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

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ASIA PACIFIC

Chemicals with non-industrial uses removed from the Australian Inventory of Chemical Substances (old Inventory)

2020-07-01

Following an extensive review and public call for information about their use, more than 1600 chemicals listed in the Australian Inventory of Chemical Substances (old Inventory) under the Industrial Chemicals (Notification and Assessment) Act 1989 will not be listed on the Australian Inventory of Industrial Chemicals (new Inventory) under the Industrial Chemicals Act 2019 which comes into force today, 1 July 2020.

These are chemicals that are listed in the non-confidential section of the old Inventory but which are not industrial chemicals under the Industrial Chemicals (Notification and Assessment) Act 1989 or under the Industrial Chemicals Act 2019. A list of these chemicals is available on this website.

The chemicals never had, and do not have, an industrial use in Australia.

The Inventory is publicly searchable on this website through a dedicated Inventory search page. There are 2 separate tabs — one for searching by CAS numbers and another for searching by keyword.

Download the list

[List of chemicals with no industrial use \(100KB\).XLSX](#)

Industrialchemicals.gov.au, 1 July 2020

<https://www.industrialchemicals.gov.au/news-and-notice/chemicals-non-industrial-uses-removed-australian-inventory-chemical-substances-old-inventory>

2 substances designated as poisonous and 14 substances designated as deleterious under Japan PDSCL/2 substances no longer designated as deleterious

2020-07-08

On 24 June 2020, the following substances were designated as poisonous under the Poisonous and Deleterious Substances Control Law (PDSCL) by Japan's Ministry of Health, Labour and Welfare (MHLW):

The chemicals never had, and do not have, an industrial use in Australia.

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Cobalt(II) oxide

Dibutyl(dichloro)stannane

The following substances were designated as deleterious:

1-Amino-2-propanol

2-Isobutoxyethanol

Oxirane-2-ylmethylmethacrylate

1-Chloro-4-nitrobenzene

2,4-Dichlorophenol

Nonylphenol

1-Vinyl-2-pyrrolidone

Ammonium fluoride

Sodium fluoride

Benzene-1,4-dicarbonyl dichloride

Benzoyl chloride

Methanesulfonic acid

Sodium bisulfide

Disodium sulfide

The following substances are no longer designated as deleterious:

4-Ethyl-octa-3-enenitrile

3,4-Dimethylbenzotrile

Yordas Hive, 8 July 2020

<https://www.yordashive.com/news/article/952>

The regulations, which took effect from July 1, are designed to create uniform standards on the disposal of tunnel-boring soil.

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West Gate Tunnel soil rules blasted as designated to 'fast-track' project

2020-07-09

Taxpayers will forfeit hundreds of millions of dollars in landfill levies that were supposed to be paid by the West Gate Tunnel's builders under new regulations quietly released by the Andrews government.

New environmental rules governing how landfill operators manage tunnel-boring soil released last week have been criticised for trading off environmental protections to resolve a protracted commercial dispute on the toll road project.

The regulations, which took effect from July 1, are designed to create uniform standards on the disposal of tunnel-boring soil. They require all landfill operators to complete an environmental management plan that will be audited and published online, but information deemed commercial in confidence will be kept secret.

However, operators can rip up key documents showing how they disposed of soil and leachate after two years under the rules written by the Department of Environment, Land, Water and Planning. Tax records must be kept for five years.

Full Article

The Age, 9 July 2020

<https://www.theage.com.au/national/victoria/west-gate-tunnel-soil-rules-blasted-as-designated-to-fast-track-project-20200708-p55a67.html>

Learn how to manage the risks of flammable liquids in your workplace

2020-07-09

Safe Work Australia has published a new guide on the storage of flammable liquids.

The guide is for small to medium sized businesses and describes the risks of flammable liquids and explains, step by step, how to manage those risks.

This includes working out how flammable the chemicals you store are, which other chemicals they're safe to be around, how to make sure there

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is proper ventilation, and ensuring you have the correct fire-fighting equipment.

The guide also includes an example of a business that uses and stores flammable liquids, and provides advice about workplace placarding for businesses storing large quantities of flammable liquids.

The guide was developed in consultation with representatives from work health and safety regulators, unions and industry groups.

Read and download the Storage of flammable liquids guide.

Safe Work Australia, 9 July 2020

<https://www.safeworkaustralia.gov.au/doc/storage-flammable-liquids>

AMERICA

New Vermont laws aimed at cutting plastic and food waste take effect

2020-07-01

The rules center around bags, take-out containers and composting

A new set of laws took effect Wednesday in Vermont that are designed to protect the environment in a state that has long prided itself on taking care of its natural resources.

As of July 1, stores across the state can no longer bag customers' purchases in plastic.

At Quality Market in Barre, customer Joe Greene picked up a reusable shopping bag for \$1.49 to carry his purchases in.

"The hardest thing is just getting to remember to bring them with you," Greene said of reusable bags.

Full Article

NBC Boston, 1 July 2020

<https://www.nbcboston.com/news/local/new-vermont-laws-aimed-at-cutting-plastic-and-food-waste-take-effect/2152402/>

As of July 1, stores across the state can no longer bag customers' purchases in plastic.

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Maine PFAS tracker—Maine standards and proposed actions

2020-07-08

Pierce Atwood LLP offers this summary of Maine Per- and Polyfluoroalkyl Substances (PFAS) standards as a convenience in evaluating PFAS and tracking Maine Department of Environmental Protection (DEP) regulatory and Maine legislative developments. We update this Maine PFAS Tracker when there are important new actions (if you found this on the Pierce Atwood LLP website, then you are seeing the most recent version). Levels are provided below in parts per million (ppm), parts per billion (ppb), or parts per trillion (ppt), depending on the matrix typically involved. Please click here if you prefer to view or print this information as a PDF.

WHAT'S NEW IN THIS EDITION: The Maine Board of Environmental Protection (BEP) adopted new regulations requiring manufacturers and distributors to report product information about certain children's products offered for sale within the State of Maine. See Section VI below for details.

I. Maine Drinking Water Program Guidance, Department of Health and Human Services

PFOA & PFOS Combined

70 ppt

This standard is taken from the U.S. Environmental Protection Agency Drinking Water Health Advisory of 2016. ME CDC, Dec. 2016 provided the same standard.

[Full Article](#)

National Law Review, 8 July 2020

<https://www.natlawreview.com/article/maine-pfas-tracker-maine-standards-and-proposed-actions>

Save the date: Join ANSI's nanotechnology standards panel virtual workshop on advanced materials

2020-07-06

The American National Standards Institute Nanotechnology Standards Panel (ANSI-NSP) invites interested stakeholders to participate in its

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virtual workshop on advanced materials on **August 19-20, 2020**. Online registration is now open.

Advanced materials are of growing interest as there is increasing recognition that size alone does not define the unique properties of a material. More and more, governments and organizations that originally focused on nanomaterials are now also focusing on advanced materials and emerging technologies.

The workshop discussions will focus on whether existing nanotechnology standards bodies should address advanced materials and how the gaps and needs relative to advanced materials standards can best be identified and prioritized.

Panelists will represent the National Nanotechnology Coordination Office, the United States Environmental Protection Agency, the U.S. Consumer Product Safety Commission, The Chemours Company, Society of Toxicology, the Organisation for Economic Co-operation and Development, among others.

The workshop will take place on **August 19-20, 2020**, from 10:00 a.m. to 1:00 p.m. ET on both days.

- Register for Day 1 (August 19) via Webex
- Register for Day 2 (August 20) via Webex

Relevant stakeholders include industry, government representatives, representatives from non-governmental organizations, and academics engaged in this subject area, among others.

Please contact Heather Benko, ANSI senior manager of nanotechnology standardization activities, with any questions: HBenko@ansi.org.

ANSI, 6 July 2020

https://www.ansi.org/news_publications/news_story?menuid=7&articleid=3f834b6c-79b7-4d74-8a13-4a96ef279737

More and more, governments and organizations that originally focused on nanomaterials are now also focusing on advanced materials and emerging technologies.

Some 350 million plastic cups and 2 billion plastic bottles are used annually, the Environment Ministry said.

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EUROPE

Greece taxing, banning single-use plastics, containers, cotton buds, straws

2020-07-07

After several failed efforts to cut down on the use of non-biodegradable products, primarily plastics, Greece's New Democracy plans to prohibit single-use plastics, from takeaway coffee cups to cotton buds, as well as straws.

That would be done ahead of an EU deadline in 2021, the government said, reported Reuters, with Greeks heavily reliant on using the items that clog waste streams and oceans and the country's low recycling rate.

Some 350 million plastic cups and 2 billion plastic bottles are used annually, the Environment Ministry said. In the European Union, about 80 percent of the litter that ends in the sea, endangering marine life, is plastic.

Prime Minister Kyriakos Mitsotakis is making environmental issues a priority, unusual for New Democracy, and the news agency said his government wants a bill to be voted on by the end of July after public consultation.

Environment Minister Kostis Hatzidakis said Greece was far behind other EU countries and belonged "more to the 19th Century" when it came to recycling with many Greeks routinely tossing garbage into recycling bins, unwilling to take a couple of more steps to put it in rubbish bins.

He said there would be a 4-euro-cent surcharge on plastic cups and food containers and plastic cups from 2022 and water facilities in public spaces from July 2021. From 2023, consumers will get a refund if they return plastic bottles. The money will be allocated to the Green Fund to finance environmentally friendly projects.

Businesses such as restaurants, cafes and takeaway outlets will be obliged to provide their customers with reusable packaging, said Kathimerini although it wasn't explained why there would be a tax on banned substances not supposed to be used.

The National Herald, 7 July 2020

https://www.thenationalherald.com/archive_general_news_greece/arthro/greece_taxing_banning_single_use_plastics_containers_cotton_buds_straws-531077/

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Covid-19: Deadline extensions, derogations and supply-chain news—Denmark

2020-07-10

The Danish EPA has ordered the company Coredesign A/S to immediately withdraw from the market the hand sanitiser, Handsprit 10ml - 70%. This is because the labelling on the product is out of line with the CLP and biocidal products Regulations.

The company now has to send a recall letter to retailers selling the disinfectant.

Chemical Watch, 10 July 2020

<https://chemicalwatch.com/133225/covid-19-deadline-extensions-derogations-and-supply-chain-news>

INTERNATIONAL

IEC 62474 Declarable Substances List updated to version D20.00

2020-07-08

On 25 June 2020, the IEC 62474 Declarable Substances List was updated to version D20.00:

Regulatory changes drove 1 addition, namely for the substance entry:

Dibutylbis(pentane-2,4-dionato-O,O')tin

The following substances were deleted from the Reference Substance List:

1,1,2,2,3,3,4,4,4-nonafluoro-N-(2-hydroxyethyl)-N-methylbutane-1-sulphonamide

1,1,2,2,3,3,4,4,4-nonafluorobutane-1-sulphonyl fluoride

There was a reorganisation of how the DSL supports California RoHS, given that California RoHS also requires reporting of total mass of heavy metals.

Yordas Hive, 8 July 2020

<https://www.yordashive.com/news>

On 25 June 2020, the IEC 62474 Declarable Substances List was updated to version D20.00:

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REACH Update

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Polymer based nanocomposites—enabling innovation, resource efficiency and helping to fight climate change

2020-07-01

The plastics industry in Europe is a vibrant sector that helps improve our quality of life by enabling innovation, facilitating resource efficiency and enhancing climate protection.

When thinking of how nanoscale particles that are added to plastic matrices can improve the properties of products, a lot of examples come to mind – for instance, the electrical or thermal properties of electrostatic packaging for microchips, electrostatic coatings, solar cells, batteries, modified lithium-ion batteries or printed electronics.

Nanoscale particles can also increase mechanical resilience of reinforced plastics used for the construction of lighter cars and planes or for the blades and wind turbines.

Moreover, they are added to modern plastic packaging for improving its material properties – e.g. thermal stability, barrier properties, UV protection.

Plastic packaging plays an important role in ensuring the freshness of food, extending its shelf life and helping to improve the quality of products for consumers. According to recent data, around 20% of food produced in the EU is lost or wasted. Plastic packaging can help make food increasingly accessible, safe and affordable.

Migration of substances into food occurs with all packaging

Migration happens whenever packaging — of any type — comes into contact with food. It is a natural physical process. The key point is that the level of migration is safe.

EU Regulation 10/2011 on plastic materials and articles intended to come into contact with food, authorises some of them as additives for plastics in food contact with certain requirements. Additives are like spices in a cooking recipe.

Nanoparticles are deliberately incorporated in the plastic matrix. But do they remain firmly bound in the plastic packaging materials also in real use conditions?

Before answering this question and to better understand what real use conditions mean, let's think of our daily life. Real use conditions mean that

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you do not put a reusable plastic bowl in the oven to warm your food, as it is not intended to be used at a high temperature, unless specifically indicated on the product.

Plastics are rigorously tested to make sure that migration - if any - is safe

Testing conditions are specified legally and need to be used by all actors performing tests in the value chain (from raw materials and packaging producers to food packers). Tests are done at several stages in the value chain to ensure that the plastic sample is suitable for its end-use.

PlasticsEurope together with Cefic-FCA – the food additive sector group of the Chemical association CEFIC - collaborated with the Fraunhofer Institute for Process Engineering and Packaging (IVV) to examine whether nanoparticles can migrate from plastic packaging into the packaged foodstuff.

In migration testing it is useful to differentiate between two types of nanoparticles, based on their morphological structures: lamellar (flat) nano-clays and (quasi-) spherical particles (e.g. silver or titanium nitride). Temperature and time-dependent experiments were performed in the polymer (LDPE).

Three plastic nanocomposites containing the nanomaterial silver, titanium nitride and laponite were investigated on the potential to release nanoparticulates under stress conditions into food simulants.

What are food simulants, you might ask? Food simulants - as prescribed by law (e.g. olive oil) - mimic the properties of different food types under typical/worst case conditions.

The results of the study conclude that laponite does not migrate into food once it is incorporated into a polymer matrix.

While laponite represents lamellar types of nanoparticles, another experimental set up could show that also spherical types of nanoparticles, like silver nanoparticles in an LDPE (Low-density polyethylene) plastic matrix cannot migrate.

In a nutshell, the studies demonstrated, that nanoparticles which are completely encapsulated in the host polymer matrix do not have a potential to migrate into food and therefore consumers will not be exposed to nanoparticles from food contact polymers when those are completely embedded in polymer and the contact surface is not altered by mechanical surface stress during application.

According to recent data, around 20% of food produced in the EU is lost or wasted. Plastic packaging can help make food increasingly accessible, safe and affordable.

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Full Article

EUON, 1 July 2020

<https://euon.echa.europa.eu/de/nanopinion/-/blogs/polymer-based-nanocomposites-enabling-innovation-resource-efficiency-and-helping-to-fight-climate-change>

European Commission planning to make PMT, vPvM 'categories' for SVHCs

2020-07-9

Intention appears in unpublished draft document on the upcoming EU chemicals strategy for sustainability

The European Commission is planning to introduce PMTs and vPvMs as "categories" of substances of very high concern (SVHCs) under REACH.

The plan raises the possibility of hundreds of additional chemicals being identified as SVHCs on the basis that they are persistent, mobile and toxic (PMT) or very persistent, very mobile (vPvM), and without reference to "equivalent level of concern".

The Commission's intention is set out in an unpublished draft communication document on the upcoming EU chemicals strategy for sustainability, circulated in June and recently seen by Chemical Watch. It is not final and is subject to change before publication, expected in the autumn.

"The first step to achieve [introduction of PMTs and vPvMs] will be to strengthen information requirements in order to perform comprehensive environmental risk assessment under the relevant legislation," the document also says.

