

Opting for green

A REDESIGN OF HOW OPTIONS OF ENERGY USE ARE PRESENTED HAS BEEN FOUND TO HELP CONSUMERS CHOOSE THE DESIRED ROUTE, WRITES S ANANTHANARAYANAN

Going green, or choosing to use energy generated from renewable or non-polluting sources, comes with some costs and the challenge is to get consumers to make the more responsible choice, even if it is expensive. Choosing the more expensive way because it is for the common good amounts to cooperation with society and surrendering a personal economy. The “natural” or “logical” choice may be to choose personal economy and not to bear higher costs that help others enjoy lower prices. This is the basis of market economy and there is always an “optimum” mix of cooperation and selfishness that drives human behaviour.



Felix Ebeling and Sebastian Lotz.

But global warming has forced the world into a corner and it is time to use every trick and stratagem possible to get consumers, and the industry and states, to consistently go for the personally expensive but socially imperative option of doing things in the more sustainable way. In this context, the study by Felix Ebeling from the University of Cologne and Sebastian Lotz from Stanford and the University of Lausanne, published in the journal *Nature Climate Change*, formally shows that a method of “nudging” the consumer with a “default” green choice at the time of exercising an option leads to a tenfold increase in the number of consumers who do go for the sustainable but personally more expensive product.

The paper describes an experiment in Germany, where a nationwide energy supplier offers two products, one the normal energy connection and the other electricity from complete-

Options for India

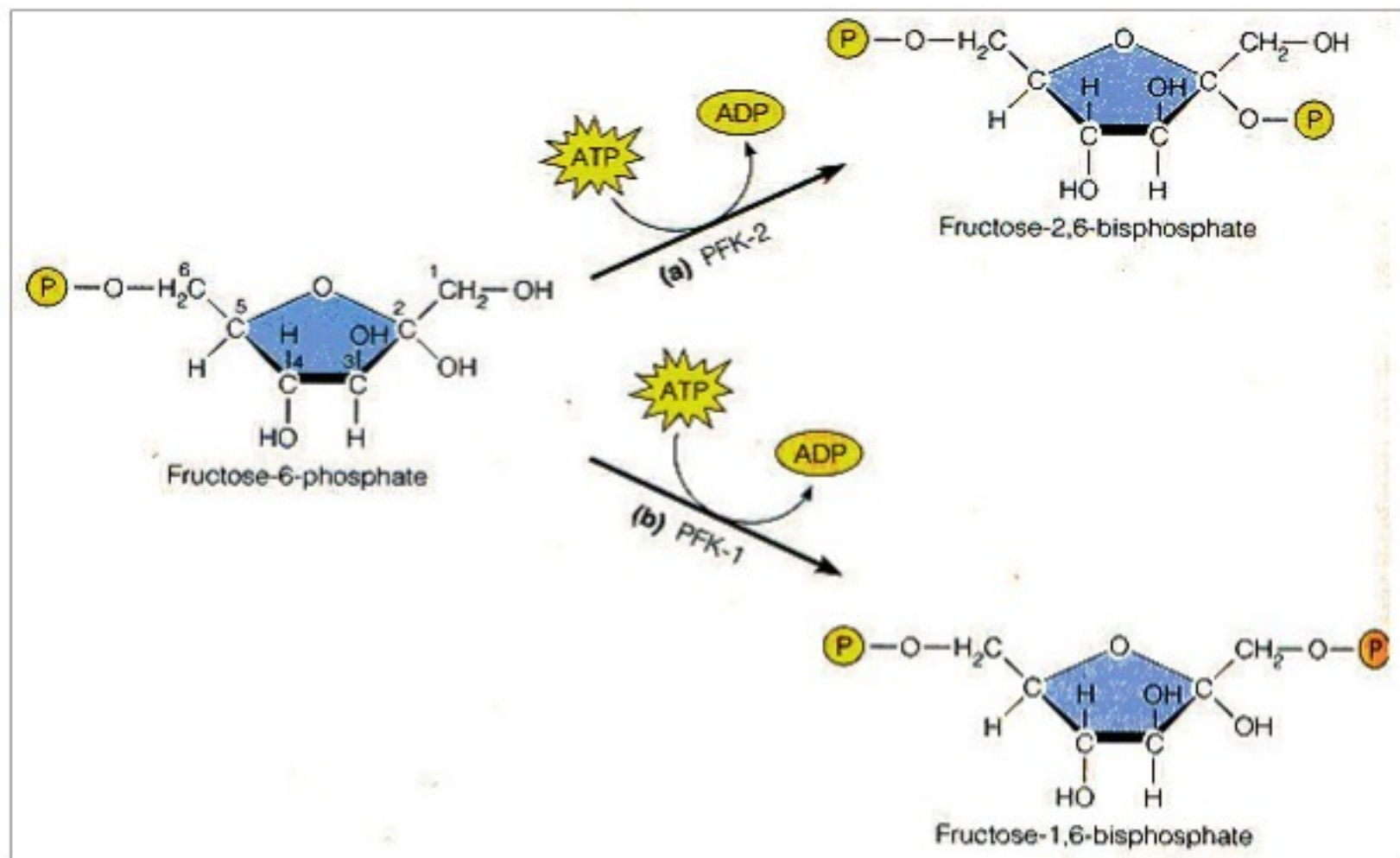
Germany is an environmentally conscious state, which has given up nuclear power and where private electricity utilities offer choices of sources of power. But even in countries like India, there are a great many situations where there is need for people to make green choices. Examples are in water use, using public transport, reducing the use of plastics and even refusing to be overcharged.

