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Remember Beta? New data reveal variant's deadly powers

People infected with a variant first identified in South Africa are more likely to die than those infected with other variants.

Ewen Callaway

People infected with the Beta coronavirus variant are more likely to need critical care and to die than are people infected with other variants[1]. The Beta variant, also known as B.1.351, was first identified in late 2020 in South Africa, where it sparked a second COVID-19 wave before spreading globally.

Some evidence has suggested that severe cases of COVID-19 were more common during South Africa's Beta-driven second wave than during its first wave, caused by the ancestral version of SARS-CoV-2. To determine whether the Beta variant is linked to increased severity, Laith Jamal Abu-Raddad, an infectious-disease epidemiologist at Weill Cornell Medicine—Qatar in Doha, studied infected people in Qatar in early 2021.

During that period two variants were circulating: Beta and Alpha, which originated in the United Kingdom in 2020 and is also known as B.1.1.7. The team did not compare Beta with the Delta variant, which is now ripping through much of the world and which has also been linked to heightened severity.

People infected with Beta were 25% more likely than those infected with Alpha to develop severe disease , and around 50% more likely to require critical care, as well as 57% more likely to die. This fits with observations at the time, says Abu-Raddad. As Beta surged in Qatar, acute-care admissions doubled, and ICU admissions and deaths quadrupled. "It was very clear we were talking about a more severe variant," he adds. The findings have not yet been peer reviewed.

The study was small, but it is important because its conclusions stem from a careful comparison of the outcomes of infections with different variants in people with similar characteristics, such as age and sex, says Waasila Jassat, a public health medicine specialist at the National Institute for Communicable Diseases in Johannesburg, South Africa. She led a study[2] published in July that found that people were around 30% more likely to die after hospitalization during South Africa's second wave than in its first. Pinning down Beta's severity will help researchers to anticipate its effects on health-care systems, Jassat adds.

As the more-transmissible Delta variant spreads, Beta is now fading in many places where it was once dominant, including South Africa and Qatar. But Abu-Raddad notes that Beta seems to be more resistant to immunity generated by vaccines and previous infections than are other variants, including Delta, and it could begin wreaking havoc again. "We should never underestimate this pathogen."

doi: https://doi.org/10.1038/d41586-021-02177-3

***Update 10 August 2021**: This story has been updated with additional detail about the Delta variant and about what makes the findings valuable.*

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https://bit.ly/3CCXRBY

A Terrifying 'Dragon' Was The Largest Known Flying Reptile of Ancient Australia

With a seven-meter wingspan, and a mouth bristling with fangs, a newly discovered pterosaur would have ruled the skies over Australia's northeast around 110 million years ago.

It's the largest species of pterosaur ever found on the continent, an extremely important find that contributes to our understanding of pterosaur diversity in Australia.

And it would have been absolutely metal.

"It's the closest thing we have to a real life dragon," said

paleontologist Tim Richards of the University of Queensland in Australia.

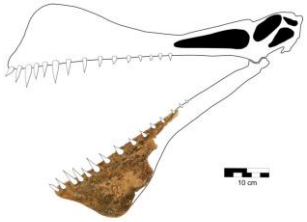
"The new pterosaur, which we named *Thapunngaka shawi*, would have been a fearsome beast, with a spear-like mouth and a wingspan around seven meters (23 feet). It was essentially just a skull with a long neck, bolted on a pair of long wings.

Artist's impression of an anhanguerian like T. shawi. **(Adobe stock)**

"This thing would have been quite savage. It would have cast a great shadow over some quivering little dinosaur that wouldn't have heard it until it was too late."

Pterosaur remains in Australia are extremely rare. Like today's birds, their bones - optimized for flight - were hollow and brittle, and thus very few have survived to the present day.

Fewer than 20 specimens have been described from the continent, and only three, prior to *T. shawi*, had been named.



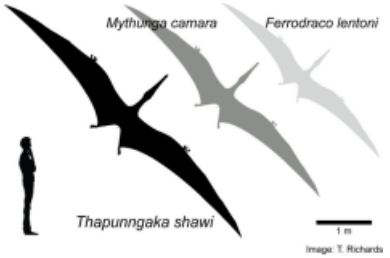
Hypothetical outline of Thapunngaka shawi. **(Tim Richards)**

Also, only two Australian pterosaurs belonged to a group known as the anhanguerian pterosaurs, both hailing from the northeastern state of Queensland. *T. shawi* marks the third anhanguerian hailing from Australia; it's also from Queensland.

Its description is based on a fragment of lower jaw, and what we know of other anhanguerian pterosaurs. It was named for the fossicker who discovered it, Len Shaw, and incorporates words from the language of the First Nations people who inhabited the region, the Wanamara Nation.

"The genus name, *Thapunngaka*, incorporates *thapun* [ta-boon] and *ngaka* [nga-ga], the Wanamara words for 'spear' and 'mouth', respectively," said paleontologist Steve Salisbury of the University of Queensland.

According to the team's reconstruction, *T. shawi*'s skull would have been around a meter long (3.3 feet), with around 40 teeth. The beast would have flown above the inland Eromanga Sea that once dominated eastern Australia, using its long, powerful jaw to pluck fish from the water.



Reconstruction of the skull of T. shawi. **(Tim Richards)**

Of particular interest, the researchers found, was a large bony crest on the bottom of the jaw. Based on what we know of anhanguerians, the animal's top jaw also sported such a crest.

"These crests probably played a role in the flight dynamics of these creatures, and hopefully future research will deliver more definitive answers," Salisbury said.

It's from this crest that the researchers estimated the pterosaur's size - it is, they said, the largest mandibular crest known from any anhanguerian. If their estimations are correct, *T. shawi* would be the third largest anhanguerian pterosaur known worldwide.

This suggests that Australian pterosaurs rivaled contemporaneous species from other continents in terms of size. In addition, the anatomical similarities between the jawbone of *T. shawi* and those of other Australian pterosaurs suggest there may have been a local pterosaur species diversification around the Eromanga sea.

"It's quite amazing fossils of these animals exist at all," Richards said.

"By world standards, the Australian pterosaur record is poor, but the discovery of *Thapunngaka* contributes greatly to our understanding of Australian pterosaur diversity."

The research has been published in the *Journal of Vertebrate Paleontology*.

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This meat-eating plant is only a part-time killer

Meat-eating plant that only catches insects when it's flowering

By Erik Stokstad

Most carnivorous plants are full-time predators—the Venus fly trap, for example, lies in wait year-round to snag flies with its jawlike leaves.

The newest known carnivorous plant, Triantha occidentalis, digests insects that are trapped by sticky hairs on its flowering stalk. **Adam Schneider**

Now, researchers describe a meat-eating plant that only catches insects when it's flowering. Overlooked because its sticky hairs are relatively common among plants, the species may be just one of many examples of "cryptic carnivores" yet to be discovered.

"It's a really interesting finding and a well-designed study," says Ulrike Bauer, a carnivorous plant expert at the University of Bristol who was not involved with the work.

There are about 800 species of carnivorous plants. Most belong to closely related groups. Many species have a snap trap, like the Venus fly trap, whereas other groups rely on sticky surfaces, and still others lure prey into chambers filled with digestive fluids. The last time a totally new type of carnivorous plant was discovered was in 2012: Researchers found a species in the Brazilian savanna that catches tiny worms with special leaves that grow underground.

The species in the new study, called the western false asphodel (*Triantha occidentalis*), lives in mountainous bogs and other nutrient-poor locations in western North America. The upper part of its flowering stalk is covered with small red hairs that exude a shimmering, sticky substance. The hairs often trap flies and small beetles in the droplets. But so do many other kinds of plants, which use these hairs as defense against pests rather than as a source of nutrition.

The clue to *Triantha*'s carnivorous diet emerged from a genomic study of plant evolution. Gregory Ross, a master's student working in the lab of Sean Graham, a botanist at the University of British Columbia (UBC), Vancouver, noticed *T. occidentalis* lacks some genes that are also missing in carnivorous plants. (The genes are involved in fine-tuning photosynthesis, for example when plants are exposed to dappled sunlight.)

Qianshi Lin, then a Ph.D. student at UBC, decided to investigate. He prepared a special diet for *Triantha*: fruit flies that had been fed with an isotope, or form, of nitrogen that is rare in nature, which could reveal whether the plants were absorbing nutrients from the flies. After 150 flies had matured, Lin froze them. Then, he and colleagues visited a bog near Vancouver, where they added fruit flies to 10 individual *Triantha* plants and, as a control, to a similar-size plant that is not carnivorous.

One to 2 weeks later, the researchers brought the plants back to the lab. They could detect the nitrogen isotope in the stems, leaves, and fruits of *Triantha*, but not in the noncarnivorous plants. *Triantha* got more than half of its nitrogen from prey, similar to sundews, a carnivorous plant living nearby, the team reports today in the *Proceedings of the National Academy of Sciences*.

"That's the point at which you prove that it's a carnivorous plant," Lin says. "I felt quite excited to discover it." He also showed that the hairs make the same enzyme, phosphatase, that other carnivorous plants use to extract the nutrient phosphorus from prey.

Many carnivorous plants use sticky hairs to snare flies and small beetles, but they locate these traps away from their flowers—it's no good to eat an insect that's needed for pollination. The western false asphodel doesn't do this; it puts these sticky hairs on the main stem bearing its flowers, which grows up to 80 centimeters tall. The authors think the red hairs and shiny droplets attract insects, like in sundews. But the droplets are only sticky enough to trap small

insects such as midges and not bees or other pollinators, says co-author Tom Givnish, a botanist at the University of Wisconsin, Madison.

Andreas Fleischmann, a botanist at the State Botanical Collection in Munich, isn't convinced that *Triantha* is a true carnivore—for that, he says, it needs to be clearly demonstrated that the plant is luring insects to their deaths. He thinks it's more likely that the hairs are used to kill insects that might steal pollen or nectar from its flowers without fertilizing them. *Triantha* is more of a passive killer, Fleischmann argues, not an active one with leaves modified for trapping.

One implication of the finding is that there may be other overlooked examples of carnivorous plants; the researchers found museum specimens of a related species with small insects attached to the flower stalk. *Triantha* is just a part-time carnivore, Lin says, because it only flowers briefly. Aaron Ellison, an ecologist at Harvard University, notes there's only one other known example of a part-time carnivorous plant, a vine in West Africa that eats insects only as a juvenile but then outgrows the habit.

There's something else remarkable about *Triantha*, Ellison notes: It's one of just a few examples of carnivorous plants in a large group of plants called the monocots (which includes all grasses and lilies, for example). Why are carnivorous monocots so rare? Lin says it might be because the typical monocot leaf, like a blade of grass, is narrow with parallel veins, which may be less suitable for evolving into complex traps. The presence of carnivory in different ancient lineages is fascinating to study, Fleischmann and others say, because it's like comparing the evolution of flight in animals as distinct as bats and insects.

"This paper will be an important piece of carnivorous plant biology," says biophysicist Rainer Hedrich of the Julius Maximilian University of Würzburg.

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Innovative Coating for Blood Vessels Substantially Reduces Rejection of Transplanted Organs

Researchers have found a way to reduce organ rejection following a transplant by using a special polymer to coat blood vessels on the organ to be transplanted.

The polymer, developed by UBC medicine professor Dr. Jayachandran Kizhakkedathu and his team at the Centre for Blood Research and Life Sciences Institute, substantially diminished rejection of transplants in mice when tested by collaborators at SFU and Northwestern University.

"We're hopeful that this breakthrough will one day improve quality of life for transplant patients and improve the lifespan of transplanted organs," said Dr. Kizhakkedathu.

The findings were published today (August 9, 2021) in *Nature Biomedical Engineering*.

The discovery has the potential to eliminate the need for drugs—typically with serious side effects—on which transplant recipients rely to prevent their immune systems from attacking a new organ as a foreign object.

Dr. Kizhakkedathu explained how that problem arises: "Blood vessels in our organs are protected with a coating of special types of sugars that suppress the immune system's reaction, but in the process of procuring organs for transplantation, these sugars are damaged and no longer able to transmit their message."

Dr. Kizhakkedathu's team synthesized a polymer to mimic these sugars and developed a chemical process for applying it to the blood vessels. He worked with UBC chemistry professor Dr. Stephen Withers and the study's co-lead authors, PhD candidate Daniel Luo, and recent chemistry PhD Dr. Erika Siren.

Dr. Siren's thinking on cell-surface engineering had been inspired by a visit to a BC Transplant facility.

"I remember seeing an organ sitting in a solution and thinking, 'Here's a perfect window to engineer something right,'" Dr. Siren recalled. "There aren't a lot of situations where you've got this beautiful four-hour window where the organ is outside the body, and you can directly engineer it for therapeutic benefit."

The work of Simon Fraser University's Dr. Jonathan Choy and Winnie Enns confirmed that a mouse artery, coated in this way and then transplanted, would exhibit strong, long-term resistance to inflammation and rejection. Dr. Caigan Du of UBC and Dr. Jenny Zhang of Northwestern University then got similar results from a kidney transplant between mice. Dr. Megan Levings of UBC and the BC Children's Hospital Research Institute firmed up the findings using new-generation immune cells.