The intention is one of several relating to persistence. The Commission says in the document that it will also "propose hazard classes and criteria" in the CLP or the Globally Harmonized System (GHS) of classification and labelling of chemicals to "fully address environmental toxicity, persistency, mobility and bioaccumulation".

Scientists say that mobility should be considered in regulatory risk assessment of chemicals in order to fill an important gap, relating to certain chemicals that pose a threat through contamination of water sources.

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Last year, the EU's Scientific Committee on Health, Environmental and Emerging Risks (Scheer) identified PMT substances as one of 14 emerging issues.

Later in the year, an initiative led by the German Environmental Agency (UBA) finalised criteria for identification of PMT and vPvM substances to facilitate risk management. Over 100 scientists representing regulatory agencies, academia and industry approved the final report. EU member states and NGOs voiced general support for implementation of the criteria under REACH, but Cefic said that they are "not fit for purpose" and could lead to unnecessary regulation. In May, European industry research organisation Ecetoc presented preliminary results of an ongoing project that suggest monitoring data does not support the threshold for aquatic mobility implied by the criteria.

Carcinogens, mutagens and reprotoxins, as well as certain types of chemicals that are both persistent and bioaccumulative, can be routinely identified as SVHCs, according to Article 57 of REACH. Chemicals falling outside of this subset – including those that are both persistent and mobile – may be identified as SVHCs "on a case-by-case basis", if there is "equivalent level of concern".

The plan was welcomed by one architect of the criteria, Hans Peter Arp of the Norwegian Geotechnical Institute (NGI) and the Norwegian University of Science and Technology. Last year, an investigation by Professor Arp and another scientist identified 260 REACH registered substances meeting the PMT and vPvM criteria, including 122 that should be prioritised for further investigation in relation to potential risk management.

"As a scientist working with both hazard and risk of PMT and vPvM substances, I really like the phrasing: 'the first step to achieve this will be to strengthen information requirements in order to perform comprehensive environmental risk assessment under the relevant legislation'. Certainly for both hazard and risk assessment of PMT and vPvM substances, we need better quality data, particularly related to environmental half-lives, the sorption properties of ionic and ionisable substances, leaching tests and exposure modelling. This could all be propelled through new regulatory requirements encouraging more, and better, data requirements for environmental properties."

Professor Arp also praised the statement in the document about CLP and GHS. "PMT and vPvM substances in drinking water and remote aquatic ecosystems is a global, trans-boundary concern, not just a European one. This needs to be addressed on the international level."

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The Commission and Cefic declined to comment for this article.

Chemical Watch, 9 July 2020

<https://chemicalwatch.com/133275/european-commission-planning-to-make-pmt-vpvm-categories-for-svhcs>

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Janet's Corner

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Chemical Formula For Coffee

2020-07-17

What Is The Chemical Formula for Coffee?

CoFe2



 CHEMISTRYJOKES.COM

~q

<https://www.chemistryjokes.com/jokes/what-is-the-chemical-formula-for-coffee/>

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Hazard Alert

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Styrene

2020-07-17

Styrene is a colourless, oily liquid that has a sweet smell. It is known by many other names, including vinylbenzene, ethenylbenzene, cinnamene, phenylethylene, styrole, styropol, and UN 2055. It is a monocyclic aromatic hydrocarbon and is highly flammable. Styrene boils at 145°C and freezes at -30.6°C. More than 15 million metric tons of styrene are produced each year. Styrene has been classified as “probably carcinogenic” by the International Agency for Research on Cancer (IARC) [1,2,3,4]

USES [1,3]

More than half of the styrene produced is made into polystyrene. The rest is used to make products such as pipes, fibreglass, car parts, food containers, rubber, plastic, carpet backing, and plastic. Specifically, it can be used to make acrylonitrile-butadiene-styrene copolymer, a hard plastic used in engineering; styrene-butadiene rubber that is used in automobile tires; and styrene-acrylonitrile copolymer for improved heat resistance

ROUTES OF EXPOSURE [2]

- The primary route of styrene exposure is via inhalation
- Occupational exposure sources include the manufacturing of reinforced plastics, and the addition of the liquid in construction materials.
- Workers can be exposed to the chemical through fibreglass processes.
- Low levels of styrene exposure can be found in fruits, vegetables, nuts, and meat.
- The general population are exposed to styrene via car exhaust fumes, cigarette smoke, and photocopiers.

HEALTH EFFECTS

Styrene poisoning affects a range of systems including the integumentary and respiratory systems.

Acute Effects [2]

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

- Acute exposure to the liquid can cause eye, skin and upper respiratory tract irritation.

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- Styrene exposure can also cause headaches, dizziness and nausea.
- Inhalation of the chemical may result in “styrene sickness” that can cause: headaches, vomiting, weakness, nausea, fatigue, dizziness, and ataxia.

Chronic Effects [2]

Styrene is toxic to multiple body systems. Long-term exposure to the chemical could result in hearing loss, peripheral neuropathy, altered liver function, and abnormal ECG patterns. It can also cause CNS depression, which can result in decreased concentration, decreased reaction times, and the impairment of short-term memory. Chronic exposure can also result in hepatotoxicity and dyschromatopsia.

SAFETY

First Aid Measures [6]

- Ingestion: DO NOT INDUCE VOMITING. Give victim large amounts of water. Immediately contact a medical professional.
- Skin contact: Immediately wash affected area with plenty of soap and water for at least 15 minutes. Remove contaminated clothing and shoes; do not re-wear until they have been thoroughly decontaminated.
- Eye contact: Rinse eyes for at least 15 minutes; don't forget to wash under both upper and lower eyelids. Immediate medical attention is required.
- Inhaled: Take victim to the nearest fresh air source and monitor their breathing. If they are not breathing (and you are qualified), perform CPR with the aid of a pocket mask or one-way valve. Contact a medical professional immediately.
- General: Never administer anything by mouth to an unconscious, exposed person.

Exposure Controls/Personal Protection [6]

- Engineering controls: Emergency eyewash fountains and safety showers should be accessible in the immediate area of the potential exposure. Ensure there is adequate ventilation. Whenever possible, material should be handled in a laboratory, underneath a fume hood.
- Personal protection: Impervious protective clothing, including gloves, boots, a lab coat, and an apron or coveralls. Wear appropriate

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eye protection. For specifications on PPE, check regulations in your jurisdiction.

REGULATION [7]

United States:

The Occupational Safety and Health Administration (OSHA) has set an 8-hour time weighted average (TWA) concentration for styrene of 100ppm.

Australia [8]

Safe Work Australia has set an 8-hour time TWA for styrene of 50ppm, with a Short Term Exposure Limit (STEL) of 100ppm.

REFERENCES

1. <https://pubchem.ncbi.nlm.nih.gov/compound/Styrene#:~:text=Styrene%20is%20primarily%20a%20synthetic,it%20a%20sharp%2C%20unpleasant%20smell.>
2. https://www.safeworkaustralia.gov.au/system/files/documents/2002/health_monitoring_guidance_-_styrene.pdf
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8. [http://www.safeenvironments.com.au/styrene/#:~:text=The%20exposure%20standard%20for%20styrene%20monomer%20is%20a%20Time%20Weighted,\(STEL\)%20of%20100%20ppm.](http://www.safeenvironments.com.au/styrene/#:~:text=The%20exposure%20standard%20for%20styrene%20monomer%20is%20a%20Time%20Weighted,(STEL)%20of%20100%20ppm.)

Bulletin Board

Gossip

JUL. 17, 2020

Tesla to make molecule printers for German COVID-19 vaccine developer CureVac

2020-07-02

Tesla Inc is building mobile molecule printers to help make the potential COVID-19 vaccine being developed by CureVac in Germany, the electric-car maker's Chief Executive Officer, Elon Musk, tweeted on Wednesday.

CureVac, an unlisted German company, has said it is developing portable, automated mRNA production units that it calls printers and which Musk described as "RNA microfactories".

They are being designed to be shipped to remote locations, where they can churn out its vaccine candidate and other mRNA-based therapies depending on the recipe fed into the machine.

But for the immediate pandemic use - should its vaccine candidate win market approval - it has production sites with regulatory approval in Germany with a capacity to produce hundreds of millions of doses.

The company, based in Tuebingen and backed by the Bill & Melinda Gates Foundation, is a pioneer of the so-called messenger RNA approach, which is also pursued by BioNTech and its partner Pfizer as well as Moderna.

RNA molecules are single-stranded, and thanks to their recurring molecular pattern, they can be produced in a relatively simple biochemical process that do not require genetically modified living cells, which are needed to produce most other biotech drugs.

CureVac is also building a new stationary site that could increase its output tenfold to billions of doses.

The "microfactories" would be built at Tesla Grohmann Automation in Germany, Musk said in a Twitter thread late on Wednesday night.

Tesla acquired the company that develops automated manufacturing systems for batteries and fuel cells in 2016 to expand its production.

CureVac has been working with Tesla Grohmann to develop the mobile printer technology, a person familiar with CureVac said.

Musk did not elaborate on his plans. Tesla and CureVac were not immediately available to comment.

Musk, who is known to make impromptu announcements on Twitter, had in March said that Tesla has extra FDA-approved ventilators that can

CureVac, an unlisted German company, has said it is developing portable, automated mRNA production units that it calls printers and which Musk described as "RNA microfactories".

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be shipped free of cost to hospitals within regions where the electric-car maker delivers.

reuters.com, 2 July 2020

<https://www.reuters.com>

CRISPR gene editing in human embryos wreaks chromosomal mayhem

2020-06-25

A suite of experiments that use the gene-editing tool CRISPR–Cas9 to modify human embryos have revealed how the process can make large, unwanted changes to the genome at or near the target site.

The studies were published this month on the preprint server bioRxiv, and have not yet been peer-reviewed^{1,2,3}. But taken together, they give scientists a good look at what some say is an underappreciated risk of CRISPR–Cas9 editing. Previous experiments have revealed that the tool can make ‘off target’ gene mutations far from the target site, but the nearby changes identified in the latest studies can be missed by standard assessment methods.

“The on-target effects are more important and would be much more difficult to eliminate,” says Gaétan Burgio, a geneticist at the Australian National University in Canberra.

These safety concerns are likely to inform the ongoing debate over whether scientists should edit human embryos to prevent genetic diseases — a process that is controversial because it creates a permanent change to the genome that can be passed down for generations. “If human embryo editing for reproductive purposes or germline editing were space flight, the new data are the equivalent of having the rocket explode at the launch pad before take-off,” says Fyodor Urnov, who studies genome editing at the University of California, Berkeley, but was not involved in any of the latest research.

Unwanted effects

Researchers conducted the first experiments using CRISPR to edit human embryos in 2015. Since then, a handful of teams around the world have begun to explore the process, which aims to make precise edits to genes. But such studies are still rare and are generally strictly regulated.

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The latest research underscores how little is known about how human embryos repair DNA cut by the genome-editing tools — a key step in CRISPR–Cas9 editing, says reproductive biologist Mary Herbert at Newcastle University, UK. “We need a basic road map of what’s going on in there before we start hitting it with DNA-cutting enzymes,” she says.

The first preprint was posted online on 5 June by developmental biologist Kathy Niakan of the Francis Crick Institute in London and her colleagues. In that study¹, the researchers used CRISPR–Cas9 to create mutations in the *POU5F1* gene, which is important for embryonic development. Of 18 genome-edited embryos, about 22% contained unwanted changes affecting large swathes of the DNA surrounding *POU5F1*. They included DNA rearrangements and large deletions of several thousand DNA letters — much greater than typically intended by researchers using this approach.

Another group, led by stem-cell biologist Dieter Egli of Columbia University in New York City, studied embryos created with sperm carrying a blindness-causing mutation in a gene called *EYS*². The team used CRISPR–Cas9 to try to correct that mutation, but about half of the embryos tested lost large segments of the chromosome — and sometimes the entire chromosome — on which *EYS* is situated.

And a third group, led by reproductive biologist Shoukhrat Mitalipov of Oregon Health & Science University in Portland, studied embryos made using sperm with a mutation that causes a heart condition³. This team also found signs that editing affected large regions of the chromosome containing the mutated gene.

In all the studies, researchers used the embryos for scientific purposes only, and not to generate pregnancies. The lead authors of the three preprints declined to discuss the details of their work with *Nature’s* news team until the articles are published in peer-reviewed journals.

Unpredictable repair

The changes are the result of DNA-repair processes harnessed by genome-editing tools. CRISPR–Cas9 uses a small strand of RNA to direct the Cas9 enzyme to a site in the genome with a similar sequence. The enzyme then cuts both strands of DNA at that site, and the cell’s repair systems heal the gap.

The edits occur during that repair: most often, the cell seals up the cut using an error-prone mechanism that can insert or delete a small number

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of DNA letters. If researchers provide a DNA template, the cell might sometimes use that sequence to mend the cut, resulting in a true rewrite. But broken DNA can also cause shuffling or loss of a large region of the chromosome.

Previous work using CRISPR in mouse embryos and other kinds of human cell had already demonstrated that editing chromosomes can cause large, unwanted effects^{4,5}. But it was important to demonstrate the work in human embryos as well, says Urnov, because different cell types might respond to genome editing differently.

Such rearrangements could be missed in many experiments, which typically look for other unwanted edits, such as single DNA-letter changes or small insertions or deletions of only a few letters. The latest studies, however, looked specifically for large deletions and chromosomal rearrangements near the target site. "This is something that all of us in the scientific community will, starting immediately, take more seriously than we already have," says Urnov. "This is not a one-time fluke."

Genetic changes

The three studies offered different explanations for how the DNA changes arose. Egli and Niakan's teams attributed the bulk of the changes observed in their embryos to large deletions and rearrangements. Mitalipov's group instead said that up to 40% of the changes it found were caused by a phenomenon called gene conversion, in which DNA-repair processes copy a sequence from one chromosome in a pair to heal the other.

Mitalipov and his colleagues reported similar findings in 2017⁶, but some researchers were sceptical that frequent gene conversions could occur in embryos. They noted that the maternal and paternal chromosomes are not next to each other at the time the gene conversion is postulated to occur, and that the assays the team used to identify gene conversions could have been picking up other chromosomal changes, including deletions^{4,7}.

Egli and his colleagues directly tested for gene conversions in their latest preprint and failed to find them, and Burgio points out that the assays used in the Mitalipov preprint are similar to those the team used in 2017. One possibility is that DNA breaks are healed differently at various positions along the chromosome, says Jin-Soo Kim, a geneticist at Seoul National University and a co-author of the Mitalipov preprint.

nature.com, 25 June 2020

<https://www.nature.com>

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Climate change will make world too hot for 60 per cent of fish species

2020-07-02

Fish are at a far greater risk from climate change than previously thought, as researchers have shown that embryos and spawning adults are more susceptible to warming oceans.

In a worst-case scenario of 5°C of global warming, up to 60 per cent of fish species around the world would be unable to cope with temperatures in their geographical range by 2100, when different stages of their lives are taken into consideration. Even if humanity meets the Paris deal's tough goal of holding warming to 1.5°C, it would be too hot for 10 per cent of fish.

Previously, we thought that just 5 per cent of fish species would struggle to cope with 5°C of global warming, but that was based on analysis of adult fish alone.

"We can say 1.5°C is not paradise, there will be changes. But we can limit those changes if we manage to stop climate change. Fish are so important for human nutrition, so this study makes a strong case for protecting our ecosystems and natural environments," says Hans-Otto Pörtner at the Alfred Wegener Institute in Bremerhaven, Germany, part of the team behind the research.

