Staying well out of sight

BEING TRANSPARENT SOMETIMES DOES NOT QUALIFY AS BEING INVISIBLE, WRITES
S ANANTHANARAYANAN

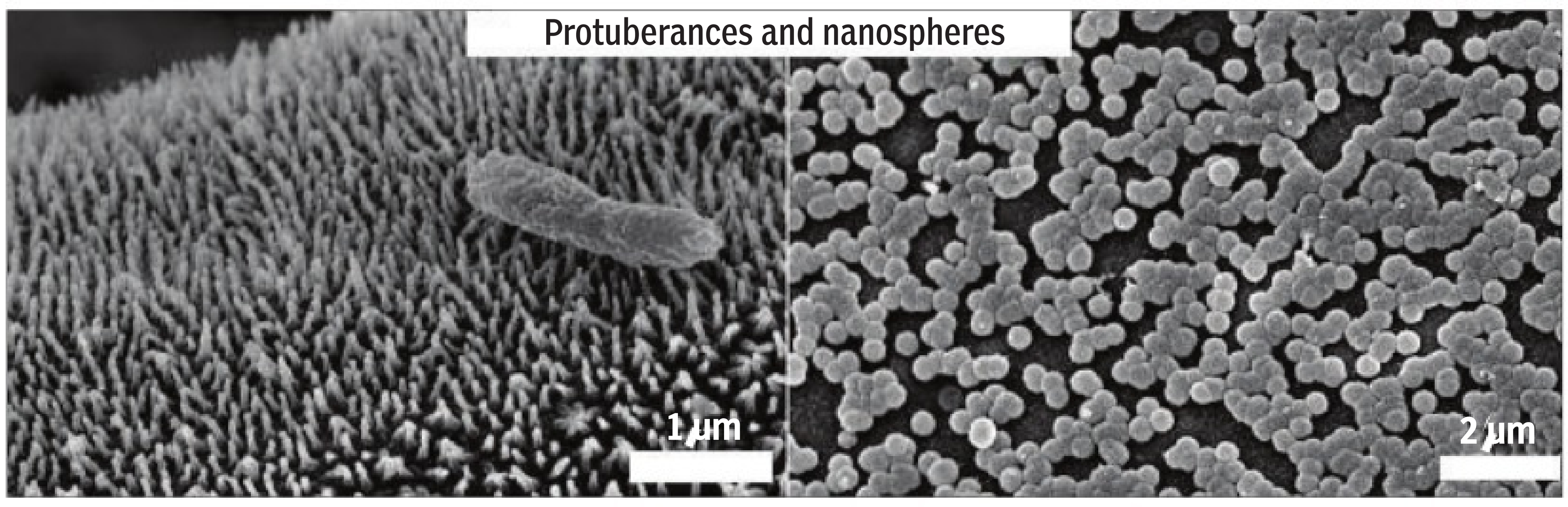
Taking on the colours of the surroundings is a good way of avoiding detection, but this may not work when one is in featureless surroundings. In such a case, what is required is transparency but, even so, transparency helps mainly when one is lit from behind and not quite as well when lit from the front. This is because there is almost always a bit of light that transparent surfaces reflect that would give the transparent object away.

Laura E Bagge, Karen J Osborn and Sönke Johnsen from Duke University, North Carolina and the Smithsonian National Museum of Natural History, Washington DC, report in the journal *Current Biology* the adaptation by a class of seawater-dwelling organisms to minimise the reflection of light by their body surface, as a means to avoid detection.

The animals studied comprise a group called hyperiids, which inhabit the upper column of sea water, short of deep water, and are covered by a light shell. These are organisms that are generally transparent but, as the downward illumination at the depths where they are found is much greater than horizontal illumination, even a small extent of reflection would make them stand out when viewed horizontally. The animals have, thus, been under evolutionary pressure to minimise the level of reflection by their surface.