"We were amazed by the ability of this new technology to prevent rejection in our studies," said Dr. Choy, professor of molecular biology and biochemistry at SFU. "To be honest, the level of protection was unexpected."

The procedure has been applied only to blood vessels and kidneys in mice so far. Clinical trials in humans could still be several years away. Still, the researchers are optimistic it could work equally well on lungs, hearts and other organs, which would be great news for prospective recipients of donated organs.

In 2019, more than 3,000 Canadians underwent organ transplantation with the aim of averting end-stage organ failure.

Reference: "Prevention of vascular-allograft rejection by protecting the endothelial glycocalyx with immunosuppressive polymers" by Erika M. J. Siren, Haiming D. Luo, Franklin Tam, Ashani Montgomery, Winnie Enns, Haisle Moon, Lyann Sim, Kevin Rey, Qiunong Guan, Jiao-Jing Wang, Christine M. Wardell, Mahdis Monajemi, Majid Mojibian, Megan K. Levings, Zheng J. Zhang, Caigan Du, Stephen G. Withers, Jonathan C. Choy and Jayachandran N. Kizhakkedathu, 9 August 2021, Nature Biomedical Engineering. DOI: 10.1038/s41551-021-00777-y

The research was supported by CIHR, NSERC, UBC, SFU, the Heart and Stroke Foundation of Canada, GlycoNet and the Michael Smith Foundation for Health Research.

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New data suggest J. & J. vaccine works against Delta and recipients don't need a booster shot.

Single dose of the Johnson & Johnson vaccine is highly effective in preventing severe illness and death from the Delta and Beta variants

By Apoorva Mandavilli

A single dose of the Covid-19 vaccine made by Johnson & Johnson is highly effective in preventing severe illness and death from the Delta and Beta variants of the coronavirus, data from a clinical trial in South Africa suggest.

The study is the first real-world test of the vaccine's efficacy against Delta, a highly contagious variant of the virus surging across the United States and much of the world. South Africa's Ministry of Health reported these preliminary results at a news conference on Friday. The data have not yet been peer-reviewed or published in a scientific journal.

In the trial, called Sisonke, the researchers evaluated one dose of the Johnson & Johnson vaccine in nearly 500,000 health care workers, who are at high risk of Covid-19. The vaccine has an efficacy of up to 95 percent against death from the Delta variant, and up to 71 percent against hospitalization, the researchers reported. (The vaccine did slightly worse against the Beta variant, which is thought to be more adept at sidestepping the immune response than Delta.)

"We believe this vaccine is doing what it was designed to do, which was to stop people going to hospital and stop them ending in I.C.U.s and dying," said Dr. Linda-Gail Bekker, co-lead of the study and director of the Desmond Tutu H.I.V. Centre at the University of Cape Town.

The results suggest that people who have received one dose of the Johnson & Johnson vaccine don't need a booster shot, Dr. Bekker

said.

When so-called breakthrough infections did occur in vaccinated volunteers, they produced mild symptoms in 96 percent of the cases and resulted in severe disease or death in less than 0.05 percent, the study found. The trial ran from February to May of this year.

The results should comfort the millions of people who have received the Johnson & Johnson vaccine, particularly because some previous studies had suggested the single shot may be vulnerable to Delta. Laboratory studies of the vaccine's performance against the variant have been mixed, and a trial comparing the one- and two-dose regimens has not yet released results.

Given the uncertainty, some Johnson & Johnson recipients have sought a second dose on their own. Health officials in San Francisco are offering residents immunized with Johnson & Johnson a supplemental dose of the Pfizer-BioNTech or Moderna vaccines.

South Africa approved the Johnson & Johnson vaccine in April. The country battled a surge of the Beta variant of the virus earlier this year, but Delta has become the dominant variant in recent weeks. More than 8 million South Africans have received the Johnson & Johnson vaccine or at least one dose of the Pfizer vaccine.

"This study was conducted as a real-world efficacy study in one of the most challenging epidemiologic settings," said Dr. Dan Barouch, a virologist at Beth Israel Deaconess Medical Center in Boston who has led some studies for J. & J. but was not involved in the trial. "This is very good news for the fight against the global Covid-19 pandemic."

The South African researchers recorded two cases of the rare clotting disorder associated with the Johnson & Johnson vaccine in the trial; both participants made a complete recovery.

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A Key Hallmark of Motor Neurone Disease Has Been Reversed in The Lab

There's no known cure – but we might have just gotten closer to finding one.

David Nield

Amyotrophic lateral sclerosis (ALS), often known as motor neurone disease, slowly kills off nerve cells in the brain and spinal cord, causing paralysis and eventually death. Right now, there's no known cure – but we might have just gotten closer to finding one.

In a new study, scientists were able to reverse one of the biological abnormalities that ALS introduces in cells. It's important to note this has only been achieved for one form of the disease so far, and only in lab samples, rather than in actual human beings.

Even with those caveats, though, it's a significant step forward in understanding how we might tackle the neurodegeneration seen in ALS cases, and gives new hope that motor neurone disease can one day be beaten.

"Demonstrating proof-of-concept for how a chemical can reverse one of the key hallmarks of ALS is incredibly exciting," says neuroscientist Jasmine Harley from the Francis Crick Institute in the UK. "We showed this worked on three key RNA binding proteins, which is important as it suggests it could work on other disease phenotypes too."

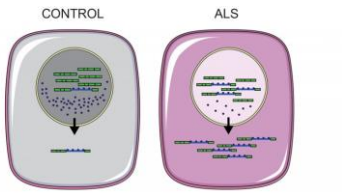
These RNA binding proteins, which help regulate RNA, get stuck in the wrong place in most people with ALS. They find their way out of the motor neuron nucleus where they should be, into the surrounding cytoplasm where they shouldn't be.

The team was able to reverse this in human cell samples taken from patients with ALS. They did it by blocking an enzyme called VCP, which suggests that, in some motor neurone disease cases, this enzyme is becoming mutated and overactive.

When the enzyme was blocked, the distribution of RNA binding proteins between the nucleus and cytoplasm returned to normal.

Encouragingly, the drug used as an inhibitor is also being tested as part of phase II cancer trials, which could help speed up its development and availability – if it is determined that the same treatment can also help those with amyotrophic lateral sclerosis.

In a second study from the same researchers, the team discovered other new insights about ALS. They found over 100 types of RNA fragments, called intron-retaining transcripts, which can also move from the cell nucleus to the cytoplasm in ALS cases.



Above: Intron retaining transcripts (green) might be carrying RNA binding proteins (blue) to the cytoplasm more in cells with ALS. **(Giulia Tyzack)**

Not only was that much more than expected, but the researchers found these introns have sequences thought to bind to the RNA binding proteins. The team suspects these sequences are what's drawing RNA binding proteins out into the cytoplasm, though more research is going to be required to confirm it.

"To imagine what's going on here we can consider watching a movie at the cinema," says neuroscientist Jacob Neeves.

"Typically, we don't expect to see adverts throughout the film, but, if something goes wrong these ads might start cropping up at odd and unexpected points. These retained introns are a little bit like these abnormal ad breaks."

Around 10 percent of ALS cases are familial, and only around 1-2 percent of these have the mutated VCP enzyme. That's a small target, and it's not yet certain that this technique will work in actual patients.

However, both studies offer new hope that by understanding more about motor neurone disease we can eventually figure out ways of undoing some of the damage that it causes to the brain and nervous system.

ALS is relatively rare – it affects about 2-3 people per 100,000 in Europe each year – but the effects can be devastating, and scientists aren't sure exactly how it gets started or how to stop it. These new studies should help find out, but there's still a lot of work ahead.

"More research is needed to investigate this further," says Harley. "We need to see if this might reverse other pathological hallmarks of ALS and also, in other ALS disease models." The research has been published in *Brain Communications* and *Brain*.

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Microbe discovery could halt malaria transmission

A microbe that is transmitted between male and female mosquitoes but can also block reproduction could be key to controlling malaria by targeting its release into mosquito populations, a study says.

The study published in *Frontiers in Microbiology* found that the microbe called Microsporidia MB can pass from one mosquito to another as they mate. It could also block the release of malaria parasites from infected mosquitoes.

"This finding is of major significance because it indicates that Microsporidia MB could be deployed as a tool to control malaria. However, for Microsporidia MB to be a viable tool, researchers will have to find a way to spread it into mosquito populations," says Jeremy Herren, a co-author of the study and a research scientist at the International Centre of Insect Physiology (icipe), in Kenya.

Herren tells SciDev.Net that while increasing use of important malaria control tools such as bed nets have led to a major decline in malaria over the last 20 years, progress in fighting malaria is stagnating.

One reason for this is that mosquitoes are becoming resistant to insecticides commonly used in treated bed nets, underscoring the need to develop new complementary disease-control tools.

"This study is, therefore, an important step towards the development of a completely new and potentially transformative strategy to control malaria." Herren adds. "The burden of malaria presents a major challenge for development goals in Africa. Over 90 percent of global malaria cases and deaths occur in Africa, which has enormous societal and economic consequences."

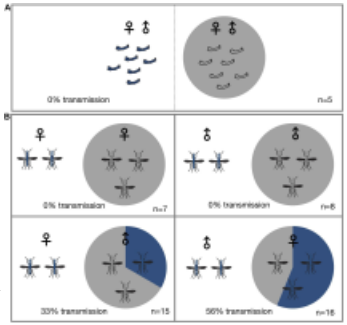


***Figure 1. Horizontal transmission of Microsporidia MB. Mosquitoes carrying Microsporidia MB are represented with blue shading in pie charts and n = number of independent experiments. (A) No transmission of Microsporidia MB was observed between An. arabiensis larvae reared in the same larval trough but separated by a screen mesh. (B) Horizontal transmission of Microsporidia MB was observed when adults were kept together in cages, and specifically when either infected males or females were housed with uninfected An. arabiensis of the opposite sex. Top row, no transmission was observed between infected and uninfected individuals of the same sex. Bottom left, transmission between Microsporidia MB infected An. arabiensis females and uninfected males was observed in 5 out of 15 cages (33%). Bottom right, out of a total of 16 experiments that had Microsporidia MB infected males and uninfected females and horizontal transmission was confirmed in 10 of these cages (56% transmission).* Credit: DOI: 10.3389/fmicb.2021.647183**

The study, which was conducted in 2019 through experiments on mosquitoes under laboratory conditions, involved the use of tools to determine whether or not individual mosquitoes have Microsporidia MB in them. Researchers also used a method called fluorescence microscopy to observe Microsporidia MB in the testes and ovaries of the mosquitoes.

According to Herren, the next step is to build on these findings to develop a viable strategy to spread Microsporidia MB through mosquito populations to control malaria transmission.

"We are exploring the feasibility of releasing male mosquitoes laden with Microsporidia MBin areas of high malaria transmission. These males would continue with their naturallife cycle, infecting wild female mosquitoes with the microbe, which would in turn infect their offspring with the malaria blocking trait," he says.

Brian Tarimo, a research scientist at the Ifakara Health Institute in Tanzania, says that the finding that the microbe is transmitted between mosquitoes of opposite sex during sexual reproduction makes it easy for this control intervention to spread throughout its population. "This makes its deployment to the field much easier as it doesn't require human compliance or behavioral change. Furthermore, Microsporidia MB doesn't come along with a fitness cost in mosquitoes. This means that the chances of developing resistance against it is very slim to none," he tells SciDev.Net.

Adopting the microbe as a disease-control method, according to Tarimo, would be feasible but requires effective engagement with regulators, policymakers and community members.

He calls on health policymakers in malaria-endemic regions to invest in using the findings to create a novel tool to control malaria.

"Trends show that there is a plateau in the reduction of malaria cases while in some areas there is an increase. Therefore, novel control tools being developed … have to be seriously considered for addition into the control toolbox," he says.

More information: *Godfrey Nattoh et al, Horizontal Transmission of the Symbiont Microsporidia MB in Anopheles arabiensis, Frontiers in Microbiology (2021). DOI: 10.3389/fmicb.2021.647183*

https://bit.ly/3sd7qLw

"Dental Origami" – How Snakes Got Their Fangs

'Dental origami' exploited by multiple species.

Ever wondered how deadly snakes evolved their fangs? The answer lies in particular microscopic features of their teeth, research led by Flinders University and the South Australian Museum suggests.