A modified “opt-out” option, where the consumer needs to actively choose the obviously less sustainable practice, would draw attention to the nature of the choice and, as the Ebeling-Lotz experiment has shown, should promote green behaviour.

ENZYME ACTIVITIES

FRUCTOSE-2,6-BISPHOSPHATE IS AN IMPORTANT REGULATOR OF GLYCOLYSIS AND GLUCONEOGENESIS, SAYS TAPAN KUMAR MAITRA

Although each of the preceding mechanisms plays a significant role in the regulation of glycolysis and gluconeogenesis, the most important regulator of both pathways is fructose-2,6-bisphosphate. F2,6BP is synthesised by ATP-dependent phosphorylation of fructose-6-phosphate, the same reaction



Fructose-6-phosphate can be phosphorylated (a) on carbon atom 2 by the enzyme phosphofructokinase-2 (PFK-2) to form fructose-2,6-bisphosphate, or (b) on carbon atom 1 by the enzyme phosphofructokinase-1 (PFK-1) to form fructose-1,6-bisphosphate (as in reaction Gly-4 of the glycolytic pathway), the regulatory roles of PFK-2 and PFK-1.

that gives rise to fructose-1,6-bisphosphate at reaction Gly-3 in the glycolytic pathway. However, synthesis of F2,6BP is catalysed by a separate form of phosphofructokinase, which is called phosphofructokinase-2 (PFK-2) to distinguish it from PFK-1, the glycolytic enzyme. As the figure indicates, F2,6BP activates the glycolytic enzyme (PFK-1) that phosphorylates fructose-6-phosphate, and it inhibits the gluconeogenic enzyme (FBPase) that catalyses the reverse reaction.

Let's look at these regulatory roles of PFK-2 and F2,6BP in more detail. The activity of PFK-2 depends on the phosphorylation status of one of its sub-units. The kinase activity of the enzyme is high when that sub-unit is in the unphosphorylated form and low when it is phosphorylated. The phosphorylation of PFK-2 by ATP is catalysed by a protein kinase. The activity of this enzyme depends, in turn, on cyclic AMP, which is a key intermediate in many cellular signal transduction pathways.

In addition to the PFK activity responsible for phosphorylation of F2,6BP, another enzyme activity, initially a kfructose-2,6-bisphosphatase, was found to cleave the phosphate group from F2,6BP converting the compound back to fructose-6-phosphate. This ac-

two ways — first, it makes the PFK-2 kinase inactive and, second, stimulates the F2,6BPase phosphatase activity. Both of these effects tend to decrease the concentration of F2,6BP in the cell. This change leads to less stimulation of PFK-1 and less inhibition of fructose-1,6-bisphosphatase, thereby decreasing the glycolytic flux and increasing the gluconeogenic flux.

The effects of cAMP are important in hormonal regulation because the cAMP level in liver cells is controlled primarily by the hormones glucagon and epinephrine (adrenalin). These hormones cause an increase in cAMP concentration, thereby stimulating gluconeogenesis. Moreover, the increase in cAMP concentration also stimulates a regulatory cascade that increases the rate of glycogen breakdown. Not surprisingly, the effect of cAMP on glycogen synthesis is just the opposite — whether triggered by glucagon or epinephrine, an increase in liver cAMP concentration leads to a decrease in the rate of glycogen formation.