Life-stages

The researchers analysed existing scientific literature on the heat tolerance of 694 species of freshwater and marine fish species.

Previous analysis has focused very little on life stages, but the team took into account differences between spawning and non-spawning adults, larvae and embryos. Spawners and embryos were found to cope with a much smaller gap between minimum and maximum temperatures, on average 7.2°C and 8.4°C respectively, than the 27.5°C range for adults.

"This is casting light on a life phase that has been largely ignored," says Pörtner.

The greater vulnerability for embryos and reproductive adults is a "major cause for concern", said Jennifer Sunday at McGill University in Montreal, Canada, who wasn't involved the study, in a commentary in the journal *Science*.

Even if humanity meets the Paris deal's tough goal of holding warming to 1.5°C, it would be too hot for 10 per cent of fish.

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The main reason spawners are less tolerant of warming oceans is down to their greater oxygen needs, and oxygen is more soluble in colder waters and less so in warmer ones. Cooler waters benefit embryos in other ways.

Unfortunately, seas are expected to warm too quickly for evolutionary adaptation. While fish can move to cooler regions, appropriate new spawning sites aren't always available. "It is worth making an effort to go for as little climate change as possible," says Pörtner.

newscientist.com, 2 July 2020

<https://www.newscientist.com>

Coronavirus is creating a crisis of energy insecurity

2020-07-01

As the nation remains in the grip of the COVID-19 pandemic, a more insidious crisis is taking root as households are unable to pay their energy bills, risking serious health consequences and increasing debt, while federal and state governments fail to adequately protect vulnerable families.

Before COVID-19, one in three American households were struggling to pay their energy bills.

An increase in extreme temperatures – brought on by climate change – combined with rising energy costs forced consumers to make impossible choices between keeping their lights on, purchasing food, or seeking medical care.

The COVID-19 pandemic only exacerbated this problem. As individuals lost their jobs at alarming rates, they were also asked, or mandated, to stay at home to stop the spread of the virus. This led to an unexpected increase in residential energy use and corresponding energy bills.

In a new nationally representative survey of 2,381 low-income households, administered in May 2020, we find that the pandemic has deepened energy insecurity. Those who lost their jobs or had their hours reduced due to the pandemic were three times more likely to report an inability to pay an energy bill in the previous month.

In addition, like COVID-19 itself, energy insecurity has disproportionately worsened for vulnerable populations. African American (16 percent) and Hispanic (19 percent) households were far more likely to report difficulty

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paying an energy bill in the last month compared to White respondents (9 percent).

The problem is also worse for households with young children, those with disabled members, and those who rely on an electronic medical device.

Respondents who power a medical device at home were twice as likely not to be able to pay an energy bill in the past month, three times as likely to receive a notice from their utility provider that their energy is in jeopardy of being disconnected, and more than four times as likely to have their service shut off.

These heightened levels of energy insecurity could spur a health crisis in low-income households by exposing at-risk populations to the summer heat while simultaneously hindering their ability to seek or afford medical care. While some policies have been implemented, the situation remains dire as several of these measures are temporary; however, there is a path forward for policymakers to protect vulnerable families by suspending all utility disconnections, forgiving late payment fees, and increasing funds for energy bill assistance throughout the hot summer months.

Health impacts

As the energy insecure population grows in the U.S., the health consequences could be calamitous, not only for those who are disabled or require an electronic medical device but also for those who live in poor housing conditions.

Energy insecurity and deficient housing stock have been linked to negative health outcomes, including increased rates of asthma, respiratory infections, and mental health issues, especially in households with children and senior citizens.

Approximately 20 percent of survey respondents noted that their home was drafty or had poor insulation; 9 percent had holes in the floors and walls; and 7 percent did not have a working air conditioner. An additional 12 percent responded that they had mold, which is associated with bronchitis, upper respiratory tract symptoms, and higher rates of depression.

The coming summer months, which are poised to be one of the hottest on record, are another looming threat. If economic conditions do not improve, millions of Americans will be vulnerable. An estimated 65,000 people visit the emergency room each year due to acute heat illnesses; however, this summer could be comparatively severe as

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25 percent of our survey respondents either lost their health insurance entirely (15 percent) or were put on a less generous plan due to COVID-19, and 40 percent of respondents indicated that the pandemic has harmed their ability to seek medical care.

In response to their energy insecurity, a third of households reported taking extreme measures to maintain comfortable temperatures in their home in the last year. Some of these measures are dangerous, such as using space heaters, which are the leading cause of household fires and associated deaths; turning on their stove; and burning trash.

As temperatures rise, we expect families to use methods of cooling their homes that will allow them to stay comfortable while keeping their energy costs low, such as taking cold showers, buying regular and dry ice, and using fans. Because we only expect conditions to worsen, it is critical that policymakers address energy insecurity; otherwise, the summer of 2020 will present unprecedented challenges to already-struggling American families.

Inadequate policy responses

In the early weeks of the pandemic, the federal government took several steps to offer relief. The Coronavirus Aid, Relief and Economic Security (CARES) Act provided every eligible low-income American with \$1,200 in stimulus funding.

However, at the time of our survey, only 32 percent of respondents had received their check, presumably because low-income individuals are less likely to have a bank account or file their taxes through direct deposit. These delays have left many vulnerable during the early days of the pandemic, especially those that are energy insecure.

Our survey results imply that those households that did receive a stimulus check were more likely to be able to pay their energy bill in the immediate aftermath of the COVID-19 outbreak.

Additionally, Congress extended federal unemployment insurance for those who lost their jobs because of the pandemic; yet, these benefits are set to expire at the end of July.

Finally, the CARES act provided \$900 million in additional funding for the Low Income Home Energy Assistance Program, which helps low-income households pay their energy bills; however, leading energy advocates are calling for billions in additional funding to meet the growing need for assistance through the summer months.

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State governments and utility commissions also enacted measures to protect residents. As of June 2020, more than half of state governors signed orders to prevent utility shutoffs, though these protections vary greatly. They range from full moratoriums to narrow protections that leave millions susceptible to immediate disconnection and eventual debt accrual if they cannot pay their bill.

In addition, many of these orders are set to expire soon, with two thirds of the population projected to be unprotected by July and 88 percent unprotected by August.

What can we do?

As we enter the warmest months of the year, stimulus relief is drying up and temporary protections are ending, leaving millions of families at risk for devastating financial and health-related consequences. Policymakers should consider near- and longer-term responses to help relieve the growing material hardship on families.

In the near-term, the federal government should impose a federal moratorium on all utility shutoffs and forgive late fees at least through the hot summer months. Congress should also increase appropriations for Low Income Home Energy Assistance Program so states can extend their utility bill assistance programs. In the longer-term, the federal government should design a stimulus package that invests in clean energy technology and increases funding for the Weatherization Assistance Program, which improves poor housing conditions by subsidizing energy efficient upgrades for low-income residents. An investment in the program would simultaneously help vulnerable households lower their energy bills, improve their health, and help those in the efficiency industry get back to work as the U.S. economy reopens.

As the economic and public health crises persist in the U.S., policymakers should prioritize helping households meet their energy needs.

Without relief, the repercussions could last well beyond the COVID-19 pandemic, especially for vulnerable families.

ehn.org, 1 July 2020

<https://www.ehn.org>

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Op-ed: PFAS chemicals—the other immune system threat

2020-07-06

“In 2014, my world changed forever when I learned my family was exposed to contaminated drinking water containing high levels of PFAS. Since then, I haven’t stopped worrying about my family’s health,” says Andrea Amico, a New Hampshire resident and PFAS community advocate turned national activist.

“Impacted communities didn’t get a choice in their exposure. We were contaminated without our knowledge or consent. And now we have to grapple with anxiety and worry that our immune systems could be harmed by PFAS contamination that could make us more vulnerable to COVID-19.”

Andrea isn’t alone. She’s one of many leaders across the country who live in [PFAS-exposed communities](#) that fear for the lives of their families and how their PFAS exposure will affect their ability to fight COVID-19.

PFAS are per- and polyfluoroalkyl substances, a class of chemicals used since the 1940s to make products non-stick, waterproof, and stain-resistant. They’re used in rain jackets, carpets, upholstery, cookware, fast food packaging, dental floss, and much more.

Dubbed ‘forever chemicals’ due to extreme environmental persistence, they’ve been found in environmental samples worldwide. An estimated 110 million American residents have PFAS in their tap water, partly due to widespread use in certain firefighting foams; the [Centers for Disease Control and Prevention](#) has found PFAS in the blood of most Americans.

PFAS also have been linked to many [health effects](#) including high cholesterol and cancers, even at low levels of exposure.

Most concerning during this global pandemic, however, is that exposure to PFAS suppresses the ability of the [immune system](#) to make antibodies—the part of the immune system critically important in fighting COVID-19 and other infectious agents.

Exposed children have been reported to have decreased responses to common childhood vaccines, an impairment that lingers into teenage years. Studies of adults exposed to PFAS also have shown diminished responses to flu vaccines.

PFAS also have been linked to many health effects including high cholesterol and cancers, even at low levels of exposure.

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Our studies have found that laboratory animals exposed to PFAS have decreased antibodies, verifying what we have seen in PFAS-exposed people and making us confident that PFAS are toxic to the immune system.

Just last month, the Agency for Toxic Substances and Disease Registry issued a statement about the potential intersection between [PFAS exposure](#) and [COVID-19](#) and cited findings linking PFAS exposure to reductions in antibody responses to vaccines and resistance to infectious diseases.

Unlike other synthetic chemicals that affect the immune system, such as polychlorinated biphenyls and trichloroethylene, PFAS are unregulated by the U.S. government; currently there are no federal drinking water standards for PFAS.

As well as being ‘forever chemicals’ in the environment, PFAS can remain in human bodies for days, weeks, months, or years. This means that as we take PFAS into our bodies each day, through the water we drink, the food we eat, and the products in our homes and workplaces, some remain behind and build up in our bodies over time.

The U.S. Environmental Protection Agency (EPA) has a drinking water “[health advisory level](#)” of 70 parts per trillion for two individual PFAS, but this advisory isn’t an enforceable standard, so public water supplies aren’t required to monitor or treat water to remove PFAS. Furthermore, this guideline only addresses two of more than 5,000 individual PFAS and is not low enough to protect the sensitive immune system, especially in children.

The public needs to be protected from PFAS in their drinking water with a legally enforceable federal standard. We support the [EPA’s efforts](#) in moving forward with such standards for PFAS.

Current policies that allow these chemicals to remain in the environment, drinking water, and commonly used products are putting human health, and our future, at risk. The chemical industry continues to add these chemicals to products despite knowing that they’re toxic and the EPA still approves [new PFAS formulations](#) for the market.

But together we can create a better future.

The responsible thing to do is shift to healthier products through changes in [policy](#) and [management](#), [consumer demand](#) and [education](#), investment in [safer alternatives](#), and [community action](#). These shifts require bold,

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coordinated action, but if we work together, we can create a healthier and more resilient future.

Andrea Amico's family was exposed to high levels of PFAS through drinking water contaminated by firefighting foam at a former Air Force Base.

She stays awake at night worrying about long term effects PFAS will have on her family's health, but now has the added burden of worrying if they're more at risk of contracting COVID-19, of experiencing symptoms longer, and when a vaccine is available, if it will be effective enough to protect her family due to the potential impacts of PFAS exposure on their immune systems.

"This global pandemic is scary for everyone and it's even scarier knowing your family has been exposed to chemicals that may hurt the immune system when it's needed most."

ehn.org, 6 July 2020

<https://www.ehn.org>

A warning from the chickens of the world

2020-07-08

IN 1997, Lam Hoi-Ka, a previously healthy three-year-old boy, died of multiple organ failure in Hong Kong. When a team of virologists from the Netherlands declared that the death-dealing agent had been **H5N1**, a virus that was previously known to infect only birds, scientists were shocked. The theoretical possibility of a deadly global pandemic, similar to the 1918 flu that killed millions of people, was suddenly made real.

While scientists from around the world urgently tracked down the origins and initial spread of the new virus, the rest of us watched the television images of people in hazmat suits. What made these images confusing and alarming were the stories that accompanied them. In Hong Kong, a chicken-adapted virus had jumped directly to a person. For most people, chickens were "healthy, low-fat" meat you bought in plastic packages at the grocery store, not agents of mass death.

As a veterinarian and epidemiologist, I knew better. A decade before the **H5N1** virus struck, I stood in a southern Ontario broiler barn—that is, a barn where chickens are grown for meat. In my plastic boots, white throwaway safety suit, and face mask, I gazed out over 10,000 identical birds. The room was spacious and the litter was clean. Delivery of food,

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water, and air was computer controlled. The birds were white feathered, plump, and only mildly curious about life. These were urban, office-dwelling birds. In five weeks, they could grow to the exact size required by **KFC**.

By the wonders of genetics and intensive breeding for specific traits, the fiercely wild stock of jungle fowl had been transformed into something that could grow faster, more uniformly, and by some standards, more efficiently. Between 1961 and 2017, world poultry meat production increased from 9 million to 122 million tons and egg production shot up from 15 million to 87 million tons. Since most of us experience a sort of cognitive dissonance when we see chickens and tons in the same sentence, let me rephrase this. In 1961, there were just over 3 billion people and just under 4 billion chickens in the world. In 2020, as I write this, about 7.7 billion people are jostling and shouting for space here, along with more than 20 billion chickens—and perhaps as many as 50 billion if one considers the short slaughter-and-restock turnover of those populations.

The fastest growth in commercial poultry production has been in the developing world. By the late 1990s, countries such as Indonesia and Brazil were increasing their commercial production by about 10 percent a year. When I was visiting South Sudan in 2012, just a few months after it gained independence following thirty years of civil war, I found "fresh" Brazilian chicken for sale in the market in Juba, the capital. China, already one of the world's biggest producers, was increasing at about 4 percent annually in the 1990s. Chickens were being grown, trucked, shipped, and fried as fast as the technology allowed. Who would have thought that so many people on this planet could be fed with such apparent ease?

The geneticists helped. These birds feeding the world weren't just any old chickens. In 2018, the authors of a peer-reviewed research paper declared that the "skeletal morphology, pathology, bone geochemistry and genetics" of modern commercial chickens—whose global body mass now exceeds that of all other birds combined—are so different from their ancestors that they may be considered a "novel morphotype."

But, in ecology—which is to say, in a world where everything is, sooner or later, connected to everything else—there are costs and trade-offs. According to that same paper, these new chickens symbolized "the unprecedented human reconfiguration of the Earth's biosphere"—a feat that would create the perfect conditions for barn-size outbreaks and then fit so neatly into a globally integrated system that would create the

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perfect conditions for pandemics. By the end of the twentieth century, epidemiologists who specialized in food-borne diseases were already well aware that a pandemic of salmonellosis, a disease with both immediate effects on the gastrointestinal system and long-term effects on arthritis and cardiovascular disease, was one of the hidden costs of mass producing chicken.

Salmonellosis could have been taken as a warning from the chickens of the world, a shot across the bow, as it were. The omen was not cryptic. It might have been something like: chickens carry their own bacterial and viral microbiomes; the economies of scale for chicken production are the same as the economies of scale for disease; small farms have outbreaks; big farms breed epidemics; globalization of big farms creates pandemics.

SoUTHEAST ASIAN farmers didn't scale up their production and increase the volume and speed of their trade in poultry products just "because"; they were responding to market demands for low-cost animal food. According to the United Nations, one in three people lived in a city in 1960. By the end of the twentieth century, almost half of all people did; by 2030, more than 60 percent of the population is expected to live in cities. Urban people want to eat, and most often, they want animal protein. Yet, without that rapid economic growth and urbanization, avian influenza would likely have remained a minor problem.