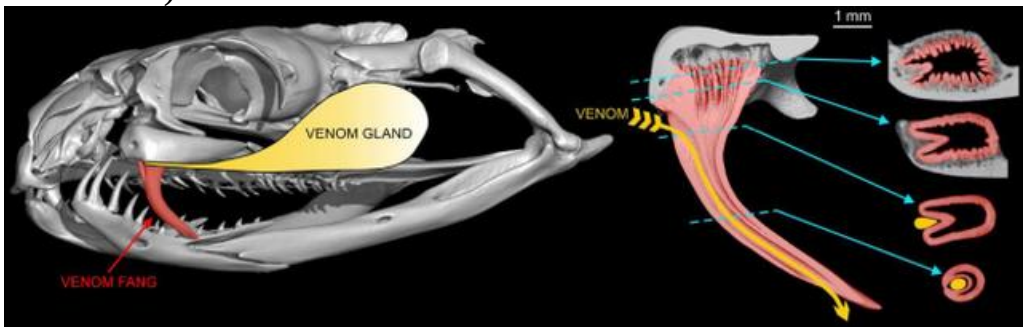
"It's always been a mystery why fangs have evolved so many times

in snakes, but rarely in other reptiles. Our study answers this, showing how easy it is for normal snake teeth to turn into hypodermic needles," says lead author Dr. Alessandro Palci, from Flinders University.

Of almost 4,000 species of snakes alive today, about 600 of them are considered 'medically significant' to humans, meaning that if you get bitten you are very likely to require a visit to the nearest hospital for treatment.

Types of venom fangs in snakes: rear fangs (crab-eating water snake), fixed front fangs (taipan), and hinged front fangs (Gaboon viper); fangs highlighted in red. **Credit A. Palci**

Venom fangs are modified teeth that are grooved and larger than other nearby teeth. They can be located at the back or at the front of the mouth, where they can be fixed or hinged (i.e. they can fold backwards).



Skull of a taipan and sections through its left fang showing the relationship between venom groove and infoldings at the base of the tooth. **Credit: A. Palci**

Australian and overseas researchers used high-tech modelling, fossils, and hours of microscope observations to reveal that snakes possess tiny infoldings, or wrinkles, at the base of the teeth. These infoldings might help teeth attach more firmly to the jaw. In venomous snakes, one of these wrinkles becomes deeper and extends all the way to the tooth tip, thus producing a venom groove and a fang.

The fang of a Gaboon viper (attached to the bone, the maxilla). **Credit: A. Palci (Flinders University)**

"Our work also highlights the opportunism and efficiency of evolution. Wrinkles which helped attach teeth to the jaw were repurposed to help inject venom," says co-author Matthew Flinders Professor Michael Lee (Flinders University and South Australian Museum).

Reference: "Plicidentine and the repeated origins of snake venom fangs" by Alessandro Palci, Aaron R. H. LeBlanc, Olga Panagiotopoulou, Silke G. C. Cleuren, Hyab Mehari Abraha, Mark N. Hutchinson, Alistair R. Evans, Michael W. Caldwell and Michael S. Y. Lee, 10 August 2021, Proceedings of the Royal Society B.DOI: 10.1098/rspb.2021.1391

Researchers received funding from an NSERC Postdoctoral Fellowship, NSERC Discovery Grant, Australian Research Council Discovery Program and University of Alberta grants.

https://bit.ly/3iHsUET

The 'Second Brain' in Your Gut Might Have Evolved Before The Brain in Your Head

New study has revealed more about how exactly the enteric nervous system in our gut works

David Nield

The enteric nervous system (ENS) in our gut operates a lot like other neural networks in the brain and the spinal cord – so much so that it's often called the 'second brain'. Now a new study has revealed more about how exactly the ENS works.

Using a recently developed technique combining high-resolution video recordings with an analysis of biological electrical activity, scientists were able to study the colons of mice, and in particular the way that the gut moves its contents along.

One of the key findings was discovering how the thousands of

neurons inside the ENS communicate with each other, causing contractions in the gastrointestinal tract to aid the digestive process. Up until now, it wasn't clear how these neurons were able to join forces to do this. "Interestingly, the same neural circuit was activated during both propulsive and non-propulsive contractions," says neurophysiologist Nick Spencer from Flinders University in Australia.

The team found large bunches of connecting neurons firing to propel the contents of the colon further down the gut, via both excitatory (causing action) and inhibitory (blocking action) motor neurons. The discovery means the ENS is made up of a more advanced network of circuitry, covering a wider section of the gut and involving a greater amount of different types of neurons working in tandem than had previously been thought.

Another important finding is that this activity is significantly different from the propulsion that's seen in other muscle organs around the body that don't have a built-in nervous system, such as lymphatic vessels, ureters, or the portal vein.

"The mechanism identified is more complex than expected and vastly different from fluid propulsion along other hollow smooth muscle organs," the researchers explain in their paper.

The team says it backs up the hypothesis that the ENS is in fact the 'first brain' rather than the second one – suggesting that it may have evolved in animals a long time before our actual brains took their current form. If that's true, the implications go far beyond the guts of mice – though further research is going to be required to find out exactly how the activities of the ENS affect the workings of the gastrointestinal tract in different species.

"Synchronization of neuronal activity across large populations of neurons is common in the nervous system of many vertebrate animals," says Spencer.

The research has been published in *Communications Biology*.

https://bit.ly/3g1pOcV

To a Salmon's Eye, Spirit Bears Have Natural Camouflage

Salmon are much more likely to avoid a black bear-shaped object than a white one.

Text and illustrations by Marina Wang

In the Great Bear Rainforest, in coastal British Columbia, two large bears—one black, one white—wade into a stream. The white bear dips its snout and comes up with a wriggling salmon clutched between its jaws. The black bear does the same.

But as time goes on, with the two bears snagging fish after fish, the white bear seems to be having an easier time. It turns out, it is—and there's an intriguing reason why.

Spirit bears are a rare white-colored morph of the black bear. **Photo by Doc White/NPL/Minden Pictures**

Spirit bears are black bears with a recessive genetic mutation that turns their regular charcoal-colored fur a ghostly white. Fewer than 200 of these unusual bears are estimated to live on British Columbia's north and central coasts, where they have long held a special significance in coastal Indigenous cultures.

According to one story from the Kitasoo/Xai'xais, the creator Raven made one out of every 10 bears white to remind people that the land had previously been covered by a glacier, and to appreciate the bounty the landscape offers today.

That ratio—about one out of 10—has fascinated scientists. Studies have shown that, in certain parts of British Columbia, from 10 to 30 percent of bears have this distinctive coloration—a rate that is far more frequent than what would be expected if the bears' white fur was the result of random chance alone.

It implies that the white bears may have some sort of evolutionary advantage over the black bears. A new study has teased apart what that advantage could be.

Thomas Reimchen, an ecologist at the University of Victoria in British Columbia who has been studying predator-prey interactions for more than 50 years, hypothesized that salmon can see black bears more easily than white bears. While swimming upstream, he thought, the fish seemed better at avoiding the black bears. The white bears would have an easier time hunting, giving them a better chance at surviving and better odds of passing on their unique genes.

To actually prove this idea, though, Reimchen had to get creative—he had to consider what a hungry bear would look like to a fish.

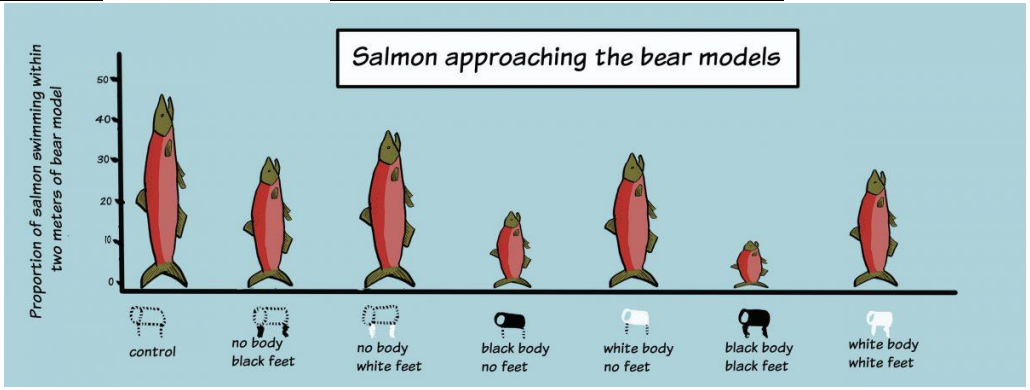
Reimchen also had to consider something called Snell's window, an optical phenomenon that distorts light passing through water.

But water in a stream is rarely smooth. When it's choppy, the amount of the landscape that gets distorted through Snell's window can open to nearly 180 degrees, cramming in the sightline from horizon to horizon. Choppy water also fragments the image the salmon would see.

To test the idea that the distortion would make spirit bears harder to see than black bears, Reimchen constructed a bear look-alike out of a plastic barrel. Covering the "bear" with white or black fur, and sometimes adding fur-covered PVC legs, he put each version in a stream for 12 minutes to see if the salmon avoided it.

Overall, the experiment confirmed Reimchen's hypothesis: salmon avoided the models with black bodies twice as often as the models with white bodies.

"A white bear against a sky will be a bunch of white fragments against a white sky—so that's still going to be camouflaged," explains Reimchen. "But a black bear against a white sky is going to look like little black spots."



Reimchen says that, over millennia, salmon would have evolved an aversion to these black spots. He adds that a similar reasoning could also explain why fish-eating birds, such as gulls and terns, have evolved white underbellies.

Interestingly, the salmon also avoided the bear model with a black body and no legs two to three times more often than the model with no body and black feet.

This seems to suggest that salmon rely more on the view through Snell's window to evade predators than what they can see through the water.

Chris Darimont, a conservation biologist from the University of Victoria and the Raincoast Conservation Foundation who was not involved in the study, lauded Reimchen's creativity in the experimental design.

"While most other researchers would rush in to study it from the perspective of the sexy spirit bear, myself included, Tom thinks about that interaction more comprehensively," he says.

"Any piece of evidence that further increases our understanding of how important salmon are to bears is of keen interest."

For future studies, Reimchen hopes other scientists will take the view from Snell's window into closer consideration when studying the interactions between animals on land and in the water.

https://bit.ly/3fYGQZl

Which COVID-19 vaccine has the lowest rate of breakthrough infections?

Is there any difference in how often people get breakthrough infections depending on the vaccine

By Nicoletta Lanese - Staff Writer

Unvaccinated people currently account for most new cases of COVID-19 in the U.S., but a small proportion of cases are in vaccinated people; these cases are known as breakthrough infections. But is there a difference in how often people get breakthrough infections depending on which vaccine they got?

The short answer is, we don't know exactly, but there are some hints in the data. The Johnson & Johnson vaccine does seem to have higher rates of breakthrough infection than the Pfizer and Moderna vaccines, but that was expected based on the results of clinical trials.

Some very early hints show a slightly lower rate of breakthrough infections with the Moderna vaccine than with the Pfizer vaccine, but that early finding is based on data on a few million people from only two locations and thus may not represent the overall picture in the country.

Because no vaccine is 100% effective, breakthrough infections have been expected from the start of the vaccine rollout. In the context of clinical trials, about 0.04% of people given the Pfizer vaccine got infected with SARS-CoV-2, versus about 0.07% with Moderna and 0.59% with Johnson & Johnson.

Now that the vaccines are authorized, scientists have the chance to track how many breakthrough infections occur in the real-world, beyond clinical trials. When breakthroughs do occur, most people experience mild symptoms, if they fall ill at all, and a small percentage develop severe disease, require hospitalization or die, current data suggests.

The recent rise of the highly-transmissible delta variant might raise the risk of breakthrough infections, though. For example, a recent Centers for Disease Control and Prevention (CDC) study, published Aug. 6 as a Morbidity and Mortality Weekly Report (MMWR) report, found that the delta variant surged in Mesa County, Colorado between May and June; at the same time, the county accrued a "significantly higher" proportion of breakthrough cases compared with other Colorado counties, where delta was less prevalent.

Reporting of breakthrough infections now falls largely on the states, and of the 25 or so states that report breakthrough infections, most don't yet provide data on the number of cases linked to each vaccine brand, Live Science found in a search of state health department websites.

However, Oklahoma and Washington, D.C., do make this information public. These data could provide "early signals" regarding how well the vaccines are working, particularly as new variants emerge, the DC Health website states. That said, there are many limitations: The data sets are small, each vaccine was given to different numbers of people and the timing of the doses makes it hard to interpret the data.

Still, as of Aug. 1, more than 299,000 D.C. residents had been fully vaccinated, according to data from DC Health. Of these people, nearly 151,000 received the two-dose Pfizer vaccine, about 124,700 got the two-dose Moderna vaccine and about 24,000 received the one-dose Johnson & Johnson vaccine.

In this population, the highest rate of breakthroughs was seen in those who got the Johnson & Johnson shot: 77 people, or 0.32% of the roughly 24,000 recipients. The second highest rate was seen among Pfizer recipients, of whom 308 people, or 0.2%, tested positive for the virus. Finally, 161, or 0.13%, of the Moderna recipients caught a breakthrough infection.

These numbers include asymptomatic, mild, moderate and severe breakthrough cases. Some people with asymptomatic or mild infections may not get tested, so their cases would be missed, meaning this is probably an undercount of breakthroughs.

Oklahoma has reported similar results.