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could be regarded as a “nudge” threw up significantly more green selection. While only some of the website visits resulted in a purchase of power supply in cases where green power had to be actually selected by “opting in”, only 0.62 per cent of the total number were selected for green power, against 5.58 per cent where the green option was “pre-selected”, and the consumer had to “opt out” if he/she so wished.

This amounts to about nine times as many green selections where there was the “nudge”. Considering only the cases where there was an actual sale, the figures were that 7.2 per cent opted for green power where they had to “opt in”, but 69.1 per cent stayed with green when they had to “opt out”. This also comes to a little more

| Opting in | | Opting out | |
|---|---|---|---|
| Contract A | Contract B | Contract A | Contract B |
| Contract Design — High Service | Contract Design — Low Service | Contract Design — High Service | Contract Design — Low Service |
| Optional Choice: | Optional Choice: | Optional Choice: | Optional Choice: |
| <input type="checkbox"/> 100% green (+0.3 cents per unit) | <input type="checkbox"/> 100% green (+0.3 cents per unit) | <input type="checkbox"/> 100% green (+0.3 cents per unit) | <input type="checkbox"/> 100% green (+0.3 cents per unit) |
| 7.00€ Base price | 5.00€ Base price | 7.00€ Base price | 5.00€ Base price |
| 23 cents price per consumed unit | 21 cents price per consumed unit | 23 cents price per consumed unit (incl. 100% green) | 21 cents price per consumed unit (incl. 100% green) |
| At our company you save: 50€ /Year | At our company you save: 55€ /Year | At our company you save: 41€ /Year | At our company you save: 46€ /Year |
| Order now | Order now | Order now | Order now |

the supplier firm (the name is not disclosed) promises to increase the green component of the generation process used by the extent of the consumer's contribution. The consumer receives power by way of the supplier's website, where they are two screens — one for normal service offered and the other for superior service at a higher cost. And each screen offers a further choice — power from the available sources or from a fully renewable, ie, green source, where the surcharge is added. If the consumer would like to take green energy then he/she has to check the box provided.

The experiment was in the way the choice of this green energy was offered — the check box was either left unchecked, in which case a consumer had to manually check the box (opt in) if he/she wanted green power, or the box came with a check mark, a default option — and the consumer had to uncheck it (opt out) if cheaper power was the choice. A total of 41,952 households participated in the trial over the length of a month and each was randomly assigned either of the two tariff presentations.

The outcome was that the default presentation, where the green option was pre-selected and

than nine times as many green options in the case where there was a “nudge”.

The value of this result was subjected to refinement in terms of the choices depending on whether the consumer had chosen ordinary service or superior service and also where there were differences in the tariff rate itself. While there was a dip in the preference for green during periods of reduced electricity consumption or where the rates were higher, the main conclusion, that calling for a “opt out” option favours a choice of staying with green, is robustly borne out.

Another analysis carried out was of how the manner of presentation affected persons who started out with a political commitment to green energy. The way this was done was by considering the postal code of subscriber homes and the political party that had been returned by the majority of voters in that district. The absence of the “nudge” results in the same, low rates of option for green energy, but with larger numbers (9.87 per cent) where the “green party” was popular and fewer (4.63 per cent) where the party had less following. But where there had been the “nudge”, by way of the pre-selected option, the

rates of choosing green energy were nearly the same, 70.19 per cent in “green party” areas and 67.06 per cent in areas with less followers.

Conscious choice

The next test applied was a very significant one — to see whether providing a pre-selected option somehow “fooled” consumers into leaving it as it was, out of lack of awareness. In this test, the conditions that the German consumers faced while placing their contracts were simulated using volunteers based in the USA through an on-line crowd sourcing service called the *Amazon Mechanical Turk*, where anybody could volunteer, for some small payment, to take part in surveys and other business exercises. The AMT volunteers based in the USA were thus asked to imagine they were entering into a power buying contract with the German utility. That they only imagined, and did not actually buy a contract, was the only difference and the screens presented were the same as used in Germany. The AMT volunteers were (hence) also offered the green option, at a higher power tariff, and in different sets, either with the blank “opt in” box or the pre-filled “opt out” box. And then, the important part, after the exercise was over, a subset of the participants was asked whether they could remember what option they had chosen.