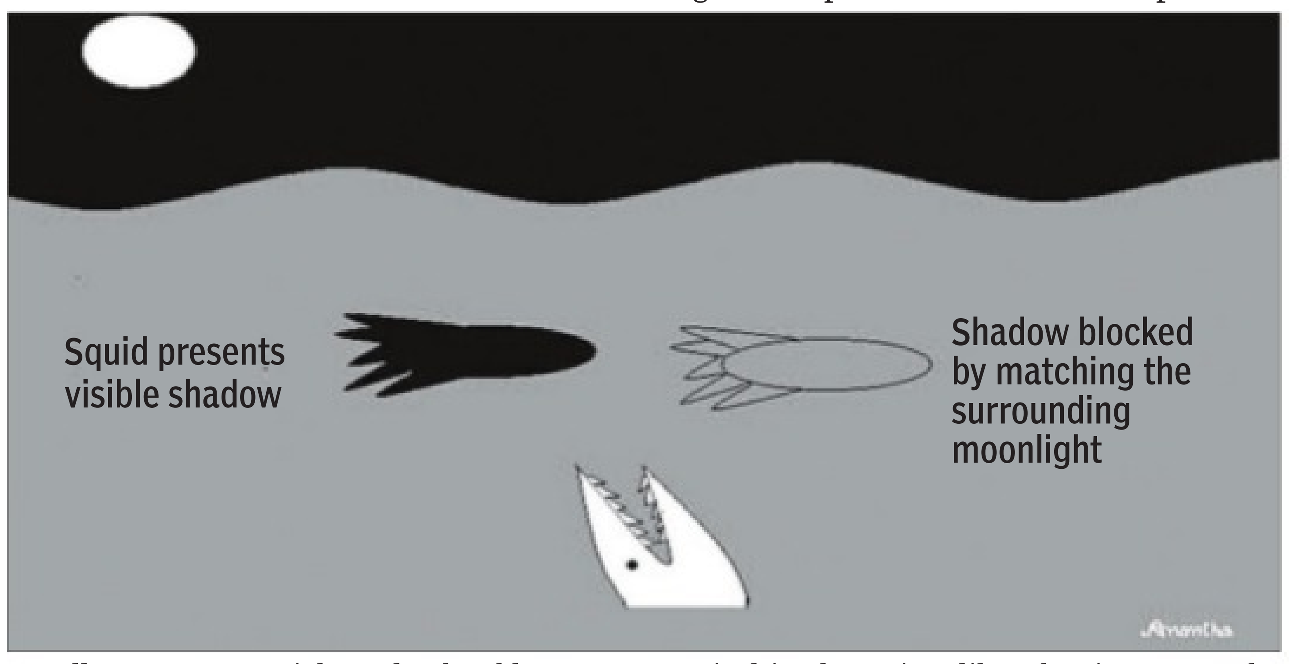
The reason that transparent surfaces also reflect part of the light that falls on them is that there is a change in the speed of light when it passes from the surrounding to the transparent material and, again, when light passes out to the surroundings. The speed of light in a material depends on the way the material supports electric and magnetic variations that light consists of. The abrupt change in these properties, when light passes from one material to another, results in a part of the energy not being transferred into the material but sent away as a reflection. One way of reducing the reflection from a surface would, hence, be to create conditions so that the change in the speed of light is not abrupt, but a little smoother.

The *Current Biology* authors report that they used a scanning electron microscope to investigate the skin surface of seven varieties of hyperiids and discovered features that had not been documented so far, which may be the way reflectance is reduced from these surfaces. The researchers found that the skin on the legs of one form of hyperiid was covered by protuberances some 200 nanometres in height and the skin of this and the other hyperiids also had a layer of spheres in the same range of dimensions.



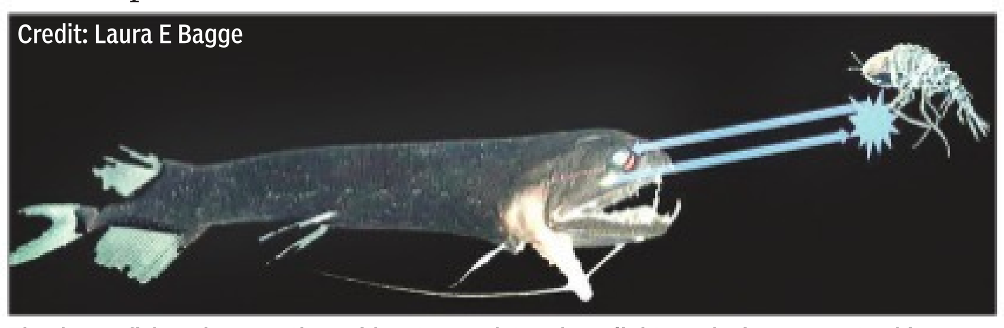
The paper notes that the effect of such protuberances of dimensions less than the wavelength of light was first observed in the case of corneas of moths and some butterflies. Moths usually come out at night and to be able to see, they need to let in as much light that comes to their eyes as possible. The cornea, or the outer layer of their eyes, which has thus evolved to minimise reflection and maximise transmission, also has protuberances of sub-wavelength dimensions. The minimised reflection also serves to make the moth more difficult to detect, in the dark, what protects it from predators. It was also later found that the wings of the moth and cicadas had a microstructure so that the area of chitin (hard tissue) the light strikes increased as one got nearer the surface, the paper says.