As of Aug. 2, more than 1.5 million Oklahomans had been fully vaccinated, according to a report from the Oklahoma State Department of Health. About 817,000 had received Pfizer shots, 674,000 received Moderna and 102,000 got Johnson & Johnson. Again, the Johnson & Johnson recipients showed the highest rate of breakthrough cases, with 215, or 0.21%, testing positive for the virus; 1,468 Pfizer recipients, or 0.17% of the total, caught a breakthrough infection; and 831 Moderna recipients, or 0.12%, tested positive for the virus.

incomplete picture of breakthrough cases in each region, however, and for now, it's unclear if the observed patterns are representative of the country as a whole. To accurately compare the vaccine brands, particularly with the delta variant still running rampant, we simply need more data, Robert Darnell, a physician scientist at The Rockefeller University in New York, told National Geographic.

That said, other preliminary research also suggests Moderna's vaccine offers more protection against the delta variant than Pfizer's, which could help explain the differences in breakthrough rates, Reuters reported. One study, posted Aug. 8 on the preprint database bioRxiv, included more than 50,000 patients in the Mayo Clinic Health System and found that the Moderna vaccine's real-world effectiveness fell from 86% to 76% between January and July, when delta gained prominence. In the same time window, Pfizer's effectiveness fell from 76% to 42%.

However, that study has not been peer-reviewed yet, so the results still need to be confirmed.

https://bit.ly/3AEfqIF

Bio-Inspired, Blood-Repelling Tissue Glue Can Seal Wounds Quickly and Stop Bleeding

A new adhesive that mimics the sticky substance barnacles use to cling to rocks may offer a better way to treat traumatic injuries.

By Anne Trafton, Massachusetts Institute of Technology

Inspired by the sticky substance that barnacles use to cling to rocks, MIT engineers have designed a strong, biocompatible glue that can seal injured tissues and stop bleeding.

The new paste can adhere to surfaces even when they are covered with blood, and can form a tight seal within about 15 seconds of application. Such a glue could offer a much more effective way to treat traumatic injuries and to help control bleeding during surgery, the researchers say.

“We are solving an adhesion problem in a challenging environment, which is this wet, dynamic environment of human tissues. At the same time, we are trying to translate this fundamental knowledge into real products that can save lives,” says Xuanhe Zhao, a professor of mechanical engineering and civil and environmental engineering at MIT and one of the senior authors of the study.

Christoph Nabzdyk, a cardiac anesthesiologist and critical care physician at the Mayo Clinic in Rochester, Minnesota, is also a senior author of the paper, which was published on August 9, 2021, in *Nature Biomedical Engineering*. MIT Research Scientist Hyunwoo Yuk and postdoc Jingjing Wu are the lead authors of the study.

Natural inspiration

Finding ways to stop bleeding is a longstanding problem that has not been adequately solved, Zhao says. Sutures are commonly used to seal wounds, but putting stitches in place is a time-consuming process that usually isn’t possible for first responders to perform during an emergency situation.

Among members of the military, blood loss is the leading cause of death following a traumatic injury, and among the general population, it is the second leading cause of death following a traumatic injury.

In recent years, some materials that can halt bleeding, also called hemostatic agents, have become commercially available. Many of these consist of patches that contain clotting factors, which help blood to clot on its own. However, these require several minutes to form a seal and don't always work on wounds that are bleeding profusely.

Zhao's lab has been working to address this problem for several years. In 2019, his team developed a double-sided tissue tape and showed that it could be used to close surgical incisions. This tape, inspired by the sticky material that spiders use to capture their prey in wet conditions, includes charged polysaccharides that can absorb water from a surface almost instantaneously, clearing off a small dry patch that the glue can adhere to.

For their new tissue glue, the researchers once again drew inspiration from the natural world. This time, they focused their attention on the barnacle, a small crustacean that attaches itself to rocks, ship hulls, and even other animals such as whales. These surfaces are wet and often dirty — conditions that make adhesion difficult.

"This caught our eye," Yuk says. "It's very interesting because to seal bleeding tissues, you have to fight with not only wetness but also the contamination from this outcoming blood. We found that this creature living in a marine environment is doing exactly the same thing that we have to do to deal with complicated bleeding issues."

The researchers' analysis of barnacle glue revealed that it has a unique composition. The sticky protein molecules that help barnacles attach to surfaces are suspended in an oil that repels water and any contaminants found on the surface, allowing the adhesive proteins to attach firmly to the surface.

The MIT team decided to try to mimic this glue by adapting an adhesive they had previously developed. This sticky material consists of a polymer called poly(acrylic acid) embedded with an organic compound called an NHS ester, which provides adhesion, and chitosan, a sugar that strengthens the material. The researchers froze sheets of this material, ground it into microparticles, and then suspended those particles in medical grade silicone oil.

When the resulting paste is applied to a wet surface such as blood-covered tissue, the oil repels the blood and other substances that may be present, allowing the adhesive microparticles to crosslink and form a tight seal over the wound.

Within 15 to 30 seconds of applying the glue, with gentle pressure applied, the glue sets and bleeding stops, the researchers showed in tests in rats.

One advantage of this new material over the double-sided tape the researchers designed in 2019 is that the paste can be molded to fit irregular wounds, while tape could be better suited to sealing surgical incisions or attaching medical devices to tissues, the researchers say.

"The moldable paste can flow in and fit any irregular shape and seal it," Wu says. "This gives freedom to the users to adapt it to irregular-shaped bleeding wounds of all kinds."

Better bleeding control

In tests in pigs, Nabzdyk and his colleagues at the Mayo Clinic found that the glue was able to rapidly stop bleeding in the liver, and it worked much faster and more effectively than the commercially available hemostatic agents that they compared it to. It even worked when strong blood thinners (heparin) were given to the pigs so that the blood did not form clots spontaneously.

Their studies showed that the seal remains intact for several weeks,

giving the tissue below time to heal itself, and that the glue induced little inflammation, similar to that produced by currently used hemostatic agents.

The glue is slowly resorbed within the body over months, and it can also be removed earlier by applying a solution that dissolves it, if surgeons need to go in after the initial application to repair the wound.

The researchers now plan to test the glue on larger wounds, which they hope will demonstrate that the glue would be useful to treat traumatic injuries. They also envision that it could be useful during surgical procedures, which often require surgeons to spend a great deal of time controlling bleeding.

"We're technically capable of carrying out a lot of complicated surgeries, but we haven't really advanced as fast in the ability to control especially severe bleeding expeditiously," Nabzdyk says.

Another possible application would be to help stop bleeding that occurs in patients who have plastic tubes inserted into their blood vessels, such as those used for arterial or central venous catheters or for extracorporeal membrane oxygenation (ECMO).

During ECMO, a machine is used to pump the patient's blood outside of the body to oxygenate it. It is used to treat people with profound heart or lung failure. Tubes often remain inserted for weeks or months, and bleeding at the sites of insertion can lead to infection.

Reference: "Rapid and coagulation-independent haemostatic sealing by a paste inspired by barnacle glue" by Hyunwoo Yuk, Jingjing Wu, Tiffany L. Sarrafian, Xinyu Mao, Claudia E. Varela, Ellen T. Roche, Leigh G. Griffiths, Christoph S. Nabzdyk and Xuanhe Zhao, 9 August 2021, Nature Biomedical Engineering.
DOI: 10.1038/s41551-021-00769-y

The researchers have received funding from the MIT Deshpande Center to help them work toward commercializing their glue, which they hope to do after performing additional preclinical studies in animal models. The research was also funded by the National Institutes of Health, the National Science Foundation, the U.S. Army Research Office through MIT's Institute for Soldier Nanotechnologies, and the Zoll Foundation.

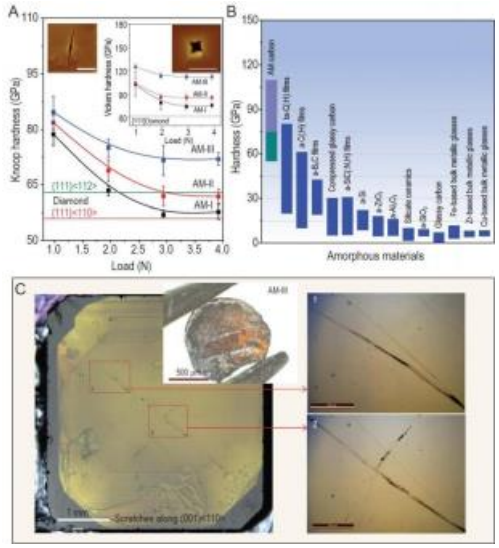
https://bit.ly/3AHq53c

Newly-synthesized AM-III carbon is hardest and strongest amorphous material to date

A team of researchers affiliated with a host of institutions across the globe has synthesized an AM-III carbon that is the hardest and strongest amorphous material created to date.

by Bob Yirka , Phys.org

In their paper published in the journal *National Science Review*, the group describes the process they used to create their new material and suggest possible uses for it.



Hardness of AM carbon materials, compared with other known amorphous materials, and scratches on diamond (001) face indented by AM-III. **Credit: National Science Review (2021). DOI: 10.1093/nsr/nwab140**

In this new effort, the researchers set out to create a new kind of glass that would be exceptionally strong. To that end, they subjected fullerenes to very high temperatures and enormous pressures and, in so doing, produced what they have called AM-III—a type of glass with crystals in it that measures higher on the Vickers hardness test than many diamonds.

When looking at a diamond under a microscope, the carbon atoms and molecules that make up its crystalline structure are lined up very neatly—glass on the other hand has very little order. This difference explains why diamonds are so hard and why glass is so easily shattered. Prior research has shown that diamonds can be made by exposing graphite to high temperatures and pressure—similar to the way they are created by nature. In this new work, the

researchers instead used fullerenes—structures made of carbon in the form of hollow cages. They also slowed down the process, heating and squeezing their material for approximately 12 hours, a move to prevent the material from forming into diamond.

The resulting material, AM-III carbon, is yellowish, with no defined structure, and is very strong—it scored 113 gigapascals on the Vickers hardness test, higher than some diamonds, which average just 100 gigapascals. The researchers note that AM-III is approximately ten times as hard as steel and should be quite a bit better at stopping bullets than most vest technology. To prove its toughness, they used one sample to cut a deep scratch into a diamond. The researchers note that the toughness comes about from the material's makeup—it has micro-structures that are orderly like crystals, along with unordered glass, which makes it part glass and part crystal. It also makes the material a semiconductor with a bandgap range similar to silicon. Because of that, the researchers suggest their new material could prove useful in solar panel products.

More information: *Shuangshuang Zhang et al, Discovery of carbon-based strongest and hardest amorphous material, National Science Review (2021). DOI: 10.1093/nsr/nwab140*

https://bit.ly/3q0INEq

Apes Have Been Observed Starting And Ending Interactions Just Like Humans Do

Researchers have documented apes purposefully using signals to start and end their interactions

Conor Feehly

When humans interact with each other, we tend to follow invisible rules. We may greet each other with 'hi, how are you?' to indicate the start of a conversation; once someone starts using phrases like 'oh, it was nice to see you', we know the chat has reached its end.

Until now, we thought we were the only species that conducted these conversational niceties. As it turns out, some of our close primate relatives do too.

In a new study, researchers have documented apes purposefully using signals to start and end their interactions.

The team analyzed 1,242 interactions within groups of bonobos and chimpanzees in zoos, finding that the apes would frequently gaze and use signals to initiate or end exchanges - something we typically associate with human interactions.

The authors believe these findings contribute to a better understanding of the origin and evolution of 'joint commitment' as a process not just in humans, but in great apes more broadly; this refers to processes where we share intentions and work together towards common goals.

"Joint commitment as process refers to the exchange of signals necessary for would-be co-participants to arrive at the mutual belief that they are committed to a course of action where each has his or her part to play," the team writes in their paper. Starting a conversation by exchanging greetings is a simple example of this.

"Behavior doesn't fossilize. You can't dig up bones to look at how behavior has evolved. But you can study our closest living relatives: great apes like chimpanzees and bonobos," says Raphaela Heesen, a social cognition researcher at Durham University, and co-author of the study.

In the study, bonobos shared entry signals and a mutual gaze prior to playing 90 percent of the time, while chimps did so 69 percent of the time.

Exiting signals were even more common, with 92 percent of bonobo and 86 percent of chimp interactions involving an exit communication. The various types of signalling included gestures like touching each other, holding hands, butting heads, or gazing at each, before and after interactions like grooming or play.

The study, which was published in *iScience*, also looked at factors such as the closeness of relationships, and the power dynamics

between the apes that were interacting. For bonobos, the closer they were to each other socially, the shorter the lengths of their entry and exit phases, or they didn't even bother. The authors believe this mirrors how humans tend to communicate with one another.

"When you're interacting with a good friend, you're less likely to put in a lot of effort in communicating politely," notes Heesen.

Conversely, the strength of social bonds and friendships didn't seem to affect entries and exits to interactions in chimpanzees. This could be down to the authoritarian power hierarchies observed in chimps, whereas bonobo groups appear to be more egalitarian in their social structure.

"This ability [to share intentions] has been suggested to be at the heart of human nature," says Heesen. "Whether this type of communication is present in other species will also be interesting to study in the future." With this research in mind, if you ever encounter a great ape, you might not want to skip the pleasantries.