Brazil, the United States, China, and the European Union are the world's biggest poultry producers. China leads the world in ducks and geese. Other countries in Southeast Asia—Thailand in particular—wanted to take advantage of these expanding urban markets and jumped into the hot economic fray. In places such as Thailand and Indonesia, increased production has sometimes been achieved by taking traditional, laid-back, no-input chicken rearing and scaling it up. However, when waterfowl are mixed with chickens and pigs and people in close quarters—as can often happen in Southeast Asia—novel opportunities for the viruses are created, they become genetically more unstable, and evolution is accelerated.

In 1996, a precursor of the **H5N1** virus killed some geese in southern China. No one paid much attention. Then the virus picked up some gene fragments from quail and ducks, spread to the poultry markets in Hong Kong, and made the leap to humans; it killed six of eighteen people who were infected. Mass killing of all the domestic poultry in Hong Kong temporarily stopped the problem, but the virus continued to infect ducks and geese and to happily, sloppily evolve. In late 2002, a new variation of the virus killed off most of the waterfowl in Hong Kong nature parks. In

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the next few years, the new, more lethal variant spread through Vietnam, Thailand, Indonesia, Cambodia, Laos, China, Malaysia—the whole regional market. Not only was it making birds sick and killing them but it was also infecting cats and ferrets and, finally, people.

In May and June of 2005, one of the new variants of **H5N1** killed more than 5,000 wild bar-headed geese, gulls, and ducks in Qinghai Lake, China. Many researchers were worried that migratory birds would carry the virus down flyways into India. It looks as if they may have indeed carried the virus to Europe and Africa, but the evidence will always be ambiguous. However, it would be disingenuous to suggest that intensification and global genetic "homogenization" of poultry production have not been driving forces in a variety of epidemics, including **H5N1**.

KNOWLEDGE OF the social and ecological dimensions of food should be part of every food consumer's education. An inability to talk intelligently about where that food comes from should be grounds for dismissal of politicians and corporate heads.

Some pontificators, for example, have suggested that farmers in south and east Asia should raise chickens the way we do in North America and Europe—inside tightly controlled buildings. These people have never lived in poor countries in the humid tropics, nor do they understand the systemic ramifications of creating a few large farms where once there were many small ones. If they want biosecurity such as we have in Europe and North America, tropical farmers would need to close off the barns. But, in the tropics, without air conditioning, the birds would start to die within minutes. With what power source would they air-condition? And what would happen to all those poor farmers in the countryside who depend on small flocks of poultry for food and to pay their school and medical bills? Even if we kill all the sick chickens and put the rest into air-conditioned hotels, there will still be ducks flying overhead or cats or ferrets slinking in and out of the shrubbery. Some of the largest outbreaks of avian influenza have been in some of the best-managed poultry operations in the world, in some of the wealthiest countries. The viruses, like all microbes, adapt quickly to new situations.

In the years following the initial outbreaks of avian influenza, I spent a lot of time and energy working with policy makers in Canada, looking at how to prevent the disease from entering North America, and with farmers in Southeast Asia, looking for ways to stop the epidemic at the source. Many officials and corporate leaders were encouraging countries to follow a program of test-and-slaughter and of discouraging villagers from raising

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free-run village chickens. In March 2008, at a market in eastern Thailand, I discovered that, if sellers were responding to economic incentives, the programs designed to stop people from raising backyard chickens were unlikely to succeed. According to a woman with a dozen gutted and cleaned birds in front of her, village chicken was going for about twice as much on a per-weight basis as the commercially reared broilers.

The next month, at the invitation of my Indonesian coworkers, my wife and I visited a Javanese village in an area reported to be highly endemic for avian influenza. Of course, villagers who attended our workshop claimed to have had no confirmed cases of bird flu. Of course, any birds that died had succumbed to some other disease.

After the meeting, the villagers took us to see their chickens. Their greatest source of pride were their Ayam Pelung—competitive singing roosters. They were tall—about a metre high—and their calls were long, drawn out, low voiced, reminding me of Cesária Évora, the “barefoot diva” of Cape Verde. These singing roosters were each worth \$2,000 to \$3,000 (US), which was more than the annual income of most of these farmers. One of the farmers was a breeder who had sold roosters to buyers from as far away as Japan. A program that relied on slaughtering chickens that tested positive and paying compensation at market rates for commercial broilers was a nonstarter for these villagers.

I remembered, then, seeing a competition of Javanese singing roosters back in 1986. The birds were in cages, high up on swaying poles, judges moving from bird to bird, listening. Were they listening for omens? Warnings of a pandemic night just over the horizon?

I do not know what criteria the judges used, but standing there in the cool of a shady tropical morning, hearing those fado-like songs of love and loss, I yearned to believe, as the Zoroastrians did, that the calls of those jungle fowl might drive away the devils of the night.

thewalrus.ca, 8 July 2020

<https://www.thewalrus.ca>

An intriguing—but far from proven—HIV cure in the ‘São Paulo Patient’

2020-07-07

A 36-year-old man in Brazil has seemingly cleared an HIV infection—making him the proof of principle in humans of a novel drug strategy

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designed to flush the AIDS virus out of all of its reservoirs in the body. After receiving an especially aggressive combination of antiretroviral (ARV) drugs and nicotinamide (vitamin B3), the man, who asks to be referred to as the São Paulo Patient to protect his privacy, went off all HIV treatment in March 2019 and has not had the virus return to his blood.

The patient’s story is “remarkable,” says Steven Deeks, an HIV/AIDS clinician at the University of California, San Francisco who was not involved with this study. But he and others, including the study leaders, caution that the success hasn’t been long or definitive enough to label it a cure. “Interesting anecdotes have long driven the HIV cure field, and they should be considered largely as hypothesis-generating observations that can simulate new areas of investigation,” says Deeks, who also conducts HIV cure research.

Most people who suppress HIV with ARVs and later stop treatment see it come racing back to high levels within weeks. Not only did the São Paulo Patient not experience a rebound, but his HIV antibodies also dropped to extremely low levels, hinting at the possibility he may have cleared infected cells in the lymph nodes and gut.

Ricardo Diaz of the Federal University of São Paulo, the clinical investigator running the study, says he doesn’t know whether the patient is cured. “He has very little antigen,” Diaz says, referring to HIV proteins that trigger the production of antibodies and other immune responses. But he notes his team has not sampled the man’s lymph nodes or gut for the virus since he stopped treatment. Diaz discussed the patient today at a press conference for *AIDS 2020*, the 23rd International AIDS Conference taking place virtually this week, and he plans to present the study in full tomorrow.

Only two people are known to have been cured of their HIV infections: Timothy Ray Brown and a man who has asked to be referred to as the London Patient; both received bone marrow transplants as part of a treatment for cancers. The transplants cleared their infections and gave them new immune systems that resist infection with the virus. But bone marrow transplants are expensive, complicated interventions that can have serious side effects, making them an impractical cure for the 38 million people now living with the AIDS virus.

Other potential HIV cure cases have received intense media attention only to see the virus return after prolonged absences. Most soberingly, a baby in Mississippi who started ARVs shortly after birth stopped treatment at 18 months and was thought to be cured until the virus suddenly resurfaced

Most people who suppress HIV with ARVs and later stop treatment see it come racing back to high levels within weeks.

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more than 2 years later. Several adults who had bone marrow transplants and appeared to have been cured were not.

HIV has proven particularly difficult to eliminate because the virus weaves its genetic material into human chromosomes, where it can lie dormant, escaping the immune surveillance that typically eliminates foreign invaders. These silently infected cells may persist, perhaps indefinitely, because they have stem cell-like properties and can make clones of themselves. Researchers have come up with several strategies to flush reservoirs of cells that harbor latent HIV infections, but none have proved effective.

To compare different reservoir-clearing strategies, Diaz and colleagues in 2015 recruited the São Paulo Patient and other individuals who had controlled their HIV infections with ARVs. The most aggressive approach, used in this man and four others, added two ARVs to the three they were already taking, in the hope this would rout out any HIV that might have dodged the standard treatment. On top of this “intensification,” the study group received nicotinamide, which can, in theory, prod infected cells to “wake up” the latent virus. When those cells make new HIV, they either self-destruct or are vulnerable to immune attack.

After 48 weeks on this intensified schedule, the five trial participants returned to their regular three-drug regimen for 3 years, after which they stopped all treatment. Four saw the virus quickly return, but the São Paulo Patient has now gone 66 weeks without signs of being infected. Sensitive tests that detect viral genetic material did not find HIV in his blood. An even more sensitive test, which mixed his blood with cells that are susceptible to HIV infection, produced no newly infected cells.

Intriguingly, during the intensification period with nicotinamide, this man was the only one of the five who twice had the virus detected on standard blood tests. To Diaz, this suggests that latently infected cells had been roused, leading to blips of viral production. “I’m always trying to be a little bit the devil’s advocate, but in this case, I’m optimistic,” Diaz says. “Maybe this strategy is not good for everybody because it only worked in one out of five here. But maybe it did get rid of virus. I don’t know. I think this is a possibility.”

Deeks says he does not know of any report, other than the two people cured by bone marrow transplants, of decreases in HIV antibody levels after stopping treatment. One large, outstanding question, he says, is whether the man indeed stopped taking his ARVs. “I have not taken any

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HIV medication since March 30, 2019,” the São Paulo Patient says. Diaz plans to confirm this by examining the man’s blood for ARVs.

Another unknown is how soon the man started ARVs after becoming infected with HIV. Studies have shown that a small percentage of people who begin ARV treatment shortly after becoming infected have a better chance of controlling the virus for prolonged periods if they cease the drugs, presumably because they never built large reservoirs of infected cells. The São Paulo Patient started treatment 2 months after being diagnosed in October 2012. As with most people who become infected with HIV, he cannot say for certain when transmission occurred, but he suspects it was in June 2012. The only certainty is that he tested negative in 2010.

It’s also unclear how nicotinamide would awaken silent infected cells. HIV DNA remains latent when it tightly spools around chromosome proteins known as histones. To make viral copies, it must unspool, and Diaz points to evidence that nicotinamide can trigger this unspooling in different ways.

Sharon Lewin, an HIV cure researcher who directs the Peter Doherty Institute for Infection and Immunity in Melbourne, Australia, finds the antibody response intriguing. But she underscores it is not a convincing, controlled experiment. “We need to move beyond case reports of HIV remission,” Lewin says. “I would be super excited to see long term remission in multiple participants in a clinical trial. This is what the field needs to really advance.”

sciencemag.org, 7 July 2020

<https://www.sciencemag.org>

Boron nitride catalyst destroys toxic PFAS “forever chemicals”

2020-07-08

Chemical pollutants mean bad news for the environment, but some types are far more harmful than others. At the extreme end of the spectrum are toxic substances such as PFAS and GenX, which fall into a class known as “forever chemicals” for their ability to endure in the environment for a very long time. Rice University researchers have happened upon a powerful new tool they say could help neutralize this threat, offering a new catalyst that can destroy them in a matter of hours.

Studies have also revealed their presence in tap water and the blood of nearly all Americans.

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The trouble with forever chemicals, or in more scientific terms perfluoroalkyl and polyfluoroalkyl substances (PFAS), is not just that they linger in the environment for a very long time, but how widely they are used. More than 4,000 compounds fall under this category of chemicals and they feature in everything from waterproof clothing and nonstick pans to firefighting foams and food packaging. Studies have also revealed their presence in tap water and the blood of nearly all Americans.

The Rice University team hoped to build on earlier work in which it developed catalysts for other chemical pollutants such as trichloroethene (TCE) and nitrates. Through a long process of trial and error, the researchers finally found some success with the synthetic mineral boron nitride (BN), in neutralizing one of the most prevalent PFAS chemicals called PFOA (perfluorooctanoic acid).

“Here’s the observation,” says leader Michael Wong. “You take a flask of water that contains some PFOA, you throw in your BN powder, and you seal it up. That’s it. You don’t need to add any hydrogen or purge it with oxygen. It’s just the air we breathe, the contaminated water and the BN powder. You expose that to ultraviolet light, specifically to UV-C light with a wavelength of 254 nanometers, come back in four hours, and 99 percent of the PFOA has been transformed into fluoride, carbon dioxide and hydrogen.”

These promising results led the researchers to explore the potential of the catalyst to tackle other forever chemicals. In the US, PFOA has been largely phased out, but other synthetic forever chemicals have come to take its place, including one known as GenX.

“It’s a similar story to PFOA,” Wong said. “They’re finding GenX everywhere now. But one difference between the two is that people have previously reported some success with catalysts for degrading PFOA. They haven’t for GenX.”

Wong and his team may have uncovered a potential path forward though. Their experiments showed that BN could also damage GenX under 254-nanometer light, although not with quite the same potency, destroying about 20 percent of it in water samples after two hours of exposure.

The researchers say they already have some ideas about how to improve the catalyst’s performance in tackling GenX. They have also filed patents for the technology and hope to continue developing it for use in water treatment systems as one of its initial applications.

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“We tried a lot of things,” says Wong. “We tried several materials that I thought were going to work. None of them did. This wasn’t supposed to work, and it did.”

newsatlas.com, 8 July 2020

<https://www.newsatlas.com>

Lockdown could be the ‘biggest conservation action’ in a century

2020-07-06

Spring is a bloody season on American roads. Yearling black bears blunder over the asphalt in search of their own territories. In the West, herds of deer, elk, and pronghorn scamper across highways as they migrate from winter pastures to summer redoubts. A smaller-scale but no less epic journey transpires in the Northeast, where wood frogs, spotted salamanders, and eastern newts emerge from their winter hideaways and trek to ephemeral breeding pools on damp March nights, braving an unforgiving gantlet of cars along the way.

Among all creatures, it’s these amphibians—tiny, sluggish, determined—that are most vulnerable to roadkill. This year, though, their journey was considerably safer.

Greg LeClair, a graduate student at the University of Maine, leads The Big Night, a citizen science initiative in Maine through which volunteers tally up migrating frogs and salamanders and escort them across roads. This spring, he assumed that coronavirus concerns would shut down the project; instead, he rallied more participants than ever. “I think people were just home and had nothing else to do,” he told me. All of those volunteers found an amphibious bonanza. In previous years, LeClair said, the project’s participants counted just two live animals for every squashed one. This spring, they found about four survivors per victim. “The ratio of living animals to dead doubled,” LeClair marveled.

Maine’s amphibians are just one of the collateral beneficiaries of the novel coronavirus, which has ground civilization to a halt. Travel bans have confined many of us to our couches; post-apocalyptic photos of empty freeways have circulated on social media. With *Homo sapiens* sidelined, wildlife has tiptoed forth. Lions basked on a road in Kruger National Park, normally crowded with tourists. Wild boars rooted in Barcelona’s medians. Roadkill surveyors in places as far apart as Santa Barbara and South Africa told me they’ve seen fewer carcasses this year than ever before. In

Maine’s amphibians are just one of the collateral beneficiaries of the novel coronavirus, which has ground civilization to a halt.

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Costa Rica, where Daniela Araya Gamboa has conducted years of roadkill studies aimed at reducing the harm of cars, highways have become less perilous for ocelots, cryptic wildcats bejeweled with black spots. In the more than three months since the pandemic began, Araya recently told me, her project had logged only one slain ocelot. “We have an average of two ocelot roadkills each month during normal times,” she added.