A gradually changing structure, at a size less than the wavelength of light, results in gradual change in the speed of light waves and, hence, a greater proportion of light being transmitted as opposed to that reflected. The paper mentions that the theoretical reduction in reflectivity, based on the dimensions of the surface structure, is verified in practice and experiment. The researchers found that the legs, which account for most of the surface area of one variety of hyperiids, were almost fully covered with an ordered, periodic array of protuberances 200 nanometres high and spaced 96 nanometres apart and conical in shape, just like what is seen on the transparent wings of insects and corneas of moths.



The paper notes that a thin transparent layer, where the speed of light is in between the speed on the two sides of a surface, could be arranged, depending on the wavelength of the light that was falling, to completely eliminate reflection. This property has been made use of to cover lenses used in the laboratory or industry to reduce reflection at the surface. While instances of this device have not been seen in nature, the paper says most of the body skin of the hyperiids were covered with a dense monolayer of identical spheres that appeared to be layer of a form of bacteria. X-Ray analysis showed that the material was all organic and some of the spheres, which were not part of the skin but external attachments, also seemed to be undergoing division. These spherical bodies measured from 52- 320 nanometres, which would affect reflectivity and appeared to be acquired from the environment.

Further analysis showed that the nanostructure clearly reduced reflectivity of the surface, particularly when light fell at glancing angles and was more likely to be reflected. A clean, smooth skin surface was found to have a reflectivity of 0.6 to one per cent when light fell squarely on the surface, increasing to seven-75 per cent at glancing angles. With the nanostructure, however, reflectivity was less than 0.5 per cent for a broad range of wavelengths and angles of incidence.



The dragonfish and many other mid-water predators have light-producing organs to shine on and detect prey. But the crustacean *Cystisoma* (right) grows an anti-reflective brush structure on its legs that diffuses light, enabling it to hide in plain sight.

Helper bacteria

Another instance of bacteria helping animals stay unseen is in the case of the Hawaiian Bobtail squid or Flashlight Squid. While foraging at night in the shallow Pacific Ocean (and some parts of the Indian Ocean), this squid presents a silhouette or shadow against the moonlight or starlight to predators below, and becomes a sitting-duck target. The squid has evolved to support a colony of light-emitting bacteria called *Vibrio Fischeri*, which live off the sugar and amino acid nutrients from the squid and repay by getting luminescent, as and when required for the host to hide its shadow.

Increasing reflectivity

A converse of the strategy described so far is employed by some silvery fish, like sardines, carp and mackerel, to stay out of sight in well-lit waters. Although their scales reflect diffuse light to match the background, there is a property in reflection that makes the light a little dimmer on reflection. It has to do with light being electrical and magnetic vibrations, in all planes transverse to the direction of motion of the light. On reflection, certain planes are reflected more easily than others, leading to a drop in intensity. These fish have a multilayered and transparent microstructure in their scales so that transmitted light is channelled to reflect and compensate for the loss. The light coming off the fish is, hence, of the same intensity as the light that fell on it, and is there in the surroundings, so that the fish stays out of sight!