The research was published in the journal *iScience*.

https://bit.ly/2VUMMvt

Most of the power sector's emissions come from a small minority of plants

Shutting down the worst 5% would cut electricity's carbon emissions by 75%.

John Timmer

The world seems to be simultaneously on fire and flooding, and the latest expert report indicates that we've just about run out of time to avoid even more severe climate change. All of that should have us looking for ways to cut carbon emissions as quickly and economically as possible.

Some good news in that regard came via the recent release of a paper that looks at how much each power plant contributes to global emissions. The study finds that many countries have many power plants that emit carbon dioxide at rates well above either the national or global average. Shutting down the worst 5 percent of this list would immediately wipe out about 75 percent of the carbon emissions produced by electricity generation.

CARMA revisited

It's easy to think of power generation in simple terms, like "renewables good, coal bad." To an extent, that statement is accurate. But it also compresses all power generation, from "somewhat bad" to "truly atrocious," into a single category. And it's clear from a variety of research that the situation is more complex. Depending on their vintage, many plants convert fossil fuels to power at different degrees of efficiency. And some of the least efficient plants are only brought online during periods of very high demand; the rest of the time, they're idle and produce no emissions at all.

The interactions among these factors determine whether a given power plant is a major contributor to emissions or simply part of a country's background noise of carbon output. If we had a global inventory of emissions and production from every power plant, we could use that data to identify the worst offenders and make a target list for efficiently lowering our carbon output.

In fact, we did have one—emphasis on the past tense. Using data from 2009, someone had put together the Carbon Monitoring for Action database, or CARMA. Now, nearly a decade later, three researchers from the University of Colorado Boulder (Don Grant, David Zelinka, and Stefania Mitova) used 2018 data to build an update to CARMA, providing emissions data that is likely to be far more current.

The task was more difficult than it might seem. Some countries provide detailed emissions data on a per-plant level, so their data could simply be imported straight into CARMA. But many others do not. For those countries, the researchers relied on everything from production data obtained by the International Energy Agency

to engineering specifications for individual plants.

When the researchers identified the largest sources of uncertainty in their data, they found that it mostly clusters in the smaller plants, which are necessarily going to have the least impact on the overall emissions. For the large facilities that are likely to be major contributors, the data is usually very good.

The worst of the worst

It should surprise nobody that all the worst offenders are coal plants. But the distribution of the highest polluting plants might include a bit of the unexpected. For example, despite its reputation as the home of coal, China only has a single plant in the top-10 worst (bottom-10?). In contrast, South Korea has three on the list, and India has two.

In general, China doesn't have many plants that stand out as exceptionally bad, in part because so many of its plants were built around the same time, during a giant boom in industrialization. As such, there's not much variance from plant to plant when it comes to efficiency. In contrast, countries like Germany, Indonesia, Russia, and the US all see a lot of variance, so they're likely to have some highly inefficient plants that are outliers.

Put a different way, the authors looked at how much of a country's pollution was produced by the worst 5 percent when all of the country's power plants were ranked by carbon emissions. In China, the worst 5 percent accounted for roughly a quarter of the country's total emissions. In the US, the worst 5 percent of plants produced about 75 percent of the power sector's carbon emissions. South Korea had similar numbers, while Australia, Germany, and Japan all saw their worst 5 percent of plants account for roughly 90 percent of the carbon emissions from their power sector.

When it comes to carbon emissions, the worst 5 percent of power plants account for 73 percent of the total power sector emissions globally. That 5 percent also produces over 14 times as much carbon pollution as it would if the plants were merely average.

All options are good

Obviously, finding ways to shutter the worst plants and replace them with emissions-free alternatives would cut the power sector's emissions by 73 percent and total emissions by about 30 percent. But that's not always possible, so the authors looked at several ways those plants could do better while continuing to produce electricity.

Simply boosting each plant's efficiency to the average for the country would drop power sector emissions by a quarter and up to 35 percent in countries like Australia and Germany. Switching them to natural gas, which produces less carbon dioxide per amount of energy released, would drop global emissions by 30 percent, with many countries (including the US) seeing drops of over 40 percent. Again, because China doesn't see a lot of variance among its plants, these switches would have less of an impact, being in the area of 10 percent drops in emissions.

But the big winner is carbon capture and storage. Outfitting the worst of the plants with a capture system that was 85 percent efficient would cut global power sector emissions in half and total global emissions by 20 percent. Countries like Australia and Germany would see their power sector emissions drop by over 75 percent.

Overall, these are massive gains, considering that it's not unreasonable to think that the modifications could be done in less than a decade. And they show the clear value of targeting the easiest wins when it comes to lowering emissions. That function could be accomplished by governmental planning, but placing a significant price on carbon could also force the private sector to plan based on emissions efficiency—something it currently has little or no incentive to do in many countries.

Environmental Research Letters, 2021. DOI: 10.1088/1748-9326/ac13f1 (About DOIs).

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For all the people who were too lazy to download the report themselves

Code:

Table 2. Top ten polluting power plants in 2018 and 2009 and 2018

	Plant Name	Country	Tons of CO2	Fuel	Age	MW	Relative Intensity
1	Belchatow	Poland	37,600,000	Coal	27	5298	1.756
2	Vindhyachal	India	33,877,953	Coal	14	4760	1.485
3	Dangjin	S. Korea	33,500,000	Coal	10	6115	1.473
4	Taean	S. Korea	31,400,000	Coal	12	6100	1.481
5	Taichung	Taiwan	29,900,000	Coal	22	5834	1.282
6	Tuoketuo	China	29,460,000	Coal	10	6720	1.450
7	Niederaussem	Germany	27,200,000	Coal	38	3826	1.451
8	Sasan	Umpp India	27,198,628	Coal	3	3960	1.401
9	Yonghungdo	S. Korea	27,000,000	Coal	9	5080	1.481
10	Hekinan	Japan	26,640,000	Coal	21	4100	1.394

Relative Intensity is the ratio of the plant's intensity to the average intensity for all fossil-fueled plants in that plant's country. Intensity is pollutants per unit of output or capacity.

https://bit.ly/3iLBa6F

AstraZeneca Scientist Says Delta Variant Makes Herd Immunity Impossible. Here's Why

The Delta variant will still infect people who have been vaccinated

Marianne Guenot, Business Insider

The Delta variant has changed the equation for achieving herd immunity, the developer of the Oxford/AstraZeneca vaccine has said. Speaking at a UK parliamentary meeting on Tuesday, Sir Andrew Pollard, a professor of pediatric infection and immunity at the University of Oxford, said that achieving herd immunity is "not a possibility" now that the Delta variant is circulating.

"We know very clearly with coronavirus that this current variant, the Delta variant, will still infect people who have been vaccinated, and that does mean that anyone who's still unvaccinated, at some point, will meet the virus," Pollard said.

He said it was unlikely that herd immunity will ever be reached, saying the next variant of the novel coronavirus will be "perhaps even better at transmitting in vaccinated populations".

Vaccinated people can still get the Delta variant, albeit as a milder case

Some experts had hoped that herd immunity could be reached with COVID-19, as was the case with measles, which is also highly infectious. Many countries have achieved herd immunity with measles by vaccinating 95 percent of the population against it, such as the US, where endemic transmission ended in 2000. That is because once a person is vaccinated against measles, they cannot transmit the virus.

With COVID-19, vaccines still fulfill their primary role: protecting against severe disease. According to the US Centers for Disease Control and Prevention, vaccinated people who catch the Delta variant are 25 times less likely to have a severe case or die. The overwhelming majority who do catch it will have mild or no symptoms.

But growing evidence suggests that, with the Delta variant, fully vaccinated people can still transmit the virus. "We don't have anything which will stop that transmission to other people," Pollard said. Israel is a good example of this: COVID-19 cases dropped in the country after it vaccinated about 80 percent of adults – prompting some to hope that it had reached herd immunity – but the Delta variant has since brought another surge of cases.

https://bit.ly/37GPruZ

An Ancient Woolly Mammoth Trekked So Far, It Could Have Circled The Globe Twice

Scientists have analyzed chemical isotopes in a mammoth tusk, mapping out its biography as it wandered the Arctic fringe

Tessa Koumoundouros

Legends of the last ice age, woolly mammoths played a pivotal ecological role in the grassy tundra they once roamed. So much so,

that scientists have even proposed resurrecting them in an attempt to mitigate some of the damage that our way of life has inflicted on the planet.

Glacial melts have defrosted incredibly well preserved specimens, with their DNA giving us new perspectives on their extinction. But as mammoths are 4,000 years long gone, many mysteries remain about how they lived their daily lives. Scientists have now analyzed chemical isotopes in the remains of one such creature, mapping out its biography as it wandered the Arctic fringe.

Today, the lands known as Beringia are made up of Siberian tundra, Alaskan ice, or the seafloor between the ocean that separates the continents. When the beast in this latest study walked the land at the end of the Pleistocene, more than 17,000 years ago, the range was a vast landscape of grasslands that offered a refuge from the worst of the icy climate.

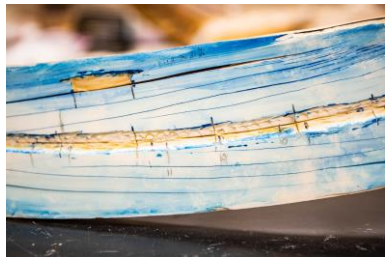
The studied remains – a 1.7-meter-long tusk – did not disappoint.

The mammoth, revealed to be male via an analysis of genetic material in the tusk, appears to have spent its entire life adventuring across the tundra, traveling far enough to have almost circled Earth twice during its 28 years of life.

"From the moment they're born until the day they die, they've got a diary and it's written in their tusks," said University of Alaska paleontologist Pat Druckenmiller. "Mother Nature doesn't usually offer up such convenient and life-long records of an individual's life." Like rings of a tree, each tusk layer records another page of the mammoth's life, written in the language of atoms.

To decipher this diary, University of Alaska paleoecologist Matthew Wooller, Druckenmiller, and colleagues used ~340,000 measurements of strontium isotopes that the ancient mammoth incorporated into its tusks from food and the environment.

Unique ratios between the isotopes of strontium ($^{87}Sr/^{86}Sr$) provide fingerprints of locations that change little across the millennia, the researchers explain. Alaskan isotope location data has been mapped from the teeth of rodents that generally stay in one location their entire life.



Comparing the mammoth's strontium and oxygen isotope data to this map, the researchers were able to obtain information on the mammoth's movements, down to the incredible resolution of a week.

Split mammoth tusk, stained blue to see the growth layers. **(JR Ancheta/University of Alaska Fairbanks)**

"It's not clear-cut if it was a seasonal migrator, but it covered some serious ground," said Wooller. "It visited many parts of Alaska at some point during its lifetime, which is pretty amazing when you think about how big that area is."

The mammoth seems to have frequented different areas during different stages of its life. The 10 cm (approx. 4 inch) tusk tip shows it spent the first year of its life in the Yukon River basin in interior Alaska, moving very little.

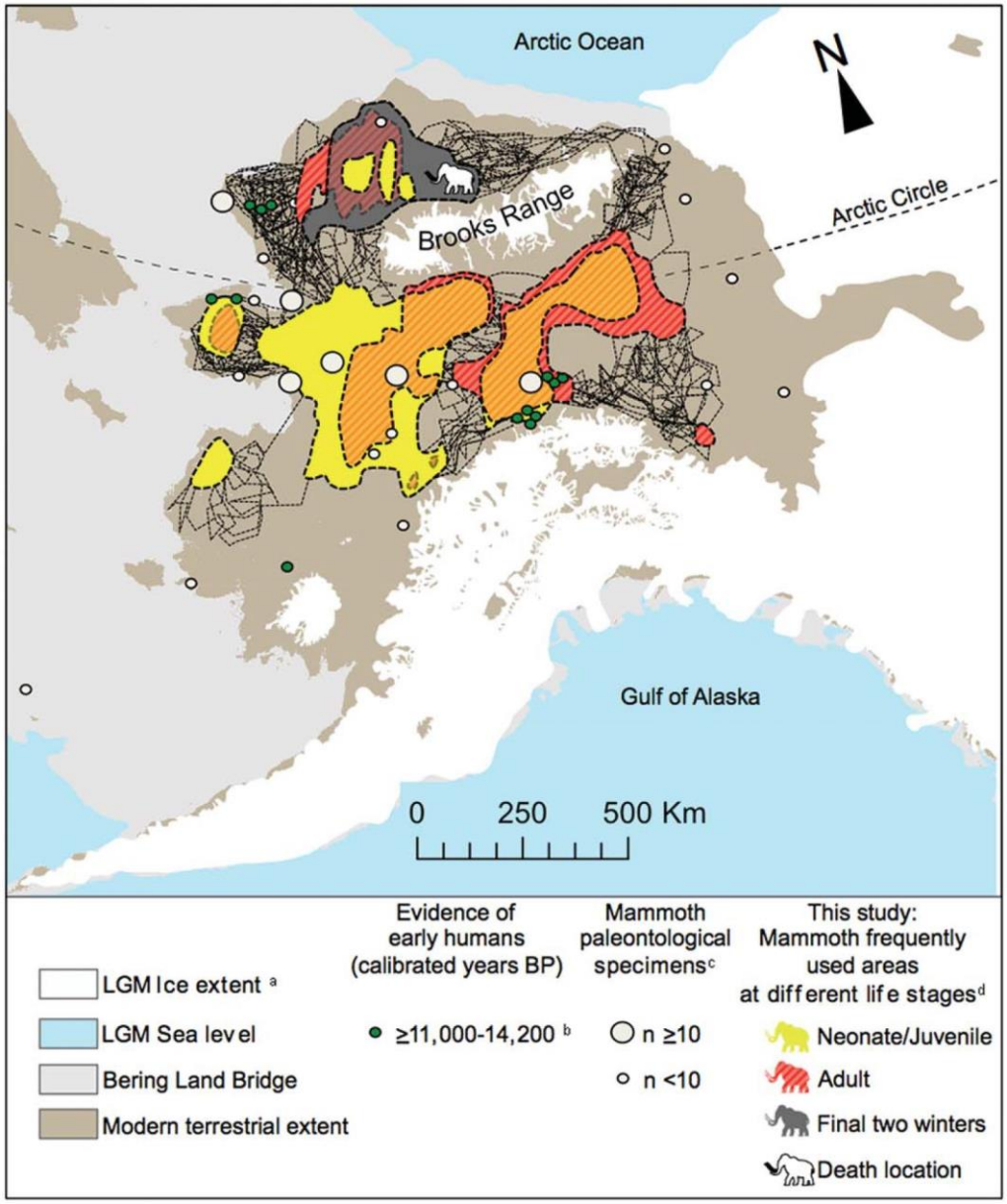
Then as a juvenile between 2 to 16 years old (the next ~75 cm of tusk), it roamed a larger range (yellow area on the map below). After this the isotopes showed even higher variation.