The results of the first part of the exercise were similar to the real-life trial, with 34.16 per cent and 93.8 per cent of the participant opting for green energy in the “opt in” and “opt out” cases, respectively. But now, when they were later asked if they remembered how they had chosen, all those who had “opted in” for green naturally remembered, but so also did 84.13 per cent of those who chose green energy in the “opt out” option. This showed that those who chose green energy by not exercising the “opt out” option had done so consciously.

Ebeling and Lotz observe that the experiment shows using a default setting has a powerful effect on behaviour, which gets households to opt for green alternatives without tax breaks or monetary compensation.

Suggestions for desired behaviour; in the form of non-binding defaults that have their effect without infringing the right to free choice, have been found useful in different areas of social and economic policy; they note, an example being organ donation, where “opt out” leads to high participation. The same method, they say, can now form part of the policy maker's toolbox to deal with climate change.

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CORRIGENDUM

In the article “Candid camera spies on nature”, which appeared in these columns on 10 June, the work reported was incorrectly attributed. The correct authors were Alexandra Swanson, Margaret Kosmala, Chris Lintott, Robert Simpson, Arfon Smith and Craig Packer from the Universities of Minnesota, Harvard, Oxford and the Adler Planetarium at Chicago, and the paper appeared in the journal *Scientific Data*.

World's smallest light bulb

STEVE CONNOR REPORTS ON THE CREATION OF A MIRACLE MATERIAL THAT IS A NEAR-PERFECT CONDUCTOR OF ELECTRICITY

Scientists have created the world's smallest light bulb from a one atom-thick layer of graphene, the miracle material that promises to transform everything from smartphones and computers to cars, buildings and satellites. The ultrathin graphene was turned into a superheated filament — just like the thin wire of an incandescent light bulb — which glowed at a temperature of about 2500° Celsius.

The light was so intense it could be seen with the naked eye even though it was on the atomic scale, which meant the high temperatures were confined to a tiny “hot spot” and did not damage the silicon chip on which it was mounted, scientists said.

The discovery, they added, could be used as the basis of a new kind of switching device for future optical computers that use pulses of light rather than electricity to process and transmit digital information far faster than conventional silicon chips.

James Hone, professor of mechanical engineering at Columbia University in New York and co-author of the study published in the journal *Nature Nanotechnology*, said this was the first time scientists had been able to create a computer chip that had its own visible light source. “We've created what is essentially the world's thinnest light bulb. This new type of ‘broadband’ light emitter can be integrated into chips and will pave the way towards the realisation of atomically thin, flexible and transparent displays, and graphene-based on-chip optical communications.

“We are just starting to dream about other uses for these structures, for example as micro-hotplates that can be heated to thousands of degrees in a fraction of a second to study high-temperature chemical reactions

just one atom thick. It is extremely strong yet lightweight, and a near-perfect conductor of electricity.

The Columbia scientists, working with researchers in South Korea, attached small strips of graphene to microscopic metal electrodes that passed an electric current through the suspended strips causing them to heat up and brighten, visible light.

“The visible light from atomically thin graphene is so intense that it is visible even to the naked eye, without any additional magnification,” said Young Duck Kim of Columbia, the co-lead author of the study.