The human cost of COVID-19 has, of course, been so incomprehensibly tragic that acknowledging the virus’s silver linings—the cleaner air, the forestalled carbon emissions—can feel ghoulish. But there’s no denying that the abrupt diminishment of human travel, a phenomenon scientists recently dubbed the “Anthropause,” has generated profound conservation benefits. Mounting evidence suggests that we’re in the midst of an unprecedented roadkill reprieve, a stay of execution for untold millions of wild creatures. “This is the biggest conservation action that we’ve taken, possibly ever, certainly since the national parks were formed,” Fraser Shilling, co-director of the Road Ecology Center at UC Davis, told me. “There’s not a single other action that has saved that many animals.”

Roadkill’s decline is so significant precisely because its impacts are ordinarily so catastrophic. One recent study calculated that cars crush about 200 million birds and 30 million mammals in Europe every year; in the United States, the toll has been estimated, albeit imprecisely, at more than 1 million each day. In Brazil, researchers wrote in 2014, roadkill has surpassed hunting to become “the leading cause of direct, human-caused mortality among terrestrial vertebrates.”

Given the scope of the carnage, even a temporary respite can save an astonishing amount of wildlife. That’s what Shilling and his colleagues documented in a recent report that analyzed collision statistics and carcass-cleanup figures from the handful of states that systematically collect roadkill data. In California, they found, roadkill fell by 21 percent in the four weeks after the state issued its stay-at-home order in March. In Idaho, the reduction was 38 percent; in Maine, it was 44 percent. A year of reduced travel, Shilling estimated, would save perhaps 27,000 large animals in those three states alone.

And although state records focus on the hefty mammals that endanger drivers—deer, elk, moose, bears, and the like—they’re mum on smaller critters, such as snakes, frogs, and birds, all of which have likely thrived during COVID-19. “We’re measuring the large animals, but I suspect it’s true for all animals, including insects,” Shilling said. (In Texas, millions of monarch butterflies succumb to grilles and windshields during their

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migrations to Mexico.) Add up all those less conspicuous casualties and extrapolate globally, and it’s hardly a stretch to say that hundreds of millions, perhaps billions, of wild animals will ultimately be spared because of the pandemic.

Nor is it just hyper-abundant animals, such as squirrels and raccoons, that are finding succor during the Anthropause. In California, the poster species for highways’ harms is the mountain lion, several populations of which may soon be protected under the state’s Endangered Species Act. Shilling found that mountain lion roadkill plummeted 58 percent after the shutdown. “When you’re talking about such small populations, you get even one cat taken out by roadkill, and that can spell doom,” Beth Pratt, the California director of the National Wildlife Federation, told me. The Anthropause isn’t merely protecting individual lives, it turns out—in some places, it may be safeguarding the persistence of entire species.

Although all available evidence suggests that net roadkill rates have dropped, it’s conceivable that, on some roads, deaths have actually ticked upward. For many species, cars—loud, terrifying, alien—deter animals from crossing altogether, leading one early road ecologist to describe traffic as a “moving fence.” In Oregon, researchers found that mule-deer collisions peaked at around 8,000 cars per day; beyond that threshold, the ungulates appeared to abandon their migration routes entirely rather than attempt to cross. As traffic has declined during COVID-19, then, animals may feel more comfortable venturing onto certain highways, at their peril—leading ultimately to localized roadkill hot spots. And even if it wasn’t more abundant this spring, roadkill might, in some states, simply be more visible, as agencies tasked with cleaning up carcasses divert resources to the coronavirus response.

How long will the benefits of the roadkill reprieve linger? In early March, Shilling and his colleagues found, Americans drove 103 billion total miles; by mid-April, shutdowns had reduced our collective travel to 29 billion miles, an astonishing 71 percent cut. As travel bans have eased, though, traffic has crept up again, to about half its pre-pandemic levels in California and Maine. Although cities like Milan, London, and New York have seized the opportunity to install new bike lanes and de-emphasize cars, many urban areas have registered more gridlock, as commuters spurn public transit for the socially distant cocoons of their personal vehicles.

“COVID is going to have a very short-term effect,” Sandra Jacobson, a retired U.S. Forest Service biologist specializing in transportation, told me. “At some point the world, but especially our country, is going to have to

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realize that we cannot simply continue to add more and more vehicles indefinitely.”

Shilling is less convinced of the Anthropause’s transience. After all, some of the trends that COVID-19 has spawned—the rise of remote work, for instance—may dampen our enthusiasm for getting behind the wheel. “Coming out of the pandemic, we will hopefully learn lessons,” he said. “One of them might be that we can get a lot of benefits out of not driving.”

Either way, the spring’s gains won’t be immediately undone. In Maine, LeClair told me, more amphibians safely reaching their mating ponds should mean more translucent, gelatinous clumps of successfully laid eggs—and, with luck, more migrants in 2021. “If we’re seeing more next year, we can get an idea that this pandemic might have actually boosted some populations,” he said. The benefits of the great roadkill reprieve, in other words, may outlast the pandemic itself.

theatlantic.com, 6 July 2020

<https://www.theatlantic.com>

Two deaths in gene therapy trial for rare muscle disease

2020-06-29

Two boys have died after receiving high doses of a gene therapy treatment for their rare muscle disease, Biopharma Dive reports. The patients, born with x-linked myotubular myopathy, developed liver problems that apparently led to sepsis, according to a 23 June letter to patient groups from trial sponsor Audentes Therapeutics. They were older patients and had existing liver disease; several younger patients who got lower doses of the treatment have done well and now breathe on their own without a ventilator. The U.S. Food and Drug Administration (FDA) has put the trial on hold. Audentes, which had stopped enrollment before the deaths, has postponed plans to seek FDA approval for the drug this year. Since the 1999 death of gene therapy patient Jesse Gelsinger slowed research, the field has rebounded and FDA has approved two rare disease treatments. But recently, animal studies have suggested high doses of gene therapy can cause dangerous liver toxicity.

sciencemag.org, 29 June 2020

<https://www.sciencemag.org>

They were older patients and had existing liver disease; several younger patients who got lower doses of the treatment have done well and now breathe on their own without a ventilator.

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‘Ghost fleas’ bring toxic mercury up from the depths of prairie lakes

2020-07-01

How toxic mercury moves through the environment—and accumulates in the fish that people eat—has been known for decades. Now, scientists have discovered an unexpected way that the neurotoxin circulates in lakes, hitching a late-night ride inside small predatory crustaceans dubbed “ghost fleas.” The finding helps explain why some lake fish contain surprising amounts of mercury. It also suggests researchers who sample lakes only during the day might be missing important clues to how those ecosystems work.

“It’s a cool food web story,” says Celia Chen, an aquatic ecologist at Dartmouth College who was not involved in the research. “This idea that mercury would migrate up—it’s novel.”

Most mercury pollution comes from small-scale gold refining and coal burning. It rises into the atmosphere, circulates globally and then falls again in rain and snow. When mercury reaches low-oxygen environments, such as wetlands and lake beds, bacteria convert it to a toxic form called methylmercury that can accumulate in plants and animals. In humans, exposure results in the highest risk to fetuses and young children, who can experience developmental problems.

Top predators such as tuna concentrate methylmercury in their tissues—hence public health warnings to limit or avoid eating certain fish. But in lakes with lots of algae and zooplankton, levels in fish are generally lower; with more creatures at the base of the food web, the amount of mercury in the ecosystem is diluted, and fish get less. There are puzzling exceptions, however. Fish in lakes on North American prairies, for example, have high levels of mercury, despite the presence of lots of algae and other aquatic life. “That was the mystery,” says Britt Hall, a biogeochemist at the University of Regina, who led the new research. “There was no mechanism to explain it.”

In 1997, Hall’s colleague—University of Regina ecologist Peter Leavitt—measured the mercury in various fish species and zooplankton in Katepwa Lake in the Canadian province Saskatchewan. He and co-workers found that yellow perch that hunted at night contained more mercury than yellow perch that fed during the day. Mercury concentrations also varied among the species of zooplankton, tiny invertebrates that drift around the lake. But the researchers couldn’t fit these puzzle pieces together until

“Scientists could be missing an important vector of [methylmercury] by predominantly sampling in the daytime.”

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years later, when University of Regina postdoc Richard Vogt looked closely at one of the zooplankton, called *Leptodora*.

Leptodora is a large relative of water fleas, about 1.5 centimeters long with a single enormous eye. (Leavitt calls them “ghost fleas,” because they are also translucent.) In 2013, Vogt and colleagues showed that adult *Leptodora*, unlike other zooplankton in the lake, migrate up and down daily. During the day, they hide from predatory fish by moving to the bottom of the lake, where there is no oxygen. They swim to the top at night, when most fish aren’t active or can’t see well, to feed on other zooplankton. Vogt also conducted experiments with fish and found that at least one kind—yellow perch—can catch *Leptodora* in the dark, likely by sensing their vibrations while swimming.

The concentration of mercury in *Leptodora* is about twice that of other zooplankton in the lake, they report in *Environmental Science & Technology Letters*. That’s likely because *Leptodora* eat bacteria or midges that live in the mercury-laden mud. At night, they act like mercury “elevators,” bringing the toxin up from the depths. The proof is in the perch: Yellow perch caught at night contained about twice as much mercury as yellow perch caught during the day, the team writes.

That elevator effect results in “astonishingly different exposures” in fish, depending on whether they feed at night or during the day, says Roxanne Razavi, an environmental toxicologist at the State University of New York College of Environmental Science and Forestry, who was not involved in the research. “Scientists could be missing an important vector of [methylmercury] by predominantly sampling in the daytime.”

Chen says this type of ecological research could also help improve the accuracy of large-scale pollution monitoring. For example, some researchers study changes in the amount of airborne mercury deposited in various lakes by monitoring concentrations in fish; the presence of *Leptodora* might skew comparisons. “These ecological factors change the amount of mercury that ends up in a standard species,” she says. “It’s not a trivial thing to monitor.”

Hall, Leavitt, and colleagues are moving on to another type of pollution: greenhouse gases. They are now looking at how prairie lakes capture carbon dioxide and whether *Leptodora* might also transport methane—

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another potent greenhouse gas—to the surface. If so, the mercury elevator might carry another kind of hazard.

sciencemag.org, 1 July 2020

<https://www.sciencemag.org>

Why did the Maya abandon the ancient city of Tikal?

2020-07-02

In the ninth century A.D., the Maya abandoned the great city of Tikal after hundreds of years of prosperity and expansion. Researchers have long sought to explain how and why the city collapsed, but despite extensive study of the site, unanswered questions remain.

Commonly cited explanations for Tikal’s downfall center on a confluence of overpopulation, overexploitation of the surrounding landscape and a spate of withering megadroughts. Now, reports Kiona Smith for *Ars Technica*, a [new study](#) of the ancient city’s reservoirs outlines evidence that mercury and toxic algae may have poisoned Tikal’s drinking water at a time when it was already struggling to survive the dry season.

Located in northern Guatemala, Tikal dates back to the third century B.C. Once among the most powerful city-states in the Americas, the rainforest metropolis boasted multiple stone temples standing more than 100 feet tall and, at its zenith in the mid-eighth century, supported upward of [60,000 inhabitants](#), according to David Roberts of [Smithsonian magazine](#).

Tikal’s residents built reservoirs to collect and store water after rainfall slowed to a trickle during multi-decade droughts in the ninth century. These reservoirs were essential during the dry season, as the city had no access to lakes or rivers, and the [local water table](#), or level at which the ground reaches saturation, lies more than 600 feet underground.

Per the study, published last month in the journal *Scientific Reports*, the Maya sought to collect as much water as possible during the region’s rainy season, developing huge, paved plazas that were sloped to send water sluicing into the reservoirs for storage. As the researchers argue, this system inadvertently contributed to the city’s undoing.

To assess the factors at play in Tikal’s demise, the team took samples of sediments at the bottom of four of Tikal’s reservoirs. Chemical and biological analyses of layers dated to the mid-800s revealed the grim history of the lakes’ contents: As Ruth Schuster reports for *Haaretz*, two of

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the largest reservoirs were not only dangerously polluted with the heavy metal mercury, but also carried traces of enormous toxic algal blooms.

The researchers attribute the mercury pollution's presence to the mineral cinnabar, or mercuric sulfide. Members of the Maya civilization mined this mercury-based ore and combined it with iron oxide to create a bloodred powder used as a versatile pigment and dye. The brilliant red—found coating the interiors of almost every high-status burial in Tikal—may have held special significance for the Maya. One grave unearthed by archaeologists contained roughly 20 pounds of powdered cinnabar.

Tikal residents' widespread use of cinnabar, especially in and around the city's temples and main palace, likely resulted in dangerous quantities of the mercury-laden powder washing into the reservoirs during heavy rainfall.

"The drinking and cooking water for the Tikal rulers and their elite entourage almost certainly came from the Palace and Temple Reservoirs," the researchers write in the study. "As a result, the leading families of Tikal likely were fed foods laced with mercury at every meal."

Another factor in Tikal's decline was an explosion of toxin-producing blue-green algae. The team found traces of DNA from two such algae species in the reservoirs' sediments.

"The bad thing about these is they're resistant to boiling," says lead author David Lentz, a paleobiologist at the University of Cincinnati, in a statement. "It made water in these reservoirs toxic to drink."

During the late 800s, sediments from Tikal's two central reservoirs were loaded with phosphate, a nutrient that blue-green algae needs to proliferate. The study's authors write that these high levels of phosphate accrued after centuries of "smoky cooking fires and ceramic plates washed in the reservoir added organic material to the waters."

The researchers also note that a midden, or trash heap, filled with food waste was located close enough to one of the reservoirs that "during the rainy seasons, effluent from this trash pile would have washed directly into the reservoir."

When the city's phosphate-filled reservoirs erupted in blooms of toxic blue-green algae, locals were probably able to tell that something major had gone wrong.

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"The water would have looked nasty," says co-author Kenneth Tankersley, an anthropologist at the University of Cincinnati, in the statement. "It would have tasted nasty. Nobody would have wanted to drink that water."

Even without the poisoned drinking supply, losing the use of two huge water stores would have been devastating for Tikal. Prior research has identified a period of drought between 820 and 870—a timeframe that corresponds with the layers of sediment in which the blue-green algae and mercury were found.

Taken together, the dry weather and befouled water supply may have led the Maya to suspect their rulers had failed to adequately appease the gods.

"These events ... must have resulted in a demoralized populace who, in the face of dwindling water and food supplies, became more willing to abandon their homes," the authors write.

Poisoned water wasn't the sole cause of Tikal's downfall, but as the researchers conclude, "The conversion of Tikal's central reservoirs from life-sustaining to sickness-inducing places would have both practically and symbolically helped to bring about the abandonment of this magnificent city."

According to *Ars Technica*, the researchers may pursue similar tests at other former Maya settlements to determine if the phenomena documented at Tikal influenced the decline of other cities across the empire.

[smithsonianmag.com](https://www.smithsonianmag.com), 2 July 2020

<https://www.smithsonianmag.com>

One U.K. trial is transforming COVID-19 treatment. Why haven't others delivered more results?

2020-07-02

On 29 June, University of Oxford clinical scientists Martin Landray and Peter Horby changed how physicians around the world consider treating COVID-19—for the third time in little more than 3 weeks. The principal investigators of a U.K. megatrial called Recovery, which has been testing existing drugs as therapies for the new infection, the pair had just finished reviewing data from 1596 patients who had received a combination of lopinavir and ritonavir, two antivirals known to curb HIV, and 3376 patients who had received only standard care. In a press release, they and their Recovery colleagues announced there had been no significant difference

This could have worked. And it was a bust," says Eric Topol, director of the Scripps Research Translational Institute. "It was really important to clarify that."

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in the death rate between the two groups. “This could have worked. And it was a bust,” says Eric Topol, director of the Scripps Research Translational Institute. “It was really important to clarify that.”