This is consistent with the youngster traveling as part of a herd, before roaming more extensively as an adult bull, just like we see in elephants today.

The ancient mammoth spent its final years in one small region in northern Alaska, where it sadly may have succumbed to starvation. There, on Alaska's North Slope, near the Arctic Circle, its massive body lay resting until the remains, including both tusks, mandible with teeth, and skull fragments, were excavated 17,000 years later.

"Evidence for starvation includes a substantial increase in ^{15}N values and a corresponding decrease in ^{13}C values," the researchers

explained in their paper.



The modeled range of the woolly mammoth, based on isotope data. **(Wooller et al., Science, 2021)**

The last woolly mammoths suffered a genomic meltdown on their way to extinction. They were confined to relatively small islands, so their ability to travel was much more limited compared to the male studied here.

But the extensive range of the mainland Beringia mammoths may have made them vulnerable to more stresses, from the warming climate to human predation, which together could have led to a faster extinction, Wooller and colleagues speculate.

"The Arctic is seeing a lot of changes now, and we can use the past to see how the future may play out for species today and in the future," Wooller said.

"Trying to solve this detective story is an example of how our planet and ecosystems react in the face of environmental change."

This research was published in *Science*.

https://bit.ly/2VUs6U8

Little kids burn so much energy, they're like a different species, study finds

Infants between the ages of 9 and 15 months expend a stunning 50% more energy in 1 day than adults do

By Ann Gibbons

As any parent knows, toddlers are bundles of energy. Now, the first comprehensive study of energy use over the human life span has quantified their burn rate: Infants between the ages of 9 and 15 months expend a stunning 50% more energy in 1 day than adults do, adjusted for body size. These wee dynamos consume and use up energy even faster than pregnant women and teenage boys, most likely to fuel their energetically expensive brains and organs.

"Little people are not burning energy like small adults," says Duke University evolutionary biologist Herman Pontzer, who led the new analysis of data from around the world. "They are burning energy superfast … like a different species."

But children also burn out fast. Their high metabolisms make them

particularly vulnerable to stunted growth and disease if they don't get the calories they need. Their cells may also metabolize drugs faster than those of adults, which means they may need more frequent doses. On the flip side, adults older than 60 begin to use less energy daily than younger people, and they may require less food or lower doses of medications, especially after age 90 when they use 26% less energy than middle-age people.

Scientists know surprisingly little about how much energy we burn throughout our lives. That's because such data require so-called doubly labeled water studies, an expensive test in which people drink "heavy" water with unusual versions of hydrogen and oxygen that can be chemically traced. Scientists measure the amount of these "isotopes" excreted in urine, blood, or saliva over 24 hours for 1 week or more to calculate how much energy individuals use on average in a day.

In the new study, Pontzer and his colleagues created a large database that pooled the results of existing, high-quality doubly labeled water studies of 6421 people from 29 nations, between the ages of 8 days and 95 years. The team calculated the daily metabolic rates for each individual by taking their total daily energy rate from the doubly labeled water studies and adjusting it for body size and mass, as well as organ size. Lean tissue in organs uses more energy than fat, and children's energetically expensive organs take up more of their body mass than in adults.

When the scientists plotted metabolic rates across life span, they found infants are born with the same metabolic rates as their mothers, when adjusted for their smaller body size. But between 9 and 15 months, they rev up their cells to burn energy faster, the team reports today in *Science*.

Children's metabolic rates stay high until age 5, but the rate slowly begins to glide down until it plateaus around age 20. Interestingly, adult rates are stable until age 60, when they begin to decline. After age 90, humans use about 26% less energy daily, Pontzer says.

The study also found that pregnant women don't have higher metabolic rates than other adults; their energy use and calorie consumption scales up with body size. "We know that pregnant women burn more calories, but they're burning more energy just by virtue of being bigger," Pontzer says.

The metabolic rate didn't zoom up in hungry teenagers either, which also makes the findings seem counterintuitive. "When kids hit puberty, there seems to be a big spike in how many calories they're consuming," Pontzer says. "In your 30s and 40s, people often feel like they slow down; when menopause hits, you slow down more." But metabolic rate doesn't change at those times. Hormonal changes, stress, disease, growth, and activity levels influence appetite, energy, and body weight, he says.

Pontzer speculates that the metabolic rate speeds up in toddlers because developmental changes in the brain, other organs, or the immune system consume lots of energy. And it slows in older people as their organs shrink and they lose gray matter in their brains.

The growing brain is likely the key energy sucker in little kids, says biological anthropologist Chris Kuzawa of Northwestern University. Kuzawa did not participate in this study, but in 2014 his team found that the brains of young children consume a stunning 43% of all energy used by the body.

"This is interesting from a public health point of view," adds Grazyna Jasienska, a biological anthropologist at Jagiellonian University in Poland who was not part of this study. She says these data should be factored into how many calories babies, pregnant women, and older adults need to consume, as well as doses of medicine. "If you think about undernourished children in many parts of the world, they may need more food than we previously thought."

https://bit.ly/3xJEMKM

A personal dosimeter is in your first aid kit

In a radiation emergency, popular painkillers can be used as personal dosimeters.

When proper precautions are taken, radioactive substances are extremely safe to use. But what if they leak into the environment in an uncontrolled manner? Then it becomes crucial to find out the dose of radiation people may have absorbed. Unfortunately, the average person does not possess a radiation dosimeter. The Institute of Nuclear Physics PAS has a new solution to this problem—and it can be found in your first aid kit.

Ionizing radiation is everywhere. It reaches us from deep space, from the Sun, it is emitted by rocks, building materials and even our bodies. It is used successfully in science, medicine and industry, especially in the energy sector. However, sometimes the intensity of the radiation increases significantly when forces of nature destroy the protective infrastructure of a reactor or as a result of human negligence. In such situations, the knowledge presented in the *IEEE Sensors* journal by scientists from the Institute of Nuclear Physics of the Polish Academy of Sciences (IFJ PAN) in Cracow may prove helpful. In practice, it translates into a simple recommendation: in a radiation emergency, put some unpacked painkillers into your pocket or backpack and don't take them out into the daylight.

"As ionizing radiation in the environment suddenly increases, many problems arise. Their nature can be easily understood by analogy with the pandemic," says Dr. Anna Mrozik (IFJ PAN), and continues to explain: "We lose the fight against coronavirus when there are too many people in need. First, there is a shortage of ventilators, then all the hospital beds are occupied, and finally doctors can't help all the patients. The situation is somewhat similar for events involving ionizing radiation. In this case, one of the main challenges is the instant lack of equipment, primarily dosimeters. Medical assistance would be effective if people could be initially segregated depending on the radiation dose absorbed by them. However, the absorbed dose is not known even by the victims themselves, since few people have access to personal dosimeters. And it is not possible to conjure up thousands of dosimeters immediately and distribute them literally in minutes among the population, especially if the threat occurs suddenly and over a large area."

Emergency dosimetry deals with methods of measuring radiation doses that are makeshift but sufficiently reliable for medical purposes. In the early stages of its development, bricks or roof tiles taken from buildings in an area at risk were analyzed. These days, emergency dosimetry is becoming more and more personal: trying to use objects that people carry with them all the time, as these are exposed to the same radiation dose as their owners.

A smartphone, for example, can be used as an emergency dosimeter. Unfortunately, in this role it works differently than a layman would expect. Reliable assessment of the radiation dose using a smartphone is possible because some of its parts are made of materials with good dosimetric properties. These include the display glass and aluminum oxide (Al2O3) used in resistors. However, these materials need to be analyzed using specialized laboratory equipment. The display has to be broken and the microscopic resistors have to be carefully dismantled and destroyed to extract the material filling them. Preparation is laborious and time-consuming, which calls into question the usefulness of the method under the conditions of a real radiation accident, especially one on a large scale. Moreover, depriving a person in danger of a tool that can be used to call for help for themselves or others, to contact their family, or to get information about the current situation is a poor and potentially dangerous idea.

Since the destruction of a valuable and useful device does not seem to be the optimal solution, scientists from the Institute of Nuclear Physics of the PAS decided to check which of the materials available to everyone could meet the criteria of emergency dosimetry.

"In our Institute we deal with luminescent emergency dosimetry techniques: thermoluminescence or optically stimulated luminescence. In the first case, materials are stimulated to glow by heating; in the second, it is done with light of a specific wavelength, usually blue. A material is a good candidate for a dosimeter when, after stimulation, it begins to glow with a greater intensity the greater the radiation dose it has been exposed to. This dependence between the luminescence signal and the absorbed dose should be as linear as possible," explains Prof. Pawel Bilski (IFJ PAN), the second author of the article in *IEEE Sensors*.

The attention of the Cracow-based researchers was drawn to medicines, especially popular painkillers, which are an obligatory component of every home first aid kit and can also be found in many women's handbags. Their great advantage is the fact that people carry them on a daily basis, exactly as one should do with dosimeters. Moreover, these drugs have a well-known composition (as opposed to, for example, the fabric of clothes) and are usually hermetically sealed, thus protected against moisture and light—factors which are very harmful from the point of view of dosimetry. All of this means that the drug analysis procedures for dosimetry can be easily standardized. In addition, preparation for testing is quick: all you need to do is unpack the tablet and crush it—and no one will protest. After all, the value of a single tablet is negligible, and there are usually several tablets in the package.

"Since painkillers have so many advantages as dosimeters, we looked at the properties of several of them. It turned out that when subjected to optically stimulated luminescence, they emit a fairly strong signal, more or less proportional to the absorbed dose of ionizing radiation—which is exactly what is needed to make a reliable measurement. Painkillers based on ibuprofen and paracetamol showed the highest sensitivity," says Dr. Mrozik.

Which substance is responsible for the luminescence of painkillers? The answer is not yet known. Physicists from the IFJ PAN intend to identify it, as this would make it possible to select the drugs best suited for dosimetric purposes more effectively.

The latest research from Cracow provides a simple piece of advice worth remembering: if you find yourself in a radiation emergency, carry a few unpacked painkillers with you, preferably in your pocket where they will be protected from the harmful effects of daylight. It's a small thing, but in a critical situation it will enable medical services to help you more effectively.

More information: *Anna Mrozik et al, Popular Medicines as Radiation Sensors, IEEE Sensors Journal (2021). DOI: 10.1109/JSEN.2021.3082285*

https://bit.ly/3shCBqd

People in the Philippines have the most Denisovan DNA

Ayta Magbukon have the highest level of Denisovan ancestry in the world

Researchers have known from several lines of evidence that the ancient hominins known as the Denisovans interbred with modern humans in the distant past. Now researchers reporting in the journal *Current Biology* on August 12 have discovered that the Philippine Negrito ethnic group known as the Ayta Magbukon have the highest level of Denisovan ancestry in the world. In fact, they carry considerably more Denisovan DNA than the Papuan Highlanders, who were previously known as the present-day population with the highest level of Denisovan ancestry.

"We made this observation despite the fact that Philippine Negritos were recently admixed with East Asian-related groups—who carry little Denisovan ancestry, and which consequently diluted their

levels of Denisovan ancestry," said Maximilian Larena of Uppsala University. "If we account for and masked away the East Asian-related ancestry in Philippine Negritos, their Denisovan ancestry can be up to 46 percent greater than that of Australians and Papuans."