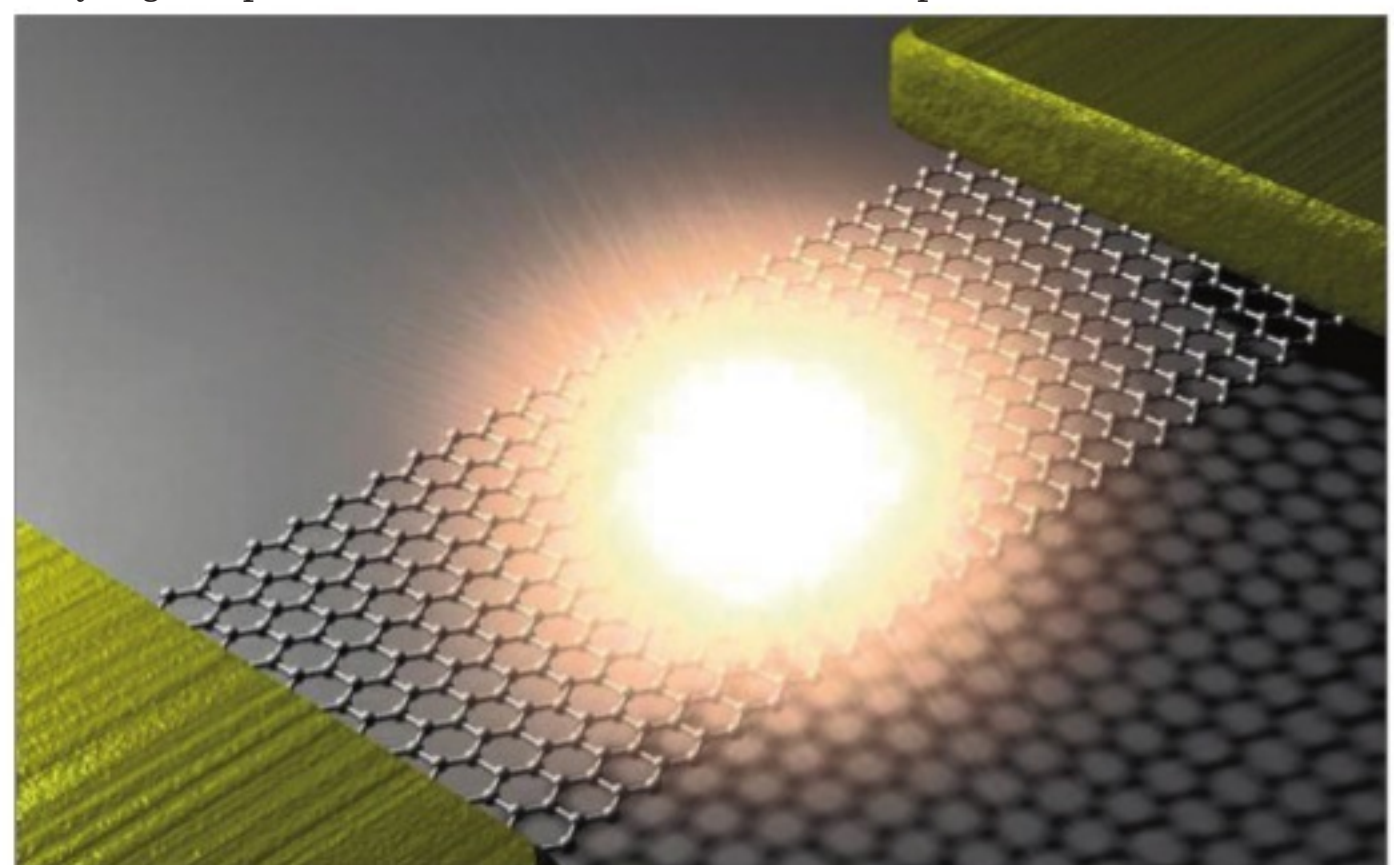
Creating such small light sources on the surface of a computer chip, the researchers said, was considered essential for developing the fully integrated “photonics” circuits of optical computers, which would in theory outperform the processing and speed of conventional silicon chips in today's computers.

They also found that it was possible to vary the wavelengths of the light by altering the distance of the graphene wafers suspended over the silicon substrate of the chip — a potentially useful way of tuning the light source and expanding its “bandwidth”.

“This is only possible because graphene is transparent, unlike any conventional filament, and allows us to tune the emission spectrum by changing the distance to the substrate,” Kim said.

Graphene's potential: ■ It could be used to desalinate seawater to make it drinkable — tiny pores in its crystal lattice could let water molecules through while blocking salt.

■ Being both transparent and conductive, graphene could be perfect for the new generation of smartphone touchscreens.



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or catalysis.” Graphene, which was discovered by two Russian émigré scientists working at the University of Manchester, is composed of layers of carbon laid down in a lattice structure

■ It repels water and is highly conductive and this combination delays the oxidising reaction that causes rust.

THE INDEPENDENT

PLUS POINTS



An artist's impression of dinosaurs that lived 200 million years ago, as they have given scientists a dramatic glimpse of what may be in store for the world if greenhouse gas emissions are not held back.

Bleak future

The fossils of dinosaurs that roamed the earth 200 million years ago have offered a bleak glimpse into what may happen if global warming is not stopped, according to a new study. Scientists attempting to understand why herbivorous dinosaurs took so long to populate the tropical parts of the planet believe that a high level of CO2 may hold the answer. Evidence of long-necked “sauropods” in equatorial regions have only been documented at least 30 million years after they first appeared on earth and the creatures did not move to the tropics until 10-15 million years after they had diversified and began traveling closer to the poles.