Earlier the same month, and again through press releases, Recovery (Randomised Evaluation of COVID-19 therapy) delivered widely accepted verdicts on two other treatments. It revealed that dexamethasone, a cheap steroid, reduced deaths by one-third in patients on a ventilator and showed that hydroxychloroquine, the antimalarial drug controversially touted for COVID-19, did not benefit hospitalized patients. A run on dexamethasone ensued as physicians in the United Kingdom and elsewhere quickly made it part of their standard of care for the sickest patients, whereas many other studies of hydroxychloroquine now looked futile and were halted.

“It’s very, very rare that you announce results at lunchtime, and it becomes policy and practice by tea time, and probably starts to save lives by the weekend,” Landray told *Science* at the time of the steroid result.

Large, randomized trials are the gold standard to test a drug’s efficacy. But they have been scarce so far in the COVID-19 pandemic. “Everybody has the first part about “randomized,” but they omitted the “large” part, says Ana Maria Henao Restrepo, a medical officer at the World Health Organization’s (WHO’s) Emergencies Programme. “Every clinician, every researcher wants to help and then they end up having a trial with 300 or 400 patients that cannot come up with conclusive evidence.” In a sea of small, single institution studies, Recovery, with 12,000 patients and hundreds of participating hospitals, stands out—and offers lessons for the few other megatrials, organized by WHO and other bodies, which have been slow off the mark. “I think the three Recovery trials are the best trials that have been performed to date,” Topol says.

One reason Recovery has done so well is that it was backed by the United Kingdom’s centralized National Health Service (NHS), involving 176 of its hospitals. In the United States, where the health care system is fragmented, the National Institutes of Health has only begun a few large trials so far and completed just one, a trial of Gilead Sciences’s antiviral compound remdesivir that showed those given the drug recovered from COVID-19 faster. The dearth of results from a country that has seen more cases of COVID-19 than any other is “surprising and a bit disappointing,” says John-Arne Røttingen, who heads the steering committee of Solidarity, WHO’s attempt to evaluate repurposed drugs as possible COVID-19 therapies.

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In contrast, the United Kingdom’s own bungled public health response to the new virus, which has led to Europe’s largest outbreak, has been taken advantage of by Recovery. “They have been able to recruit well, because they have had a lot of hospitalized patients,” Røttingen says. (The United Kingdom has had more than 43,000 deaths, surpassed only by the United States and Brazil, far more populous countries.)

In a letter to all NHS hospitals, the United Kingdom’s five most senior doctors urged health care workers to enroll patients in Recovery and two other important trials. “Use of treatments outside of a trial, where participation was possible, is a wasted opportunity to create information that will benefit others,” the doctors, including Chris Whitty, chief medical officer for England, wrote. Because of that coordination, “One in every six COVID-19 patients that come into the U.K. hospitals go into the trial,” Landray says.

Organizers also kept Recovery simple, allowing any NHS hospital to participate. Inspired by trials that his Oxford colleague Richard Peto and others did in the 1980s on treating heart attacks, Landray says they radically cut down on the data health care workers need to collect, with only a few questions asked at enrolment and at only one more data collection point: when the patient dies, is discharged, or 28 days after enrollment. Clinical trials have become excessively cumbersome in recent years, he argues. “It’s actually quite hard to make them really simple.”

WHO’s Solidarity trial has a similarly straightforward design, but its more international nature has proved a challenge. The trial, designed to test four treatments—hydroxychloroquine, lopinavir/ritonavir, interferon beta plus lopinavir/ritonavir, and remdesivir—was announced on 20 March and enrolled its first patient in Norway 1 week later. But rolling out the trial in dozens of countries has meant getting approval from dozens of regulatory agencies and ethics boards as well. “That has taken a surprisingly long time in many jurisdictions, including in Europe,” Røttingen says, and recruitment in Europe slowed over time as the epidemic subsided. “When countries were ready to sort of start, the epidemic was under control in many ways,” he notes.

A European trial called Discovery, coordinated by the French research institute INSERM and partnered with Solidarity in testing the same drugs, also fell short. The goal was to enroll 3200 patients across the continent, but although the study almost met its goal of 800 participants in France, it barely managed to recruit patients elsewhere. Though France funded its part of the trial, it expected partner countries to pick up the tab for their

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own trials. "One of the issues was that not all the countries had funding," says Yazdan Yazdanpanah, head of infectious diseases at INSERM.

Meanwhile dozens of small trials competed for patients in many countries, most of them focusing on the same drugs, such as hydroxychloroquine. "I don't understand why everyone was looking at the same thing," Yazdanpanah says. "I think we can do better." Susanne Herold, an expert on pulmonary infections at the University of Giessen, agrees. "There needs to be more coordination both within countries and across borders," she says.

Another problem has been the widespread use of treatments outside of randomized trials. Landray notes that tens of thousands of COVID-19 patients in the United States have been given convalescent plasma, for instance, but not alongside a control population receiving a placebo. "We'll know what happened to those patients, but we won't know whether they would have been better off actually, if they hadn't got the convalescent plasma. Partly it is about convincing clinicians that there is still an open question," Henao Restrepo says. "I have talked to about 2000 clinicians all over the world in the process of establishing Solidarity, and some of them are convinced they know which drugs work."

Henao Restrepo still has high expectations for the Solidarity trial. "The preparatory work is paying off," she says. Its recruitment pace has picked up as more countries have joined, many with surging cases, including Iran and countries in Latin America. So far, 31 countries have joined and 60 more are in the process. "One of the advantages of such a global trial is that you can follow the pandemic as it evolves," Røttingen says.

With recruitment running at about 500 patients per week now, Solidarity's three remaining treatment arms—it stopped the hydroxychloroquine one—are likely to yield answers soon, raising the question of what drugs to test afterward. Some repurposed drugs such as camostat mesylate or favipiravir are still being discussed, but increasingly the attention is turning to monoclonal antibodies, designed to target the virus.

Henao Restrepo thinks the international nature of the effort makes its results more generalizable. "The feeling that all kinds of patients and hospitals participated is an important part of accepting the findings," she says. And the global effort "gives the people all over the world, clinicians all over the world the possibility to contribute."

Herold adds that the Discovery trial will also contribute, because it is designed to gather more detailed data than Recovery and Solidarity.

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Started in an effort to supplement Solidarity, it collects not only basic data on mortality, but also information on viral levels and certain blood parameters. Those data can indicate not just which drugs are effective, but also how they work and at what stage of the disease, Herold says, crucial to informing follow-up research or trials.

Work on the Recovery trial continues, with Landray, Horby, and the rest of their team scrambling to publish full results. Some researchers have criticized its practice of releasing important results as press releases; so far, it has given details for only one of the three headline findings, on dexamethasone, in a preprint posted 6 days after the release. The researchers are also continuing to collect data on the antibiotic azithromycin, an antibody called tocilizumab, and the antibody-rich plasma collected from recovered patients.

Results on those therapies are likely months away, Landray says. But he cautions he has been wrong before. On the morning of 4 June, he had predicted the first results from Recovery would likely come in early July. A few hours later, the chairperson of the trial's data monitoring committee called him to say there was enough patient data to declare a verdict on hydroxychloroquine.

[sciencemag.org](https://www.sciencemag.org), 2 July 2020

<https://www.sciencemag.org>

Plastic-tracking yacht adds splash of environmentalism to ocean racing

2020-07-03

La Trinité-sur-Mer (France) (AFP) - When he sets sail alone for a gruelling round-the-world yacht race this year Fabrice Amedeo will have a scientific mission to add to his sporting goal: collecting microplastics.

His boat has been specially-fitted with equipment to filter and store an array of plastic samples from remote areas of open water to help scientists map the scope of man's pollution of the oceans.

Extensive studies have already confirmed the presence of minute plastic particles in the bodies of living organisms throughout the world's oceans, even in the deepest reaches of the Pacific's Marianas Trench.

But researchers are hoping to learn more about which areas are most contaminated with the remnants of the some eight million tonnes of plastic that end up in the ocean each year.

His boat has been specially-fitted with equipment to filter and store an array of plastic samples from remote areas of open water to help scientists map the scope of man's pollution of the oceans.

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Like other skippers, Amedeo has already helped track CO₂ levels and water temperature when out on the water.

But for the next Vendée Globe race, which is due to leave from France's west coast on November 8, his Imoca monohull yacht has been fitted with a new system that pumps seawater from the front keel through three filters of 300, 100 and 30 microns to trap microplastics.

Amedeo will have to change them every 12 hours and store the samples during the estimated 85 days of his solo race around the world.

"It's real work," the former journalist told AFP aboard the 60-foot boat in Brittany.

He said he wanted to give something back to the ocean.

"I will have to focus on something other than competition so it's true that it has an impact, but I think it's really worth it."

Cargo ships have been equipped with sensors for a long time to support scientific research.

But "sailboats are less environmentally intrusive and go to regions where merchant ships do not," said Thierry Reynaud, a researcher from France's ocean science institute Ifremer.

Reynaud's work will be helped by temperature and salinity data from the yacht, but the boating fan had other reasons to be enthusiastic about joining over a dozen colleagues involved in the project on board in late June.

"I am passionate about sailing, so touching an Imoca is like touching a thoroughbred," he told AFP.

- Race against pollution -

When it comes to plastic pollution, some areas are better studied than others.

The "Great Pacific garbage patch" for example, a floating trash pile twice the size of France that swirls in the ocean halfway between California and Hawaii, has attracted infamy and high profile clean up efforts.

But in other regions "we have a glaring lack of data", especially in the Indian Ocean and the South Atlantic, said Christophe Maes, physicist oceanographer at France's Research Institute for Development.

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"These big races will allow us to get snapshots of the whole circulation" of plastics, and to learn more about the ocean currents which transport them, he added.

Before mapping can be undertaken, laboratories will have to analyse the samples collected in order to identify and quantify them: polystyrene, polyamide, polyethylene...

"Unfortunately it is done by hand," said Catherine Dreanno, from Ifremer, smiling. In fact it takes half a day to go through each sample.

Regardless of their field of study, the researchers gathered on Amedeo's boat all agreed that installing sensors on racing yachts that crisscross remote waters provides valuable information.

To encourage this approach, the Intergovernmental Oceanic Commission of UNESCO and the association Imoca -- which manages races of monohulls of the same name -- signed a partnership to promote ocean sciences in January.

Martin Kramp, coordinator of the UN's Joint Technical Commission for Oceanography and Marine Meteorology observation programme, wants the collaboration to go further.

"I hope that for the Vendée Globe 2024 there will be a new rule that makes a scientific contribution compulsory," he said.

[news.yahoo.com](https://www.news.yahoo.com), 3 July 2020

<https://www.news.yahoo.com>

Arctic battling climate change and beavers

2020-07-01

Beavers are running amok in the Arctic, taking advantage of climate change and likely exacerbating its impact.

Studies show they are now able to move into many tundra regions where they've never been seen before, and once there are building dams and creating new water bodies.

This is changing the landscape and could accelerate the thawing of the permafrost soils, releasing massive quantities of greenhouse gases, according to research by a US-German team reported in the journal *Environmental Research Letters*.

Over the 17-year study period the overall water area in the Kotzebue region grew by 8.3%, and roughly two-thirds of that growth was due to the beavers, the researchers believe.

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Two years ago, a team from the University of Alaska (UA) and Germany's Alfred Wegener Institute (AWI) calculated that North American beavers living in an 18,000-square-kilometre section of northwest Alaska had created 56 new lakes in just five years.

In the new study, they and colleagues from the University of Minnesota used satellite data and extended time series to track beaver activity in two other regions in Alaska – and were surprised by what they found.

In a 100-square-kilometre area near the town of Kotzebue there were two dams in 2002 and 98 by 2019, with more than five new dams being constructed per year. The same trend emerged in a larger survey area covering the entire northern Baldwin Peninsula.

"We're seeing exponential growth there," says AWI's Ingmar Nitze. "The number of these structures doubles roughly every four years."

This has already affected the water balance, the researchers say. Beavers appear to work in those parts of the landscape that they can most easily flood. Sometimes they dam small streams, and sometimes the outlets of existing lakes, which expand as a result.

"The animals have intuitively found that damming the outlet drainage channels at the sites of former lakes is an efficient way to create habitat," says UA's Benjamin Jones, the study's lead author. "So a new lake is formed which degrades ice-rich permafrost in the basin, adding to the effect of increasing the depth of the engineered water body."

Over the 17-year study period the overall water area in the Kotzebue region grew by 8.3%, and roughly two-thirds of that growth was due to the beavers, the researchers believe. They also suspect there have been similar construction booms in other regions of the Arctic.

"The growth in Canada, for example, is most likely even more extreme," says Nitze. "And each additional lake thaws the permafrost below it and on its banks."

"Granted, the frozen soil could theoretically bounce back after a few years, when the beaver dams break; but whether or not the conditions will be sufficiently cold for that to happen is anyone's guess."

cosmosmagazine.com, 1 July 2020

<https://www.cosmosmagazine.com>

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The bees are dying. Can we replace with them flies?

2020-06-29

The humble honey bee is responsible for up to 80 per cent of plant pollination worldwide. But population numbers are in steep decline because of habitat loss, pesticides and pollution – threatening our food security. One startup has identified a potential solution – the common hoverfly.

UK-based designer Tashia Tucker has created an AI-based technology called Olombria, which encourages hoverflies to increase their pollination levels to match that of bees.

Although flies perform approximately 30 per cent of the world's pollination, they aren't as efficient as bees, often getting distracted and "wandering off" before they can carry pollen between plants.

Olombria is a solution – an AI pollination system that encourages hoverflies to pollinate targeted sites when the plants are in bloom. The system consists of sensors, cameras and chemical signalling devices placed within specified areas of an orchard or field.

It starts by collecting data on the level and diversity of pollinators in a grower's field as well as pollination effectiveness. This information, combined with other environmental data – time, location and temperature – allows the system to paint an overall picture of pollinator health, then take action. "We first provide that baseline data," Tucker explains, "so we have an understanding of where there are deficiencies and areas that need to be improved, then we distribute our natural chemical signalling from the device."

Depending on what areas of an orchard need pollinating, Olombria's AI cloud system triggers chosen devices to release organic chemicals that encourage hoverflies to move towards those specific areas. "The chemicals do not alter what the flies would naturally do, but targets their location and increases the amount of pollen that they're picking up and transferring," Tucker explains.

Like planting a mint bush to discourage ants, or basil to deter worms, the chemicals use a combination of plant volatiles and natural signals that insects respond to. The hoverflies work in synergy with the bees and, through Tucker's research, she's found that the hoverflies even encourage bees to become more efficient pollinators. "There's a bit of competition;

One startup has identified a potential solution – the common hoverfly.

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it focuses the bees' pollination as there's another insect in the area," says Tucker.

As a result of climate change, optimising pollination is increasingly important for growers, and predicting weather changes is an ongoing issue. "In the UK, blooms can come in far earlier than a farmer is expecting, or we have cold or wet weather when it should be warm, and the blooms are late," says Tucker. "Matching up available bees when there are crazy things going on with the environment is tricky – it's not always the easiest to just buy more bees to put out."

In the almond industry, farmers pay a combined \$1.5 billion just to rent or purchase bee-hives throughout the bloom season. "In the US, almost every single commercial beehive goes to almond farms for those 3-4 weeks," says Tucker. "If something happens to your hive, all the other hives are being used, so farmers are at a pinch to figure out how they can pollinate their crops."

In the UK, many crops are grown inside polytunnels, which honey bees don't pollinate effectively. Farmers often use bumblebees, which is becoming increasingly untenable, as the species is near extinction. Unlike bumblebees and honey bees, hoverflies are tiny enough to efficiently pollinate small plants and flowers such as blueberry flowers within polytunnels, and are also efficient in rainy weather and at high altitudes.