In the new study, Larena and colleagues, including Mattias Jakobsson, aimed to establish the demographic history of the Philippines. Through a partnership between Uppsala University of Sweden and the National Commission for Culture and the Arts of the Philippines (NCCA), aided by collaboration with indigenous cultural communities, local universities, local government units, non-governmental organizations, and/or regional offices of the National Commission for Indigenous Peoples, they analyzed about 2.3 million genotypes from 118 ethnic groups of the Philippines including diverse self-identified Negrito populations. The sample also included high-coverage genomes of AustraloPapuans and Ayta Magbukon Negritos.

The study shows that Ayta Magbukon possess the highest level of Denisovan ancestry in the world, consistent with an independent admixture event into Negritos from Denisovans. Together with the recent discovery of a small-bodied hominin, called *Homo luzonensis*, the data suggest that there were multiple archaic species that inhabited the Philippines prior to the arrival of modern humans, and that these archaic groups may have been genetically related.

Altogether, the researchers say that the findings unveil a complex intertwined history of modern and archaic humans in the Asia-Pacific region, where distinct Islander Denisovan populations differentially admixed with incoming Australasians across multiple locations and at various points in time.

"This admixture led to variable levels of Denisovan ancestry in the genomes of Philippine Negritos and Papuans," Jakobsson said. "In Island Southeast Asia, Philippine Negritos later admixed with East Asian migrants who possess little Denisovan ancestry, which subsequently diluted their archaic ancestry. Some groups, though, such as the Ayta Magbukon, minimally admixed with the more recent incoming migrants. For this reason, the Ayta Magbukon retained most of their inherited archaic tracts and were left with the highest level of Denisovan ancestry in the world."

"By sequencing more genomes in the future, we will have better resolution in addressing multiple questions, including how the inherited archaic tracts influenced our biology and how it contributed to our adaptation as a species," Larena said.

More information: *Current Biology, Larena et al.: "Philippine Ayta possess the highest level of Denisovan ancestry in the world"* *www.cell.com/current-biology/f ... 0960-9822(21)00977-5* , *DOI: 10.1016/j.cub.2021.07.022*

https://bit.ly/3xMfawD

Discovered: Fossilized Spores Suggestive of Early Land Plants

Spores found in 480 million-year-old rock bring the fossil record in line with molecular estimates of when plants first adapted to life on land.

Ruth Williams

A variety of fossilized plant spores have been found in rocks from Western Australia that date from the early Ordovician era—approximately 480 million years ago. According to a paper published in *Science* today (12 August), some of the spores may have belonged to early forms of land-dwelling algae, from which other land plants are thought to have originated.

“I think [the paper] is interesting for a few reasons,” says paleobiologist Philip Donoghue of the University of Bristol who was not involved with the study. “It extends the fossil record of [early land plants] by something like 20 million years. . . . Also, potentially [the fossils] provide a sort of intermediate between the Cambrian record and the later Ordovician records.”

Plants that live on land are thought to have evolved from algae—typically aquatic plants lacking stems, roots, leaves, and vascular systems. But when and how plants first adapted to life on land is a matter of debate. The first macrofossil evidence of land plants is in the form of 425 million-year-old specimens of *Cooksonia*, a primitive vascular plant. However, molecular clock estimates—which are based on, among other things, genetic mutation rates—have suggested an origin for land plants in the Cambrian period (approximately 505 million years ago).

This 80-million-year disconnect between the molecular and fossil data exists in part because molecular genetic changes always precede morphological ones, says Donoghue. Other researchers have suggested that it might also be because early land plants had soft, nonvascular tissues that would not have been well preserved.

In contrast to soft vegetative tissues, the spores of land plants have tough cell walls that protect them against drying out and enable their preservation and fossilization, says Boston College paleobotanist Paul Strother, who coauthored the new paper. For this reason, he says, "spores can be used as a proxy for land plants" in the fossil record.

This toughened quality of spores, in fact, is why it has long been hypothesized that spores were one of the earliest plant adaptations to life on land, says Strother. Just as the egg preceded the chicken, evolutionarily speaking, so spores preceded sporophytes, the spore-producing plant structures that can take the form of, say, fruiting bodies of moss, fronds of a ferns, trees, and so on.

Strother and colleagues have previously found fossilized land-plant spores dating from the mid-Ordovician period—approximately 460 million years ago—closing the 80 million-year gap somewhat. They've also found spore-like microfossils dating from the mid-Cambrian era. These spore-like forms don't look like traditional land-plant spores produced by meiosis, but are preserved in the same way. They more closely resemble the haploid cells generated by modern-day Charophyte algae—the closest relatives to land plants. These land-plant and algal traits lead Strother to argue that the spores may belong to ancient algal species that had adapted to living on land. This interpretation has been questioned, however.

Now, Strother and coauthor Clinton Foster, a palynologist at the Australian National University, report the discovery of fossilized spores in rocks that fall right between their previous finds in terms of age.

The rock samples had been drilled from the Canning basin in Western Australia and prepared as slides back in 1958 as part of Australia's search for oil—fossil analysis being a standard technique in the hunt for black gold. Knowing that the samples dated from the early Ordivician, Foster had been scouring the 60-year-old slides for potentially interesting microfossils when "he found these clusters of odd-looking spore-like things and, long story short, he eventually got hold of me," explains Strother. Some of the spores in the samples resembled the previously discovered 460 million-year-old land plant spores, while others were akin to the mid-Cambrian spore-like fossils, Strother says.

The spores are "of intermediate age between the youngest verifiable land plants and the oldest putative ones," says Richard McCourt, who studies the evolution and ecology of green algae at Drexel University in Philadelphia and was not involved in the project. This means "the fossil record is being filled in to the extent that it seems to reconcile the molecules and the morphology," he adds.

The findings not only push back the fossil record of land plants another 20 million years, says paleobotanist Patricia Gensel of the University of North Carolina who was not involved in the research, they also add weight to the idea that the spore-like fossils belonged to land-based algae. "It's supporting the idea that there were some land-dwelling algae and early [land] plants that lived together," she

says. It just goes to show, continues Gensel, that “you never know what you’re going to find in fossil records. It really pays to keep looking.”

https://wb.md/37Gq8ZU

CDC: More Than 1 Million Have Received Unauthorized Third Dose

More than 1 million people have already received a third shot of the Moderna or Pfizer COVID-19 vaccine, which isn't yet authorized by the FDA, according to ABC News.

Carolyn Crist

The estimate of 1.1 million third shots is likely an undercount, according to an internal CDC document obtained by ABC News. The number includes people who received the two-shot Moderna and Pfizer vaccines and then received another dose, but it doesn't count people who may have received the one-shot Johnson & Johnson vaccine and then received a second dose of either Moderna or Pfizer vaccines.

Florida, Ohio, California, Illinois, and Tennessee have reported the highest number of people who received an unauthorized third shot, ABC News reported. CDC authorities haven't determined whether people who received a third shot did so through the advice of their doctor, ABC News reported. The FDA hasn't authorized a booster shot yet, though some doctors have encouraged severely immunocompromised patients to get one.

The FDA is expected to authorize a third shot for those with compromised immune systems within days. On Thursday or Friday, the agency could amend its emergency use authorization to make the change.

The CDC's Advisory Committee on Immunization Practices (ACIP) will also meet on Friday to discuss additional doses for immunocompromised people, according to the committee's meeting agenda. The group will discuss overall "considerations for booster doses of COVID-19 vaccines" as well. At an ACIP meeting in late July, committee members expressed concerns about those with weak immune systems and discussed the need for some people to receive a third shot for full COVID-19 protection. The committee can't recommend a booster shot until the FDA gives full approval to a vaccine or amends its current emergency use authorization.

Camille Kotton, MD, a committee member and transplant medicine doctor at Massachusetts General Hospital, said in July that some patients had "taken matters into their own hands" and already sought out additional doses without a doctor's supervision. She also raised concerns about equity, with some patients receiving a third shot while others remain unprotected.

"I have major concerns about equity because, from my experience, I have noted that it is patients who tend to be more educated and more empowered to take care of their own health care who are getting these additional doses," she said. "I worry that some are being left behind."

Sources

ABC News: "At least 1 million people got unauthorized third booster shot."

CDC: "Meeting of the Advisory Committee on Immunization Practices," Aug. 13, 2021.

https://bit.ly/2VWJckv

We Just Got Closer to Understanding Why Ketamine Is Such a Powerful Antidepressant

Lowered glutamate levels may explain some of the effects of ketamine

Carly Cassella

Oral ketamine, known both as an anesthetic and a recreational drug, has recently emerged as a highly promising, rapid treatment for severe depression.

Within hours, a single dose of the psychedelic substance has been shown to curb suicidal intent, and recent clinical trials suggest these effects work on two thirds of patients, lasting for up to several

weeks before fading away.

Given the promising early results and the limits of currently available antidepressants, oral ketamine is now available as a nasal spray in the United States for those with intractable depression and chronic suicidal thoughts.

Yet despite the drug's growing use nationwide, we still don't really know the full extent of its antidepressant activity. Ketamine interacts with a range of receptors in the brain, but which are the ones that lead to anti-depressant effects?

Some scientists think ketamine's therapeutic power relies on its influence over glutamate, a neurotransmitter that is secreted by the ends of certain neurons in the brain. But while ketamine appears to increase glutamate release in some parts of the brain in both mice and humans, in other parts of the mammalian brain, the drug seems to *decrease* this release.

"Elevated glutamate release has been linked to stress, depression and other mood disorders, so lowered glutamate levels may explain some of the effects of ketamine," explains neuroscientist Per Svenningsson from the Karolinska Institutet in Sweden.

Now, new results from experiments on mice and their neurons further support that hypothesis - at least for the prefrontal cortex, which is connected to complex cognitive behavior and the modulation of emotion.

Measuring glutamate levels among free-moving and anesthetized mice, Svenningsson and colleagues have found ketamine reduces the persistent release of this neurotransmitter almost immediately.

When researchers injected ketamine into the prefrontal cortex of a mouse's brain, they noticed a reduction in extracellular glutamate levels within 30 minutes. What's more, the authors saw similar effects for both normal mice and mice that showed depression-like symptoms.

"These effects could contribute to the efficacy of ketamine to instantly alleviate depressive symptoms and suicidal ideation, taking into account that excessive glutamate levels have been linked to MDD and other mood disorders," the authors write.

Further analysis under the microscope suggests ketamine acts on the neurons that usually receive glutamate, causing these cells to release more of a neurotransmitter called adenosine.

Adenosine then enters the space between neurons, known as the synapse, to tell the presynaptic neurons to stop producing so much glutamate.

When researchers blocked ketamine receptors on the postsynaptic neuron to test its role, they were able to completely prevent the decrease in glutamate from the presynaptic neuron.

"This suggests that the antidepressant action of ketamine can be regulated by a feedback mechanism," says Svenningsson

"It is new knowledge that can explain some of the rapid effects of ketamine."

The fast inhibitory action could be part of why ketamine is so successful at treating depressive symptoms. Some cells in the cerebrospinal fluid that help control glutamate levels, for instance, have recently been linked to stress-induced depression and anxiety-like behaviors in mouse models.

Today, while oral ketamine has provided much-needed relief for many patients with severe depression resistant to other antidepressants, its use is limited by its side effects.

Ketamine is a psychoactive drug that can cause feelings of fatigue, restlessness, anxiety, dizziness and hallucinations - all of which make it a tricky treatment to control clinically.

Some scientists are therefore exploring whether they can isolate the parts of ketamine that rapidly treat depression without having to include the parts that drive unwanted side effects.

But maybe it's the hallucinogenic parts that make the medicine work. We still don't really know, which is why we need to learn

more about what makes ketamine such a powerful antidepressant.

If drug engineers can one day mimic the most important antidepressant effects of glutamate, they could potentially produce an alternative that comes with far fewer side effects but still works just as rapidly and aggressively as ketamine itself

So far, scientists have only engineered two non-hallucinogenic drugs that show clinical benefits similar to ketamine, neither of which specifically targets glutamate production, and these drugs have only been tested on mice. That said, the drugs did appear to show rapid anti-depressant effects without any of the usual head twitches that ketamine can cause.

The research to date is still being conducted on animal models, but if the findings prove promising enough, clinical trials among humans could be just around the corner.

The study was published in *Molecular Psychiatry*.

https://bit.ly/2UjHGIm

Massive New Analysis Confirms Just How Many COVID-19 Cases Are Truly Asymptomatic

Metanalysis of more than 350 studies has found just over 35 percent of all COVID-19 infections don't proceed to a symptomatic phase.

Within months of SARS-CoV-2's emergence as a global catastrophe it was becoming clear that many who spread the disease did so unwittingly, experiencing not so much as a tickle in their throat to alert them of the danger within.

Distinguishing those who are truly asymptomatic from those who are simply yet to show signs of the virus has made it hard to calculate a precise figure on the risks of succumbing to the illness.

Now an analysis by a group of US medical researchers on more than 350 studies has found just over 35 percent of all COVID-19 infections don't proceed to a symptomatic phase.