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UNCONTROLLED GROWTH

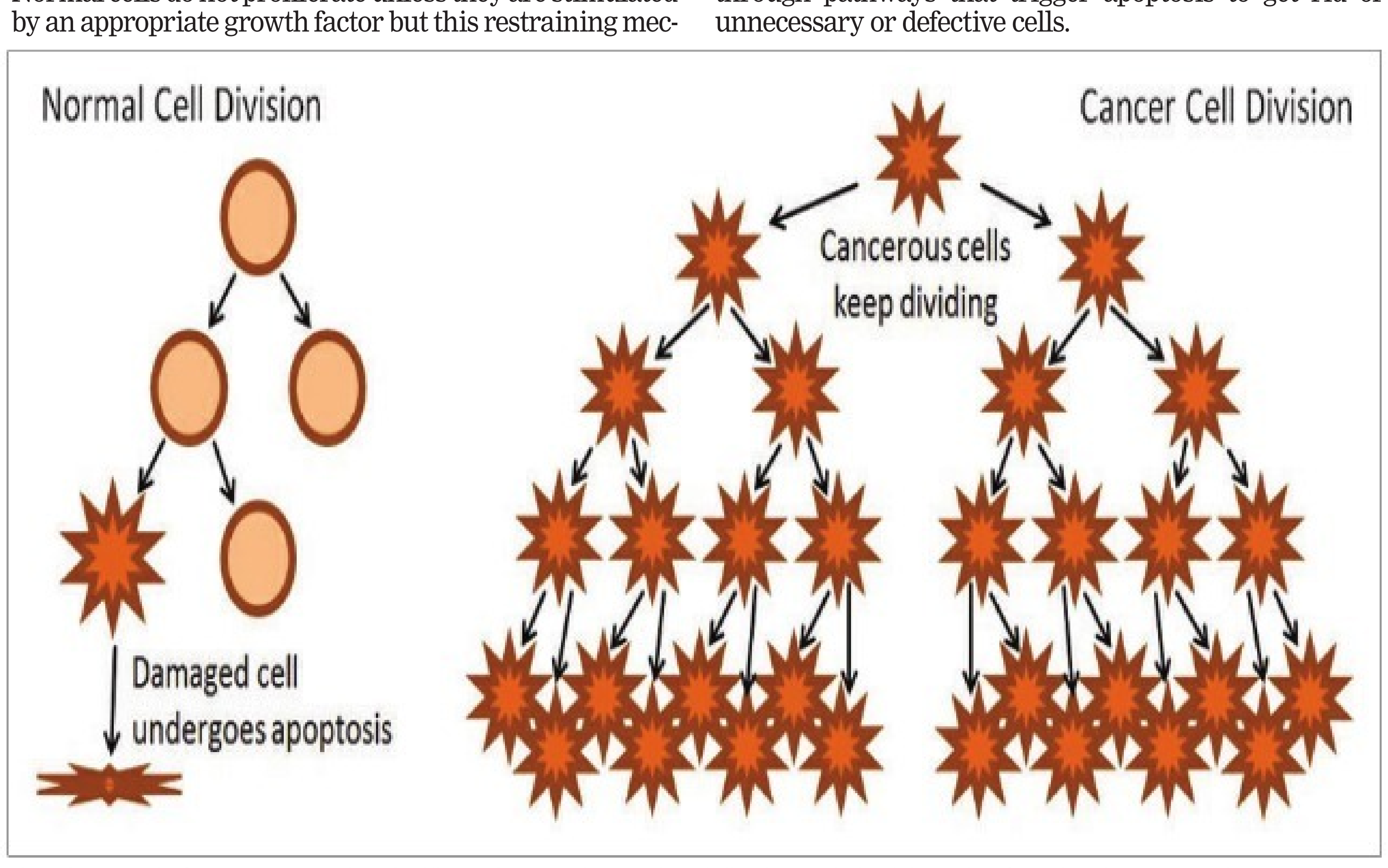
VARIOUS ABNORMALITIES IN CELL DIVISION LEAD TO THE PROLIFERATION OF CANCER CELLS, WRITES **TAPAN KUMAR MAITRA**

Mechanisms that maintain telomere length play a permissive role in allowing cancer cells to continue dividing but they do not actually cause cells to divide. The abnormalities that drive the ongoing proliferation of cancer cells can be traced to defects in the various signalling mechanisms that control cell division.

Cell proliferation is normally regulated by extracellular growth factors that bind to cell surface receptors and activate signalling pathways within the targeted cells. Normal cells do not proliferate unless they are stimulated by an appropriate growth factor but this restraining mechanism is circumvented in cancer cells by defects that create a constant signal to divide.

Besides failing to respond appropriately to external signals, cancer cells are also unresponsive to internal conditions, such as DNA damage, that would normally trigger checkpoint mechanisms.