As a designer, Tucker initially designed Olombria's device to look like a fruit to reflect the ethos of the design. "When I started working with farmers, I needed to design the technology to be robust enough to stay out on the field and within various weather conditions," says Tucker. Since then, Tucker has reconfigured the design and is exploring what colours work well with insects. "As we start to streamline the technology, it is becoming more refined," Tucker explains. "As an AI system, it's great, as it's just getting smarter as the technology develops."

A challenge for Tucker has been to get the balance between the technology that's needed and what works well for the growers, insects and the environmental conditions. But by developing and refining a product that is accessible, low maintenance and yet high tech, Tucker aims to tackle the pollination crisis, orchard by orchard.

wired.co.uk, 29 June 2020

<https://www.wired.co.uk>

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Pools in the Mexican desert are a window into Earth's early life

2020-06-30

Valeria Souza Saldívar never planned to devote her life to a remote and ancient oasis more than 1000 kilometers north of her laboratory in Mexico City. But a call in early 1999 changed that.

"It's one of the best cold calls I've ever made," says James Elser, a limnologist at the University of Montana. He had picked up the phone to invite Souza Saldívar to join a NASA-funded astrobiology project in Cuatro Ciénegas—a butterfly-shaped basin with colorful pools, or *pozas*, in the middle of Mexico's Chihuahuan Desert.

Neither Souza Saldívar, a microbial ecologist at the National Autonomous University of Mexico, University City, nor her ecologist husband and research partner Luis Eguiarte Fruns, also at UNAM, had ever visited Cuatro Ciénegas in the state of Coahuila. That first trip convinced them to completely change their research plans. "Looking at those mountains and the water, I fell in love," Souza Saldívar says.

The landscape—more than 300 turquoise-blue *pozas* scattered across 800 square kilometers, among marshes and majestic mountains—wasn't the only draw. The waters, whose chemistry resembled that of Earth's ancient seas, teemed with microbes; unusual bacterial mats and formations called stromatolites carpeted the shallows. When Souza Saldívar first cultured the organisms from the *pozas*, "The amount of microbes was enormous, as was the diversity of colors and colony sizes," she recalls. For her, this remote microbial hot spot was an irresistible mystery.

Since then, work by Souza Saldívar, Eguiarte Fruns, and a widening circle of collaborators in Mexico and the United States has shown that Cuatro Ciénegas—which means "four marshes" in Spanish—is one of the most biodiverse places on the planet. "There's nowhere that has so much ancient diversity of microorganisms," says Michael Travisano, an evolutionary ecologist at University of Minnesota, Twin Cities, who has collaborated with the Mexican researchers since 2001. Among the most recent additions to that menagerie are hundreds of species of archaea, the ancient microbes that may have given rise to eukaryotes—organisms with complex, nucleated cells.

The diversity includes strains with unusual adaptations, such as the ability to build their lipid membranes with sulfur instead of the usual phosphorus, which is scarce in the waters of the *pozas*. It includes

"The amount of microbes was enormous, as was the diversity of colors and colony sizes," she recalls

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potential sources of new compounds for medicine and agriculture. And it poses a question that has occupied Souza Saldívar and Eguiarte Fruns for the past 20 years: How did this Noah's Ark of ancient microbes arise? "It's a dream for every biologist to know the origin of diversification," Souza Saldívar says.

But her dream might be short-lived. Since the 1970s, farmers have intensively drained water from the *pozas* and rivers to irrigate nearby fields of alfalfa, grown for cattle fodder, gradually drying the improbable oasis. Souza Saldívar has galvanized a conservation effort that has slowed the drainage; in the coming weeks, a canal that removes 100 million cubic meters of Cuatro Ciénegas's water annually is scheduled to close. In the meantime, the researchers have been trying to describe as much as they can, as fast as they can, before their beloved *pozas* dry up and the precious microscopic life that has survived undisturbed for millions of years dies off.

CUATRO CIÉNEGAS SERVED as a stopping point for hunter-gatherers for thousands of years. To date, 50 archaeological sites with cave paintings—some dating to 2275 B.C.E.—have been found in mountain caves around the basin. Much later, the region made a mark on history when Venustiano Carranza, born in a village at the basin's margin, became a leader of the Mexican Revolution and president of Mexico from 1917 to 1920. Nowadays, the village is called Cuatro Ciénegas de Carranza after him.

But in the 1960s, Cuatro Ciénegas started to become famous for its biodiversity, as biologists began to describe new species of snails, fish, turtles, and plants found in the pools and marshes—and often nowhere else.

Wendell "Minck" Minckley, a renowned ichthyologist at Arizona State University (ASU), Tempe, was first lured to Cuatro Ciénegas after learning that the world's only aquatic box turtle (*Terrapene coahuila*) lived there. Over the years, Minckley made frequent trips to the *pozas*, describing their snails and fish (*Herichthys minckleyi*, a cichlid, bears his name) while making connections with the local people.

Minckley also noticed peculiar, rocky structures in the pools. They were stromatolites, biological structures normally found as fossils dating back as much as 3.5 billion years. Colonies of photosynthesizing bacteria, which boosted early Earth's oxygen, created the layered formations by depositing carbonates and trapping sediment in ancient, shallow seas. But these stromatolites were alive. Also found in other extreme environments such as Australia's warm, salty Shark Bay, living stromatolites "are sort of a

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window into early Earth," Elser says. The *pozas* also nurture bacterial mats, a soft form of stromatolites normally found deep in the ocean.

As early as the 1970s, Minckley realized the pools and their diversity were under threat: Local farmers were carving canals to tap their water. Thanks in part to his lobbying, the Mexican government in 1994 designated an 85,000-hectare protected area. But the drainage continued. "Minckley knew that Cuatro Ciénegas was going to die," Souza Saldívar says. He thought NASA might be its salvation.

In 1998, NASA established its Astrobiology Institute, a network of researchers studying life in extreme environments that might resemble conditions on other planets. Minckley saw an ideal astrobiology study site in the waters of the *pozas*, with their seemingly inhospitable chemistry and living stromatolites. But he was no expert on extreme environments, so he enlisted Elser, who specializes in how water chemistry affects ecosystems and also works at ASU. After they submitted a 1998 proposal to fund the project, however, NASA said they should add experts on microbiology and evolution—and those experts had to be Mexican to help secure permits to obtain samples. Based on colleagues' suggestions, Elser called Souza Saldívar and Eguiarte Fruns, newly minted professors at UNAM. They joined, and NASA approved the 3-year project.

With two children in tow, the couple met Minckley and Elser at Cuatro Ciénegas. Next to the turquoise-blue waters of La Becerra *poza*, Minckley told them he believed the ecosystem was a glimpse of deep time. "Do you see these miniature snails in my hand?" Souza Saldívar recalls him saying. "I just scooped them from the springhead, but their direct ancestors were eating sulfur bacteria in hydrothermal vents 220 million years ago in the bottom of the ancient Pacific."

Based on the water chemistry—low in phosphorus, iron, and nitrogen—and the presence of living stromatolites, Minckley believed Cuatro Ciénegas re-created the marine conditions found worldwide millions of years ago. He challenged the two researchers to explore its mysteries—and to protect its *pozas*. "Only you, as Mexicans, can save them from the extinction caused by humans," Souza Saldívar recalls him saying.

Minckley died 2 years later, in 2001.

TO INVENTORY THE FULL DIVERSITY of microbes at Cuatro Ciénegas and trace their relationships, Souza Saldívar needed to study their DNA. To do so, scientists normally take microbial samples from a site and grow them in a lab. But many bacteria and archaea are difficult to culture, and only a few

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groups at the time had successfully analyzed DNA isolated directly from the environment. High magnesium levels in the water and “slime” from the microbes made isolating DNA from the *pozas* especially difficult.

But Souza Saldívar and her students Ana Escalante and Laura Espinosa Asuar made a start. In 2006, they reported in the *Proceedings of the National Academy of Sciences* that they had found 38 distinct groups of microbes—four times as many as in a typical salt marsh—corresponding to 10 major lineages of bacteria and one of archaea. Half the bacterial groups were most closely related to marine microbes. Almost 10% of the groups resembled ones that live on hydrothermal vents—fissures deep in the ocean where microbes thrive despite extreme heat and mineral concentrations.

As Minckley had suspected, Cuatro Ciénegas had somehow preserved ancient marine life forms deep in the desert, more than 500 kilometers from the Gulf of Mexico, at a site where the last seas retreated some 20 million years ago.

“The deep time aspect [of Cuatro Ciénegas] is very surprising,” Travisano says. It is a true “lost world,” preserved by the hostile water chemistry, he and the Mexican team argued in a 2018 paper in *eLife*. Millions of years ago, they proposed, ancient marine ancestors found their way to the place, adapted to the extreme environment, and didn’t change much.

The *pozas* themselves are not particularly ancient. The springs that nurture them are fed by deep aquifers in Sierra San Marcos y Pinos, filled with water accumulated during the last ice ages, Eguiarte Fruns says. Now, the water seeps to the surface because of an active fault beneath the basin. It rises through ancient marine sediments, picking up its unusual chemistry along the way. Somehow, the ancient microbes persisted and diversified in a succession of springs that must have appeared and vanished throughout geologic time. As in an ancient clock, Souza Saldívar says, all the original mechanisms are still working together to sustain unusual life.

To Frederick Cohan, a microbial ecologist at Wesleyan University who is not part of the Cuatro Ciénegas project, the fact that many of the microbes are related to marine species and not species found inland is compelling. “I think it’s saying those organisms are anciently there.”

WHEN THE RESEARCHERS looked at the stromatolites, they found even more diversity. Samples from one site, Pozas Azules II, yielded more than 58,000 distinct microbial sequences, predominantly from bacteria—not a direct count of species, but an indicator of biodiversity. In the Río

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Mezquites, a stream that flows through the northern part of the basin and recharges several pools, they identified 30,000 sequences, mostly from cyanobacteria. More than 1000 sequences from Pozas Azules II appeared to be from archaea, the researchers reported in *Environmental Microbiology* in 2009. The stromatolites also teemed with bacteria-infecting viruses—strains that were unique to each pool and resembled marine viruses.

Studying the microbes hasn’t been easy. “There are thousands and thousands of new bacteria that we can’t grow in culture,” Souza Saldívar says. They could, however, identify some startling adaptations to the extreme conditions. In one bacterium found only in El Churince, a system of lagoons and *pozas* on the western part of the basin, researchers sequenced the smallest genome ever found in its genus, *Bacillus*. The work, led by Gabriela Olmedo Álvarez, a genetic engineer at Center for Research and Advanced Studies of the National Polytechnic Institute, Irapuato, also showed that the microbe—*B. coahuilensis*—could synthesize membrane sulfolipids. This meant that, like some plants and cyanobacteria, it could use sulfur from the environment—instead of phosphorus—to form its cell membranes.

Lost arks

Shallow, mineral-rich pools and lagoons, with conditions like those in ancient oceans, are hot spots of microbial diversity. Floating mats at Cuatro Ciénegas teem with the primordial microbes known as archaea, leading researchers to call them “archaeal domes.”

“It likely ‘stole’ these genes from a cyanobacterium,” Olmedo Álvarez says, enabling it to cope with scarce phosphorus, a condition thought to have prevailed in Earth’s earliest oceans. The microbe’s small genome may also have helped it thrive, as it required less phosphorus to build its DNA. Olmedo Álvarez thinks the organism may offer a glimpse of the stratagems used by early microbes to adapt to their new environment.

“We’re just starting to understand the depth of diversity,” says Olmedo Álvarez, who found that *B. coahuilensis* is itself starting to split into strains with variations in phosphorus metabolism.

The low phosphorus conditions found in Cuatro Ciénegas not only promoted local adaptations, but also accelerated microbial diversification, Souza Saldívar and Elser argued in a perspective published in 2008 in *Nature Reviews Microbiology*. Bacteria normally share bits of DNA with their neighbors in a process called horizontal gene transfer, which blurs

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the divisions between strains. But in Cuatro Ciénegas, the microbes—hungry for phosphorus—essentially consume free DNA rather than incorporating it into their genomes. “They will eat the DNA to get the phosphorus,” Elser says.

Besides offering insights into evolution, Cuatro Ciénegas’s microbial diversity may hold practical payoffs. “Cuatro Ciénegas is one of the richest places on the planet for genetic resources,” Souza Saldívar says. For example, most modern antibiotics are derived from actinobacteria, which are abundant in the pozas. Susana De la Torre Zavala, a biotechnologist at the Autonomous University of Nuevo León (UANL), University City, is searching for potential antibiotics in a library of 350 actinobacteria from the basin. Her team has also found that an extract from a microalga living in the pools shows anticancer activity.

Agriculture, too, could benefit, Olmedo Álvarez says. By 2050, the reservoirs of phosphorus that help sustain global harvests could become scarce, and the microbes’ ability to concentrate the element from different sources could hold solutions. “We’re understanding Cuatro Ciénegas, but we’re also understanding basic principles of ecological interactions that have an application in medicine and agriculture,” she says.

AS THE SCIENTIFIC STORY of Cuatro Ciénegas unfolded, its fate has hung in the balance, with Souza Saldívar fighting a long series of battles over its water with local farmers and landowners, dairy companies, and politicians. Her weapons have been her rising scientific profile and a tireless outreach to the public, especially young people.

Souza Saldívar has drawn fire—during a 2013 microbiology congress, police had to protect her from protesting locals—but she has won a series of victories. In 2007, the daughter of the CEO of LALA, a giant dairy consortium with roots in the state of Coahuila, told her father she wouldn’t speak to him because “he was killing Cuatro Ciénegas,” Souza Saldívar says. The executive promptly scheduled a meeting with the scientist. “You need to change your cows’ diet,” Souza Saldívar says she told him, refusing to accept a courtesy yogurt he offered. “I’ll accept your yogurt when you do so.” He promised not only to stop buying the region’s alfalfa, but also to invest in environmental education projects for local children.

Two years later, she won an unusual ally, the powerful Mexican billionaire Carlos Slim. His foundation collaborated with the World Wildlife Fund (WWF) to buy the land surrounding El Churince in the western basin, and to provide researchers with a 5-year, 18 million Mexican peso (\$1.4 million) grant to study Souza Saldívar’s favorite *poza*. This allowed them to set up

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the infrastructure to perform long-term experiments. But it did not save the water.

In 2010, Mexico’s National Water Commission (CONAGUA) set out to replace the open, leaky canals, which lose 75% of the drained water, with less wasteful enclosed conduits. But the project was abandoned midway—most likely because of corruption—and the old canals were never closed. As Cuatro Ciénegas continued to dry up, the researchers raced to study El Churince, finding 5167 distinct species of bacteria and archaea in the last remaining pool. A close inspection of the genomes of *Bacillus* bacteria from one single square kilometer increased the known diversity of the group by more than 20%. By comparing DNA sequences, the team traced the *Bacillus* diversity to two ancient ancestors, one dating back 680 million years, the other 160 million years. Those dates coincide with the breakup of the supercontinents Rodinia and Pangaea, respectively, and the team thinks the oceans that formed during those convulsions carried the ancestral microbes to what is now the Cuatro Ciénegas Basin, where they have persisted ever since.

Cohan says that’s plausible. *Bacillus* from elsewhere fail to thrive in Cuatro Ciénegas, most likely because they are outcompeted by the local microbes and can’t adapt to the extreme conditions. And the *Bacillus* species from Cuatro Ciénegas are not found anywhere else in the world. “It’s just bizarre,” Cohan says, but it makes the *pozas* so much more valuable and worth saving. “It’s kind of a paleontological microbial park.”