Early estimates ranged from just 4 percent of infections being asymptomatic, all the way up to 81 percent. Even as the pandemic ensued, figures conservatively estimated fewer than 20 percent of people might be infectious without showing any signs.

Confidently nailing down a number is harder than it might seem. Without the fever, loss of smell, sore throat, aches, and cough to encourage a trip to a clinic, few people bother lining up for a test.

One of the simplest ways to capture the true spread of infection is to conduct a cross-sectional survey, randomly sampling a population to detect the presence of the virus regardless of the subject's health. There's just one problem with this approach. Anybody who's feeling well on the day they're tested can potentially fall sick hours or days later, making 'no symptoms' look the same like 'no symptoms... yet'.

To make the challenge even harder, SARS-CoV-2 can produce a variety of symptoms, some of which we're still learning about late in the game. Going back through the literature to identify those who might have been symptomatic after all is no easy task.

It's not that scientists haven't tried. But according to the researchers who published this most recent effort, most either don't account for the bias of symptomatic individuals seeking tests more than people without symptoms, or didn't include enough longitudinal data to capture those who might have fallen ill later. The result is likely to be an under-appreciation of the true extent of asymptomatic cases.

To address these limitations, the team systematically conducted two separate meta-analyses of existing COVID-19 studies that reported on laboratory-confirmed infections.

The first was limited to studies that included a substantial follow-up period to clear those who experienced some kind of effect from the virus later. The results of this particular analysis suggest 35.1 percent of people who might receive a positive laboratory result won't personally suffer any consequences of their infection.

The second included studies that both distinguished silent infections

at the time of testing as well as conducting a follow-up analysis. The number here was 36.9 percent.

The figures are close enough to convince the researchers that their method has merit, reinforcing speculations that many of our best guesses have been too low. Even taking into account index cases that could be biasing calculations, their figures are at least one in every four cases being silent ones.

Without looking at the development of symptoms at a later date, around 40 percent of individuals with a positive COVID result were feeling well at the time of their test.

In time, more studies might add data that skew these figures further. Long COVID – the residual symptoms that cling long after the initial period of illness subsides – came as a bit of a surprise to epidemiologists, so future work might yet uncover a few symptoms we missed. Still, the take-home-message from the research remains clear. Many of us, more than we might think, can carry the virus in spite of feeling on top of the world.

With vaccines limiting symptoms while still leaving gaps for the virus to replicate, appreciating the ability for COVID-19 to tread silently through our midst is more important than ever.

This research was published in *PNAS*.

https://bit.ly/2XwaNcP

New Immunotherapy Drug Combo Shows Early Potential for Treating Pancreatic Cancer

Researchers find three immunotherapy drugs given together can eliminate pancreatic tumors in mice.

By Anne Trafton, Massachusetts Institute of Technology

Pancreatic cancer, which affects about 60,000 Americans every year, is one of the deadliest forms of cancer. After diagnosis, fewer than 10 percent of patients survive for five years.

While some chemotherapies are initially effective, pancreatic tumors often become resistant to them. The disease has also proven difficult to treat with newer approaches such as immunotherapy. However, a team of MIT researchers has now developed an immunotherapy strategy and shown that it can eliminate pancreatic tumors in mice.

The new therapy, which is a combination of three drugs that help boost the body's own immune defenses against tumors, is expected to enter clinical trials later this year.

"We don't have a lot of good options for treating pancreatic cancer. It's a devastating disease clinically," says William Freed-Pastor, a senior postdoc at MIT's Koch Institute for Integrative Cancer Research. "If this approach led to durable responses in patients, it would make a big impact in at least a subset of patients' lives, but we need to see how it will actually perform in trials."

Freed-Pastor, who is also a medical oncologist at Dana-Farber Cancer Institute, is the lead author of the new study, which was published on August 5, 2021, in *Cancer Cell*. Tyler Jacks, the David H. Koch Professor of Biology and a member of the Koch Institute, is the paper's senior author.

Immune attack

The body's immune system contains T cells that can recognize and destroy cells that express cancerous proteins, but most tumors create a highly immunosuppressive environment that disables these T cells, helping the tumor to survive.

Immune checkpoint therapy (the most common form of immunotherapy currently being used clinically) works by removing the brakes on these T cells, rejuvenating them so they can destroy tumors. One class of immunotherapy drug that has shown success in treating many types of cancer targets the interactions between PD-L1, a cancer-linked protein that turns off T cells, and PD-1, the T cell protein that PD-L1 binds to. Drugs that block PD-L1 or PD-1, also called checkpoint inhibitors, have been approved to treat cancers such as melanoma and lung cancer, but they have very little

effect on pancreatic tumors.

Some researchers had hypothesized that this failure could be due to the possibility that pancreatic tumors don't express as many cancerous proteins, known as neoantigens. This would give T cells fewer targets to attack, so that even when T cells were stimulated by checkpoint inhibitors, they wouldn't be able to identify and destroy tumor cells.

However, some recent studies had shown, and the new MIT study confirmed, that many pancreatic tumors do in fact express cancer-specific neoantigens. This finding led the researchers to suspect that perhaps a different type of brake, other than the PD-1/PD-L1 system, was disabling T cells in pancreatic cancer patients.

In a study using mouse models of pancreatic cancer, the researchers found that in fact, PD-L1 is not highly expressed on pancreatic cancer cells. Instead, most pancreatic cancer cells express a protein called CD155, which activates a receptor on T cells known as TIGIT.

When TIGIT is activated, the T cells enter a state known as "T cell exhaustion," in which they are unable to mount an attack on pancreatic tumor cells. In an analysis of tumors removed from pancreatic cancer patients, the researchers observed TIGIT expression and T cell exhaustion from about 60 percent of patients, and they also found high levels of CD155 on tumor cells from patients.

"The CD155/TIGIT axis functions in a very similar way to the more established PD-L1/PD-1 axis. TIGIT is expressed on T cells and serves as a brake to those T cells," Freed-Pastor says. "When a TIGIT-positive T cell encounters any cell expressing high levels of CD155, it can essentially shut that T cell down."

Drug combination

The researchers then set out to see if they could use this knowledge to rejuvenate exhausted T cells and stimulate them to attack pancreatic tumor cells. They tested a variety of combinations of experimental drugs that inhibit PD-1 and TIGIT, along with another type of drug called a CD40 agonist antibody.

CD40 agonist antibodies, some of which are currently being clinically evaluated to treat pancreatic cancer, are drugs that activate T cells and drive them into tumors. In tests in mice, the MIT team found that drugs against PD-1 had little effect on their own, as has previously been shown for pancreatic cancer. They also found that a CD40 agonist antibody combined with either a PD-1 inhibitor or a TIGIT inhibitor was able to halt tumor growth in some animals, but did not substantially shrink tumors.

However, when they combined CD40 agonist antibodies with both a PD-1 inhibitor and a TIGIT inhibitor, they found a dramatic effect. Pancreatic tumors shrank in about half of the animals given this treatment, and in 25 percent of the mice, the tumors disappeared completely. Furthermore, the tumors did not regrow after the treatment was stopped. "We were obviously quite excited about that," Freed-Pastor says.

Working with the Lustgarten Foundation for Pancreatic Cancer Research, which helped to fund this study, the MIT team sought out two pharmaceutical companies who between them have a PD-1 inhibitor, TIGIT inhibitor, and CD40 agonist antibody in development. None of these drugs are FDA-approved yet, but they have each reached phase 2 clinical trials. A clinical trial on the triple combination is expected to begin later this year.

"This work uses highly sophisticated, genetically engineered mouse models to investigate the details of immune suppression in pancreas cancer, and the results have pointed to potential new therapies for this devastating disease," Jacks says. "We are pushing as quickly as possible to test these therapies in patients and are grateful for the Lustgarten Foundation and Stand Up to Cancer for their help in supporting the research."

Alongside the clinical trial, the MIT team plans to analyze which types of pancreatic tumors might respond best to this drug combination. They are also doing further animal studies to see if they can boost the treatment's effectiveness beyond the 50 percent that they saw in this study.

Reference: "The CD155/TIGIT axis promotes and maintains immune evasion in neoantigen-expressing pancreatic cancer" by William A. Freed-Pastor, Laurens J. Lambert, Zackery A. Ely, Nimisha B. Pattada, Arjun Bhutkar, George Eng, Kim L. Mercer, Ana P. Garcia, Lin Lin, William M. Rideout III, William L. Hwang, Jason M. Schenkel, Alex M. Jaeger, Roderick T. Bronson, Peter M. K. Westcott, Tyler D. Hether, Prajan Divakar, Jason W. Reeves, Vikram Deshpande, Toni Delorey, Devan Phillips, Omer H. Yilmaz, Aviv Regev and Tyler Jacks

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https://bit.ly/3CP7Tjq

Natural Compound Found in Fruit May Prevent and Treat Parkinson's Disease

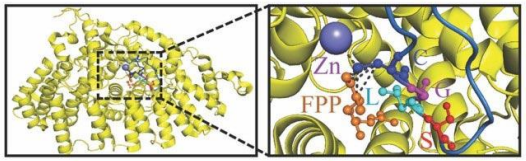
Farnesol, found naturally in herbs, and berries and other fruits, prevents and reverses brain damage linked to Parkinson's disease

Johns Hopkins Medicine researchers say they have added to evidence that the compound farnesol, found naturally in herbs, and berries and other fruits, prevents and reverses brain damage linked to Parkinson's disease in mouse studies.

The compound, used in flavorings and perfume-making, can prevent the loss of neurons that produce dopamine in the brains of mice by deactivating PARIS, a key protein involved in the disease's progression. Loss of such neurons affects movement and cognition, leading to hallmark symptoms of Parkinson's disease such as tremors, muscle rigidity, confusion and dementia. Farnesol's ability to block PARIS, say the researchers, could guide development of new Parkinson's disease interventions that specifically target this protein.

"Our experiments showed that farnesol both significantly prevented the loss of dopamine neurons and reversed behavioral deficits in mice, indicating its promise as a potential drug treatment to prevent Parkinson's disease," says Ted Dawson, M.D., Ph.D., director of the Johns Hopkins Institute for Cell Engineering and professor of neurology at the Johns Hopkins University School of Medicine.

Results of the new study, published on July 28, 2021, in *Science Translational Medicine*, detail how the researchers identified farnesol's potential by screening a large library of drugs to find those that inhibited PARIS.



An illustration of PARIS with the crystal structure of Farnesyltransferase, the enzyme that enables farnesylation. **Credit: Johns Hopkins Medicine**

In the brains of people with Parkinson's disease, a buildup of PARIS slows down the manufacture of the protective protein PGC-1alpha. The protein shields brain cells from damaging reactive oxygen molecules that accumulate in the brain. Without PGC-1alpha, dopamine neurons die off, leading to the cognitive and physical changes associated with Parkinson's disease.

To study whether farnesol could protect brains from the effects of PARIS accumulation, the researchers fed mice either a farnesol-supplemented diet or a regular mouse diet for one week. Then, the researchers administered pre-formed fibrils of the protein alpha-synuclein, which is associated with the effects of Parkinson's disease in the brain.

The researchers found that the mice fed the farnesol diet performed better on a strength and coordination test designed to detect advancement of Parkinson's disease symptoms. On average, the mice performed 100% better than mice injected with alpha-synuclein, but fed a regular diet.

When the researchers later studied brain tissue of mice in the two

groups, they found that the mice fed a farnesol-supplemented diet had twice as many healthy dopamine neurons than mice not fed the farnesol-enriched diet. The farnesol-fed mice also had approximately 55% more of the protective protein PGC-1alpha in their brains than the untreated mice.

In chemical experiments, the researchers confirmed that farnesol binds to PARIS, changing the protein's shape so that it can no longer interfere with PGC-1alpha production.

While farnesol is naturally produced, synthetic versions are used in commerce, and the amounts people get through diet is unclear. The researchers caution that safe doses of farnesol for humans have not yet been determined, and that only carefully controlled clinical trials can do so.

Though more research is needed, Dawson and his team hope farnesol can someday be used to create treatments that prevent or reverse brain damage caused by Parkinson's disease.

Reference: "PARIS farnesylation prevents neurodegeneration in models of Parkinson's disease" by Areum Jo, Yunjong Lee, Tae-In Kam, Sung-Ung Kang, Stewart Neifert, Senthilkumar S. Karuppagounder, Rin Khang, Hojin Kang, Hyejin Park, Shih-Ching Chou, Sungtaek Oh, Haisong Jiang, Deborah A. Swing, Sangwoo Ham, Sheila Pirooznia, George K. E. Umanah, Xiaobo Mao, Manoj Kumar, Han Seok Ko, Ho Chul Kang, Byoung Dae Lee, Yun-Il Lee, Shaida A. Andrabi, Chi-Hu Park, Ji-Yeong Lee, Hanna Kim, Hyein Kim, Hyojung Kim, Jin Whan Cho, Sun Ha Paek, Chan Hyun Na, Lino Tessarollo, Valina L. Dawson, Ted M. Dawson and Joo-Ho Shin, 28 July 2021, Science Translational Medicine.

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