Experts now believe the dinosaurs were kept from the equatorial regions during the late Triassic period because of the effects of atmospheric carbon dioxide, which were at levels four to six times what they are today. According to findings published in the journal *Proceedings of the National Academy of Sciences*, when CO2 levels were high, the tropical climate would change dramatically between wet and dry years. During the dry periods, vegetation would die and fuel raging wild fires that burned at temperatures as high as 600° Celsius.

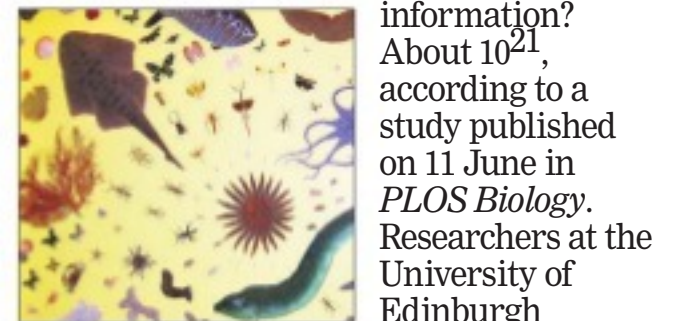
US expert Randall Irmis from the Natural History Museum of Utah warned, “If we continue along our present course, similar conditions in a high CO2 world may develop and suppress low-latitude ecosystems.”

The scientists said they hope the findings will improve our understanding of the consequences of human-caused climate change.

KASHMIRA GANDER/THE INDEPENDENT

Life quantified

How many supercomputers would it take to store all of life's DNA



information? About 10²¹, according to a study published on 11 June in *PLOS Biology*. Researchers at the University of Edinburgh

estimated the total amount of DNA present in earth's biosphere, a number they suggest could be used as a measure of biodiversity. “We know that there are a lot of things that change in the natural environment, such as habitat loss. This obviously has an effect on the species living there. This approach offers a complementary way to quantify the changes,” study coauthor Hanna Landenmark, a graduate student at Edinburgh, told *The Independent*.

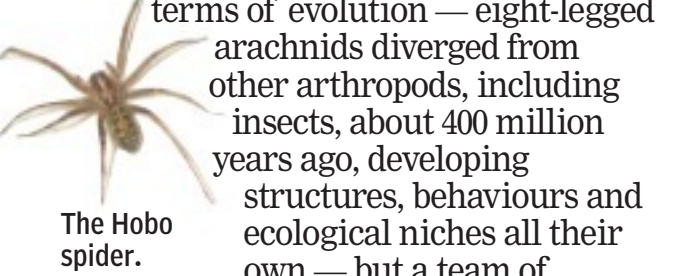
The researchers used previous biomass estimates to come up with total cell numbers for each of the major groups of life: prokaryotes, plants, animal, and protists. By considering the average genome size for each group and the estimated weight of an around 1,000 megabase-long strand of DNA, they estimated that life on earth contains at least 5.3 x 10³¹ megabases of DNA, weighing a total of around 5 x 10¹⁰ tons.

Put another way, the team calculated that it would require one billion standard shipping containers to contain all of life's DNA. It left out chloroplast and mitochondrial DNA given their small genome sizes and also disregarded fossilised DNA and leaf litter, which, members said, was “analogous to old garbage data”.

AMANDA B KEENER/THE SCIENTIST

Remarkably similar

Spiders and centipedes don't have a whole lot in common, at least in terms of evolution — eight-legged arachnids diverged from other arthropods, including insects, about 400 million years ago, developing structures, behaviours and ecological niches all their own — but a team of researchers has found that at least some spider and centipede species share molecular architecture in their venom proteins, thanks to convergent evolution.



University of Queensland structural biologist Glenn King and his co-authors reported on 11 June in *Structure* that an insulin-like protein in the venom of hobo spiders (*Eratigena agrestis*) and some centipede species had a very similar molecular structure to the hormone from which both compounds evolved. “If you take the sequence of the spider toxin and you do a Blast search, the hormone is so different now that you don't pull it out,” King said. “But when we did a structural search and it pulled up the hormone, that's what really surprised us — the sequence didn't tell us where the toxins evolved from, but the structure did pretty clearly.”

BOB GRANT/THE SCIENTIST