.

"I'm not convinced that the funding the government is committing to water quality is sufficient to achieve the necessary levels of catchment restoration," he said. "Recent research suggests that nutrients in seawater make bleaching worse."

On Friday, scientists from the United States, Australia, New Zealand and Saudi Arabia published a study in the journal *Science Advances* that points to proof that coastal runoff exacerbated recent coral bleaching events in the Red Sea.

The public comment period for the new Great Barrier Reef protection plan closes Sept. 30.

scientificamerican.com, 25 August 2020

https://www.scientificamerican.com

Growing underwater heat blob speeds demise of Arctic sea ice

2020-08-25

Arctic sea ice is itself an endangered species.

In March, soon after arriving aboard the *Polarstern*, a German icebreaker frozen into Arctic sea ice, Jennifer Hutchings watched as ice broke up around the ship, weeks earlier than expected. Even as scientists on the research cruise scrambled to keep field instruments from plunging into

the ocean, Hutchings, who studies ice deformation at Oregon State University, Corvallis, couldn't suppress a thrill at seeing the crack up, as if she had spotted a rare bird. "I got to observe firsthand what I studied," she says.

Arctic sea ice is itself an endangered species. Next month its extent will reach its annual minimum, which is poised to be among the lowest on record. The trend is clear: Summer ice covers half the area it did in the 1980s, and because it is thinner, its volume is down 75%. With the Arctic warming three times faster than the global average, most scientists grimly acknowledge the inevitability of ice-free summers, perhaps as soon as 2035. "It's definitely a when, not an if," says Alek Petty, a polar scientist at NASA's Goddard Space Flight Center.

Now, he and others are learning that a warming atmosphere is far from the only factor speeding up the ice loss. Strengthening currents and waves are pulverizing the ice. And a study published last week suggests deep heat in the Arctic Ocean has risen and is now melting the ice from below.

Ice has kept its grip on the Arctic with the help of an unusual temperature inversion in the underlying waters. Unlike the Atlantic or Pacific oceans, the Arctic gets warmer as it gets deeper. Bitter winters and chilly, buoyant freshwater from Eurasian rivers cool its surface layers, which helps preserve the underside of the ice. But at greater depths sits a warm blob of salty Atlantic water, thought to be safely separated from the sea ice.

As the reflective ice melts, however, it is replaced by darker water, which absorbs more of the Sun's energy and warms. Those warming surface waters are likely migrating down into the blob, which robotic temperature probes, moorings, and oceanographic surveys show is steadily warming and growing. With enough heat to melt the Arctic's ice three to four times over, the blob could devour the ice from below if the barrier of the cold surface layers ever dissipates.

Measurements from the eastern Arctic Ocean, published last week in the *Journal of Climate*, show the blob, usually found 150 meters below or deeper, has recently moved up to within 80 meters of the surface. Increased turbulence means some of that heat is now melting ice, says Igor Polyakov, an oceanographer at the University of Alaska, Fairbanks. "This heat has become, regionally, the key forcing for sea ice decay."

The process, called "Atlantification," is already well underway in the Barents Sea, north of Norway, where fingers of warm Atlantic water have spread north and risen, melting sea ice even in winter months. The invasion shows

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no sign of stopping, says Helene Asbjørnsen, an oceanographer at the University of Bergen who has helped chart this migration. "Ultimately we expect it to extend into the Arctic more."

The $134 million Multidisciplinary Drifting Observatory for the Study of Arctic Climate (MOSAiC), based on the *Polarstern*, is exploring another ice-destroying feedback. The ship froze itself into a floe in October 2019, to give the team a chance to observe the floe for one full year as the summer melt season shifted back into freezing. But the project ran into challenges. First came the COVID-19 pandemic, which made planned personnel rotations difficult. Then the ice drifted too far south too quickly. In late July, the day after the team pulled up its remaining instruments, the floe broke up and melted. "To me that is a big loss, and I'm pretty bummed about it," says Matthew Shupe, a climate scientist at the University of Colorado, Boulder, who helped lead U.S. contributions to the cruise. But, he added, there was a bonus: "We never planned to be around for that 'death of an ice floe' process."

The *Polarstern*'s floe is not an isolated case. Remote sensing satellites show that over the past 20 years, ice has been drifting faster, potentially sweeping it into warmer waters, says Sinéad Farrell, a sea ice scientist at the University of Maryland, College Park. One reason for the change in pace could be faster currents in the Arctic Ocean, as ice melt exposes more water to the push of the wind, says Arild Sundfjord, a physical oceanographer at the Norwegian Polar Institute. "We think we see signs of that."

Another factor could be an increase in the roughness of the sea ice, which allows wind to catch and propel it. MOSAiC scientists deployed GPS stations across the floe's melange of first-year and thicker multiyear ice to monitor its speed and deformation. They suspect that as the ice becomes thinner and weaker, it is more prone to the crunch and crumble that builds up wind-catching ridges, Hutchings says, but they're still resolving whether that is true. The turmoil took a heavy toll on the expedition, crushing some instruments like aluminum cans and destroying snow sampling sites. It was frustrating, Shupe says. "We don't really control anything here," he says. "The Arctic is telling us its story and we just need to be clever enough to document it."

ICESat-2, a laser altimeter launched by NASA in 2018, will help extrapolate findings from MOSAiC to the rest of the Arctic. Unlike previous satellites, ICESat-2 can distinguish between ice floe cracks and melt ponds on top, and it is already showing stark differences between multiyear and first-

year ice, Farrell says. In a surprise, the ICESat-2 team is finding that the multiyear ice overall is twice as rough as first-year ice. "It's kind of like aging skin," she says. "They get more wrinkly over time." The satellite also seems to be capable of capturing waves amid the ice, and linking them to nearby storms, Petty says. It's another worrying mechanism that could speed up ice loss, he says. "As waves break the ice apart, it gets more exposed to heat—and melts further."

The retreat of the ice bodes ill for global climate, but it is making the Arctic easier to study. This month saw the start of the Synoptic Arctic Survey, which will knit together more than a dozen national Arctic cruises by ice breakers and other research ships. The survey will cover the Arctic's entirety, providing a near-simultaneous picture of currents, life, and water conditions and chemistry, rather than a collection of regional snapshots over time. The pandemic delayed all but two of the cruises, which were planned for this summer: those of Japan's *Mirai* and South Korea's *Aron*. But once completed, the survey could answer basic questions, such as whether the Arctic is a net source or sink of carbon dioxide.

And it could not have been done in the ice-bound Arctic of old. "Now," Sundfjord says, "we can go wherever, and whenever, we want."

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