Another factor that influences the growth of cancer cells is the rate at which they die. If the normal mechanisms for triggering cell death are disrupted, proliferating cells will accumulate faster than they would normally do. The control of cell death is exerted largely through pathways that trigger apoptosis to get rid of unnecessary or defective cells.



There is no particular temperature that signifies an ice age; they are just defined as periods of time when large ice sheets cover the planet like now.

Disruptions in cell-cycle control also contribute to the unrestrained proliferation of cancer cells. The commitment to proceed through the cell cycle is made at the restriction point, which controls progression from Gl into S phase. If normal cells are grown under sub-optimal conditions (for example, insufficient growth factors, high cell density, lack of anchorage, or inadequate nutrients), the cells become arrested at the restriction point and stop dividing.

In comparable situations, cancer cells continue to proliferate; if conditions are extremely adverse, as occurs with extreme nutritional deprivation, they eventually die at random points in the cell cycle rather than arresting in Gl. The reason for this abnormal behaviour is that cell-cycle controls do not function properly in cancer cells.

Since cancer cells fit the classic definition of unnecessary or defective cells — that is, they grow in an uncontrolled fashion and exhibit DNA and chromosomal damage — why aren't they killed by apoptosis? The answer is that cancer cells have various ways of blocking the pathways that trigger apoptosis and that allows them to survive and proliferate under conditions that would otherwise cause cell death.

Uncontrolled cell proliferation is a complex trait that arises from failures in growth signalling pathways, cell-cycle controls and apoptosis. The molecular defects responsible for such failures are the kind of gene mutations that lead to cancer.

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Answers from the oceans

THERE'S A FASCINATING NEW THEORY ABOUT WHY THE WORLD PLUMMETS INTO ICE AGES EVERY 100,000 YEARS. **LINDSAY DODGSON** REPORTS

For the past million years or so, the earth has gone through an ice age every 100,000 years. Nobody knows precisely why. Before that, colder summers occurred about every 40,000 years until the Earth entered a phase called the middle Pleistocene transition where the intervals became over twice as long.

Researchers at Cardiff University in the UK have just put forward their new theory — published in the journal *Geology* — about why this cycle changed so dramatically. As it turns out, some of the answers may lie at the bottom of the ocean.

The team studied the fossils of tiny marine algae and small photosynthetic organisms that act like the trees of the ocean by sucking up carbon dioxide. Algae in the different layers of sediment were shown to have stored varying levels of carbon dioxide, and there were much higher levels in the particular layers, which were formed every 100,000 years.

That means there was probably less carbon dioxide left in the atmosphere at these points, and this could have influenced lower temperatures, potentially allowing vast sheets of ice to engulf North America, Europe, and Asia.

The team looked towards the ocean for answers because of the vast amount of information that can be gained there compared to other sources. "It's really difficult to get good records of past climate changes on land, especially from this time period, because the ice sheets themselves are really good at destroying their own geological record," lead researcher Professor Carrie Lear, a professor of earth science at Cardiff University told Business Insider. "But there is a continuous accumulation of sediment on the seafloor, which we can study."

As for why this happens in a 100,000 year cycle, Lear said it's probably down to a combination of factors. For example, ocean circulation patterns — the movement of water through the seas — adjusts the amount of carbon dioxide that can be trapped underwater due to its salinity and temperature.

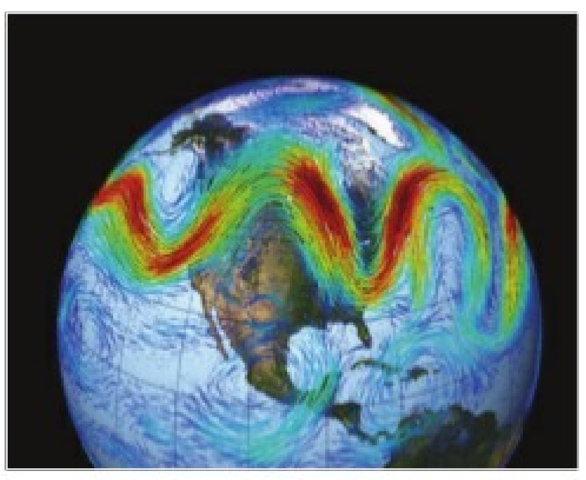
The temperature of the ocean can have a huge impact on the earth. When oceans are colder, they can absorb more carbon dioxide. As the temperature increases, more gas molecules leave the water than enter it. This theory also provides an explanation for how global warming and the increase of carbon in the atmosphere are connected.