In 2016, El Churince dried up just after the funding from the WWF—Carlos Slim Foundation ended. The researchers felt devastated. Souza Saldívar says it was painful to see turtle shells lying on the now-barren soil. “It’s really sad,” Olmedo Álvarez says. “It’s gone.”

ON THE EASTERN SIDE of the basin, things are looking brighter. In 2000, the conservation nongovernmental organization Pronatura Noreste acquired the Pozas Azules ranch: 2721 hectares hosting about 100 *pozas*. Pronatura eventually gained rights to the water as well, enabling it to close canals draining the *pozas* in the ranch. Farmers are now encouraged to adopt water-sparing drip irrigation, and some are growing nopal—an edible cactus popular in Mexican cuisine—which requires much less water than alfalfa.

The researchers have focused their recent studies on Pozas Azules. In 2019, after an unusual spring rain, the team noticed alien-looking structures in the shallow waters of a site near Pozas Azules II: white microbial mats buoyed by gas. The gas appeared to be largely methane, and a genetic

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analysis showed the mats were teeming with archaea—230 distinct species, they report in a preprint. That makes the spot “the most diverse place of archaea that we know of,” De la Torre Zavala says.

Now, the team hopes to analyze samples from the structures, which it calls “archaean domes,” in search of the elusive Asgard archaea, organisms previously found only in the deep ocean and thought to hold clues to the evolution of simple microbes into complex eukaryotes. Although some in her team are skeptical, Souza Saldívar is convinced they will find them. “Valeria’s usually right,” De la Torre Zavala says.

Such prospects have added to Souza Saldívar’s determination to preserve Cuatro Ciénegas, and she is enlisting young people for support. In every field trip since 2004, her team has spent time with students from the local high school, showing them how to use a microscope and take simple environmental measurements, and teaching them about sustainable agriculture. In 2011, with funding from the LALA Foundation and the WWF–Carlos Slim Foundation, the scientists set up a college-level molecular biology lab at the school, which is now ranked among the best rural high schools in Mexico.

Héctor Arocha Garza is one of its graduates. Inspired by the secrets of Cuatro Ciénegas, he pursued a Ph.D. in biotechnology at UANL with De la Torre Zavala, then returned to his hometown. “My heart was in Cuatro Ciénegas,” he says. Now, he’s leading the scientific branch of a privately funded megaproject called Cuatro Ciénegas 2040 that aims to build a science museum and make Cuatro Ciénegas a scientific tourism destination, while supporting education and medical care for the village’s young people.

The effort comes at a critical moment. More than 90% of the marshes are gone, and some *pozas* and lagoons are dry. But this year, CONAGUA committed to regulating water usage and closing illegal wells, and Pronatura Noreste will close the Saca Salada Canal, which drains the Río Mezquites, as soon as the COVID-19 pandemic permits.

Those developments, and stories like Arocha Garza’s, give Souza Saldívar hope for the future of Cuatro Ciénegas. “It has been a very complicated, long, and difficult process,” she says. But now, she wrote in a recent book,

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“There is a revolution occurring in this oasis: Science is the tool and kids are the drivers.”

sciencemag.org, 30 June 2020

<https://www.sciencemag.org>

Vermont just banned food waste in trash. Here’s how it works

2020-07-06

Vermonters can no longer simply toss their food into trash cans. Under a new law that went into effect at the start of the month, residents are now required to compost any unfinished food—including inedible scraps like peels, egg shells, and pits—in their yard or through a professional compost facility. While other states have taken steps to curb food waste, particularly at the business level, Vermont is the first to implement a statewide ban on food waste that also affects individuals.

It’s an ambitious policy, but one that Vermont lawmakers believe the state must take to achieve its goal of diverting 50% of all waste from landfills to facilities where it can be composted, recycled, or reused. That target has been in place for more than a decade, says Josh Kelly, materials management section chief with the Vermont Agency of Natural Resources, yet the best they’d been able to do was reduce waste by about 36%. “The only way you can really bring that down is by focusing on the food waste issue,” he says.

Every five years, Vermont officials dig through the state’s trash to see what residents are tossing, and they’ve consistently found that 20% is food waste. Food waste has also been shown to be a significant source of methane, a greenhouse gas that is about 25 times more powerful than carbon dioxide when it comes to warming the Earth.

Officials won’t be digging through curbside cans to bust composting delinquents, though. “People say, ‘What does this mean with a food waste ban? [Are] people going to be out there looking in my garbage for my apple cores?’” Kelly says. “That’s not the intent of this.” The state doesn’t have the resources or desire, he explains, to enforce the ban at the residential level. Instead, officials are asking for voluntary compliance—and they expect to get it, based on how seriously Vermonters take their environmentalism.

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Even before the ban went into effect, 72% of Vermonters were composting at home or fed their food scraps to livestock, according to a study from the [University of Vermont](#). “The Vermont story is that we have been working at composting and reducing food waste for nearly a decade before the law came into effect,” Kelly says. Many people live in Vermont because they love the rural landscape, so it’s part of their ethics to keep that landscape pristine and to use food waste to nurture their soil.

The state did invest in composting infrastructure to make compliance easier. Officials set aside about \$970,000 dollars in grants for compost facilities to purchase equipment, expand their curbside pick-up or drop-off services, and build anaerobic digesters that turn compost into energy. Vermont has both publicly owned and private compost facilities; even if not every area has curbside collection, Kelly says that there are more than 100 drop-off stations that offer food scrap collection, and almost every town has one within 10 miles.

The new law, known as the Food Scrap Ban, addresses food waste from a few angles, by providing different options for drop-off and curbside collection, along with resources to help residents [compost at home](#) (if you do compost at home, the law allows you to toss bones and meat in the trash). It also provides more support for food rescue and donation efforts, to divert edible food from the trash to those in need.

There are potential downsides. Some professional facilities are worried that, without strict enforcement, compost may become contaminated by people who don’t properly sort out plastics or paper products. (Many Vermont composting facilities are food scrap-only, meaning they don’t accept napkins or compostable cups.) That means their compost may not be able to be used by farmers as a soil nutrient. “If people are taking this material and making a lot of compost, but the compost is full of plastic contamination, you’re essentially just taking one waste and converting it to another waste,” says Kurt Erickson, general manager at Vermont Compost Company.

To Erickson, the success of this law hinges on both sides of that equation—the input and output of the compost. “If the simple objective is to divert material from the landfill, I think the success there is really limited,” he says. “To me, what success would look like is, yes, we’re diverting this material from landfill, but we’re managing it well, keeping contamination as close to zero as we can, and we’re returning these nutrients back to farmland to grow food.”

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Still, he agrees that Vermont is already a step ahead of most states when it comes to handling things in an environmentally responsible way. Even if this law isn’t 100% perfect at its start, Kelly hopes Vermont can be a model for other states looking to address their food waste.

[fastcompany.com](#), 6 July 2020

<https://www.fastcompany.com>

HotSpots H20: In Somalia, Covid-19 compounds water stress

2020-06-29

The fragile situation for herders in Somalia and Somaliland, where harsh weather has stripped the land of food and water, is being exacerbated by the spread of Covid-19.

Somalia reported its first case of the disease in March. As of June 28, a total of 2,894 cases [had been confirmed](#), and 90 people had died. Camps that house people who have been uprooted by drought and violence are among the highest-risk locations.

In recent years, parts of Somalia have become so hot and dry that they are virtually uninhabitable. Crops and herds are perishing in the harsh conditions, and residents of hard-hit areas are being forced to relocate.

Conditions in Somaliland, an autonomous region of Somalia, are among the most severe. The climate in Somaliland began shifting three decades ago, leading to a severe drought from 2016 to 2018.

Today, more than half a million residents of Somaliland, along with thousands of other Somalis, have abandoned their semi-nomadic lifestyles. Some have moved to urban areas, but many are stranded indefinitely in camps for internally displaced people (IDPs). Food and clean water are minimal in these camps and settlements.

Cecilia Jimenez-Damary, the UN Special Rapporteur on the human rights of internally displaced persons, [has called on all governments](#) to provide IDPs with “access to water, sanitation, facilities for personal hygiene, adequate housing, and food.” In Somalia, authorities have conducted information campaigns and set up a call center where Somalis can receive free medical consultations.

Despite these efforts, many people have not been reached, especially in rural areas and informal settlements.

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“Our lack of financial resources prevents us from seeking healthcare and buying protection, such as face masks or alcohol-based hand rub,” Maryam Abdullahi, a resident of an informal camp in southern Somalia, told representatives from the UN peacekeeping organization.

She went on: “Getting clean water to wash hands is even itself a struggle. Twenty liters of clean water is sold at around half a U.S. dollar, and people like me, who do not have formal jobs or a good source of earnings, do not have the luxury to buy water and wash hands, so we often cut back on its usage.”

For most Somalis, the fight against Covid-19 has compounded pre-existing water stress. Prior to the pandemic, countless people already relied on distant or inconsistent water sources. The call for increased handwashing has only made shortages worse.

Even if Somalia manages to contain the spread of Covid-19, the country’s long-term future is uncertain. A study by a climate expert at the University of Arizona found that the Horn of Africa is drying more quickly than it has at any time in the past 2,000 years. If the trend continues, the recent patterns of crop failure, herd deaths, and displacement are likely to continue as well.

[circlofblue.org](https://www.circleofblue.org), 29 June 2020

<https://www.circleofblue.org>

Year 2020: Last chance to avoid rebound into carbon chaos

2020-07-01

The decisions made during the remainder of this year – a mere 6 months – to recover economically from the COVID-19 crisis, are likely to determine the practical actions set in motion for the next 3 years, in terms of controlling carbon emissions, and thence the course of the climate crisis up to 2050... and beyond.

It is now part of the public psyche that to mitigate climate change requires curbing our use of fossil fuels, although the vast scale of this, as necessary to check global warming to within necessary limits, is less readily comprehended. Likewise, that there should be such a large difference in consequences between a rise of 2 degrees Celsius, and one of just half a degree less than this, is not immediately obvious, until the massive

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amount of additional energy absorbed into the Earth system that this represents, is appreciated.

It is sometimes tempting to despair that zero-carbon will be attained by 2050, and the chances of doing so by 2030 appear far less compelling. Nonetheless, the reduction in carbon dioxide emissions that have been “achieved” as an inadvertent consequence of locking down to control the transmission of the coronavirus, by *almost one sixth in April 2020, compared with 2019 levels*, might be taken to indicate that significant progress along this path is indeed possible. The question arises, however, of whether such an ameliorated emissions level might be preserved in the longer run, but the subsequent “rebound” in CO₂ being poured into the atmosphere to within about 5% of 2019 levels, somewhat dilutes optimism about this.

Clearly, by simply curbing the milliard tonnage of fossil fuels that we burn, CO₂ emissions would be attenuated, but with economic catastrophe as an unwelcome bedfellow. Huge sums of money are being pledged by governments across the globe this year, to stimulate their economies post COVID-19, totalling \$9 trillion. Since, with the aid of these fiscal booster-jabs, the die will be cast for the global economy over the next 3 years, how the money is spent is critical, and if it does not coincide with a dramatic and permanent fall in CO₂ emissions, climate targets will become unattainable. In short, the time is now or never.

However, according to a recent International Energy Agency (IEA) report, a “green alternative” is within our grasp. Not surprisingly, this requires a principal emphasis on the proliferation of wind and solar energy, but also that buildings and industries be made more energy efficient, and that electricity grids are remodelled and updated. The creation of millions of new jobs across the world is vital, particularly in those nations where very many have been rendered unemployed, as a result of the lockdowns imposed to hold the COVID-19 crisis in check.

The report concludes that rather than injecting finance into the prevailing high-carbon economy, more jobs can be created by investing in such activities as retrofitting buildings, fabricating wind farms, installing solar panels, inaugurating new power networks, implementing greater numbers of electric vehicles, improving the energy efficiencies of industry, long distance transportation, and appliances in general, along with more end-use renewables, biofuels production, and creating environmentally sound urban infrastructure. It is thought that such a “sustainable recovery plan” could generate an annual 9 million new jobs.

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While the European Union, for example, appears poised to initiate a swathe of green as part of its recovery, globally, little money has so far been directed toward low-carbon industries, with the majority of the pledged funding aimed toward their high-carbon counterparts. For example, the aviation industry is targeted for a \$33 billion bailout. As the Executive Director of the IEA, Fatih Birol, has commented, governments “had an excuse” to support these industries, as a first reaction to dealing with the suddenness and scale of the COVID-19 crisis, since “the first recovery plans were more aimed at creating firewalls round the economy.” However, some governments are still investing in high-carbon projects, such as coal-fired power stations.

There is an additional danger, namely that the currently available cheap and plentiful oil might act to derail the essential transformation to renewable energy. Especially at this critical time, to allow this to happen would be very short sighted, to say the least, and it is the longer game we must prepare for. As has been stressed elsewhere, the oversupply of oil is temporary, and will finally be drained away into the enlarging backdrop of declining conventional fields.

Investment in the countryside has also been proposed as a potentially significant source of new jobs. Sir Mark Rylance, the actor and former artistic director of Shakespeare’s Globe theatre, in London, has said that members of the theatrical profession are not happy “just sitting on their butts”, furloughed or unemployed due to COVID-19, and would prefer to be occupied in hands-on environmental activities. He has declared that, due to his own freelance status, he is prepared to devote one month per year for the next decade, to carry out building and digging work in the service of countryside and environmental initiatives, which he very much believes in. Sir Mark is also said to have proposed that the UK government invest £315 million in a range of countryside and environmental projects which could create (paid) jobs and improve the nation’s health.

A considerable opposing force to making such vital changes is the incentivisation of global capitalism, which, as a result of its massive resource consumption, is now reckoned to be eroding the safe, operating space of human civilization, leading to breaches of key planetary boundaries, such as land-use change, biosphere integrity and climate change. There are also indications that it may be more difficult than is generally thought to transform to a low-carbon society, and until renewables have been established on a sufficient scale to achieve net energy payback, a large-scale expansion of low carbon energy

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capacity will rely upon subsidies from the fossil fuels, which are, in any case, becoming increasingly scarce.

Most probably, a redesign of our system of industrialised civilization, to *use less energy overall*, primarily involving relocalisation strategies, is the critical approach to addressing these and many other issues that confront us, and it would be perilous to overlook this.

resilience.org, 1 July 2020

<https://www.resilience.org>

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Technical Notes

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

CHEMICAL EFFECTS

[A multi-residue method by supercritical fluid chromatography coupled with tandem mass spectrometry method for the analysis of chiral and non-chiral chemicals of emerging concern in environmental samples](#)

[Current mechanistic perspectives on male reproductive toxicity induced by heavy metals](#)

[Towards a Computational Ecotoxicity Assay](#)

ENVIRONMENTAL RESEARCH

[Environmental Exposures and Hearing Loss](#)

[Suspect screening based on market data of polar halogenated micropollutants in river water affected by wastewater](#)

[Environmental contaminants in coastal populations: Comparisons with the National Health and Nutrition Examination Survey \(NHANES\) and resident dolphins](#)

OCCUPATIONAL

[Neuropsychological effects of long-term occupational exposure to mercury among chloralkali workers](#)

[Relationship between butyrylcholinesterase activity and lipid parameters in workers occupationally exposed to pesticides](#)

PHARMACEUTICAL/TOXICOLOGY

[Lung Cancer Occurrence-Correlation with Serum Chromium Levels and Genotypes](#)

[Recent Advances in the Electrochemical Sensing of Venlafaxine: An Antidepressant Drug and Environmental Contaminant](#)