"You can start with a small change in climate, which changes the amount of carbon dioxide in the atmosphere, and then leads to a bigger change in climate," Lear said.

The Earth is currently in a warm spell, as the last ice age occurred about 11,000 years ago. There is no particular temperature that signifies an ice age; they are just defined as periods of time when large ice sheets cover the planet. "Technically we are still in an ice age now, as we have a large ice sheet on Antarctica and Greenland," Lear said.

THE INDEPENDENT

PLUS POINTS



Severe winters

Scientists have agreed for the first time that recent severe cold winter weather in the UK and US may have been influenced by climate change in the Arctic, according to a new study.

The research, carried out by an international team of scientists has found that warming in the Arctic may be intensifying the effects of the jet stream's position, which in winter can cause extreme cold weather, such as 2014-15 that saw record snowfall levels in New York.

Scientists previously had two schools of thought. One group believes that natural variability in the jet stream's position has caused the recent severe cold winter weather seen in places like eastern US and the UK. The other camp includes scientists who are finding possible connections between the warming of the Arctic — such as melting sea ice, warming air temperatures, and rising sea surface temperatures — and the emerging pattern of severe cold winter weather.

Now, professor Edward Hanna and Dr Richard Hall from Sheffield University's department of geography together with professor James E Overland from the US Oceanographic and Atmospheric Administration have brought together a diverse group of researchers from both sides of the debate.

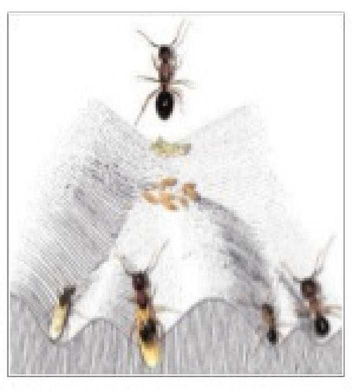
Hanna said, "How climate change is affecting the jet stream will help to improve our long-term prediction of winter weather in some of the most highly populated regions of the world."

The study, called "Non-linear response of mid-latitude weather to the changing Arctic", was published last week in the journal *Nature Climate Change.*

Frankenstein ants

Cold room biochemist Danny Reinberg's lab at the New York University Langone School of Medicine is anything but because, illuminated for 12 hours a day and kept at 25° Celsius, it is downright balmy. But entomophobes would be well advised to steer clear because the room is filled not with test tubes and petri dishes — and with ants. Lots and lots of them.

The idea of establishing an ant colony as a model system for epigenetics dates back nearly 12 years to a conversation Reinberg had with Shelley Berger, an epigeneticist at the University of Pennsylvania. Berger recently returned from a family vacation in Costa Rica, where she spent time watching leaf-cutter ants in action. Ant colonies are highly homogeneous, genetically speaking. Yet their members vary dramatically in shape, size and behaviour. "In some cases the worker and queen are absolutely identical genetically, and yet they have completely different functions," Berger explains. "The workers give up their reproduction to the queen." Such phenotypic differences, Berger and Reinberg realised, must come down to epigenetics — variations in gene expression caused by transcription factors, differences in histone modification, noncoding RNA abundance, DNA methylation, and so on.



Members of carpenter ant (*Camponotus floridanus*) colonies come in a variety of shapes and sizes that fit into different castes, including the queen (top), major workers (bottom right), minor workers (next to major workers), and reproductive male and female swarmers (bottom left).

They recruited ant expert Juergen Liebig of Arizona State University, and the trio settled on a pair of species to study the carpenter ant (Camponotus floridanus) and Harpegnathos saltator, aka Jerdon's jumping ant.

According to Berger, each species offers unique attributes. The carpenter ant has several genetically identical "castes", including a queen and two worker classes with different body morphologies and behaviours: petite foragers and brawny soldiers. The jumping ant has only one worker caste, but, unlike workers of most ant species, they retain the ability to become fertile. If the queen dies or is removed from the colony, some of the workers will fight until a winner emerges, at which point she transforms into a queen — a feature that also makes classical genetics studies feasible, as it allows colonies to be manipulated and propagated.

THE SCIENTIST