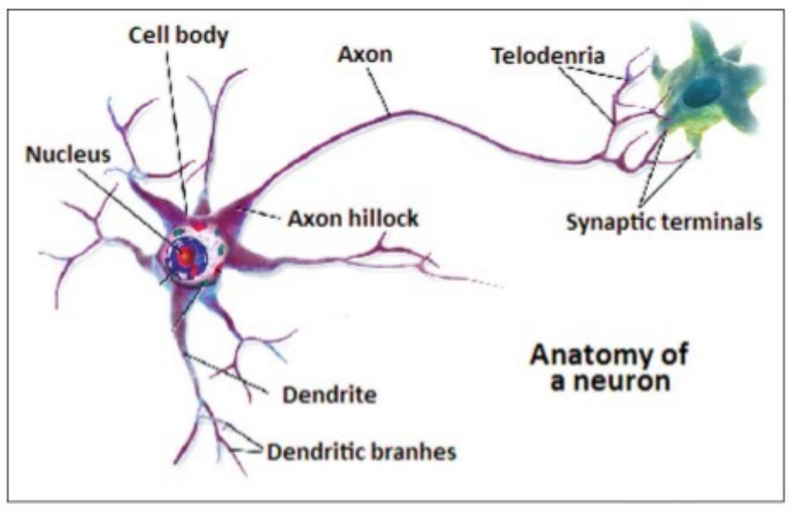
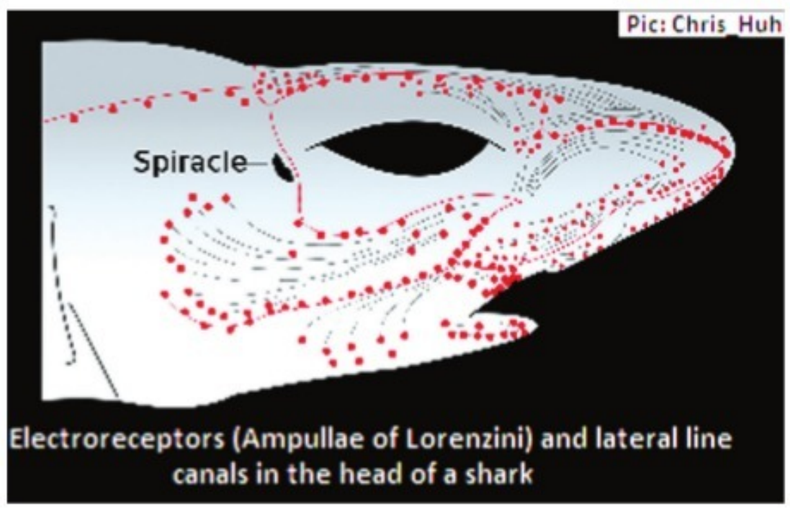
Silent signals in the deep

Not sight, sound or smell — there is yet another way by which animals pass messages





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Living things communicate. They use colours of feathers, fur and petals, calls and there are scents — even plants use scents to signal a predator's enemies when under attack. But all three involve something material, like dyes, vibrating molecules of air or chemicals. Communicating through electric fields would be different.

After the signals of light, sound or chemicals reach the body, of course, it is through electrical effects that the information is conveyed to the brain. But could the cells of the body directly receive electric fields, without an active role of the intervening media?

It turns out that there is a large group of animals that do just that. Apart from an image, sound and smell, living things also radiate electric fields. And there are animals that are able to detect the fields, a faculty called electroreception, for communication, navigation and detecting prey. As salt water is a good conductor, it is predominantly fish or water-dwelling animals that have evolved the ability. Nicholas W Bellono, Duncan B Leitch and David Julius from the University of California, San Francisco, write in the journal, *Nature*, about the molecular and biophysical modifications seen in the sensory cells of sharks and skates. They report that the shark is less selective of frequencies of electric fields than the skate, reflecting its use of the signal for predation, unlike the skate, which uses electric fields for communication.

The neuron, or the nerve cell, works by moving electric charges about. The cell consists of a cell body, which is normally negatively charged, and a mechanism to hold a stock of positive potassium ions, in good numbers, and sodium ions in lesser numbers. The membrane that covers the cell is normally impervious, but has openings, some that can allow either potassium ions and some that can allow sodium ions to pass through, from time to time.

The concentration of sodium and potassium ions in the medium surrounding the cell is the reverse of what it is inside, that is to say, it is rich in sodium ions and depleted in potassium ions. And the pores in the cell wall are normally closed, on account of the negative charge inside the cell. There is hence tension — of sodium ions wanting to get in and potassium ions wanting to get out.

The nerve cell also has a number of protrusions, called dendrites, which branch out with endings that are sensitive to stimuli. These stimuli could be touch, heat, light, or electrical. When the stimulus strikes, the effect on the nerve cell is that sodium channels get opened.

As there are more sodium ions outside the cell than inside, sodium ions rush in through the open channel. The entry of positive sodium ions leads to reduction of the net negative charge inside the cell, an effect called depolarisation. If the reduction goes far enough, it is like tripping a switch and many more channels open and there is a surge of sodium ions. The charge, which was about minus 75 millivolts at the starts, goes to +40 millivolts, all in one millisecond.

When the charge rises like, this, the sodium channels close and potassium channels open. The rich store of potassium ions in the cell then rush out, to reduce the positive charge and bring back the starting charge condition. As there is now a change in the sodium and potassium content, there are mechanisms, which consume energy and kick in to pump out the sodium and take in the potassium, to restore the original state.

The sudden rise in charge, by over a tenth of a volt, is called an action potential, and this passes down another protrusion of the cell, the axon. The axon forms the bulk of the length of the cell and has endings, the axon terminals, which pass signals on to muscles, glands or other neurons. Typically, the axon ends in a synapse, or the junction of two neurons.

The action potential, in the presynaptic or first neuron, leads to the axon terminal to release an electrical or chemical signal, to the dendrites of the signal-receiving or postsynaptic, the second neuron, which is there at the synapse. The signal to the second neuron then starts of the sequence of channels opening and closing, firing of action potential, and so on, while the first neuron takes time to get restored.

While the start of the cascade, which sends signals to the brain, is a stimulus that comes to the first, peripheral and stimulus-sensitive neuron, the stimulus itself could be an electrical signal. The neuron would then need to be sensitive to electric fields. For this sensitivity to be of any use, it needs to respond to extremely weak electric fields, which are generated by the feeble electric activity in nerve cells or other processes in animals.

The shark is known to be the most electrically sensitive of all animals and it can detect a field as low as five nano volts per centimetre, which helps it to locate prey for the final strike, at close range. The picture shows where such sensitive electroreceptors are found in the head of the shark. It is reported that approaching a shark with any object that radiates an electric field could induce it to attack!

The use of electric fields for detection, like the shark does, is called passive electroreception. Another form of electroreception, which the skate, another sea animal, uses, is for communication, mainly to inform other skates that it is there. Skates then emit and receive electric signals. But to be able to be made out in the general electric noise, the skate has to modulate its electric signal, and to be sensitive to identify the modulated signal from other skates.

The work of the authors of the paper in *Nature* traces the differences in the way the signal receptors in the shark and the skate function and they find the differences correspond to the function that electroreception discharges in the two categories. "In the shark, electroreception may act as a threshold detector for broad frequencies, potentially reflecting its role in predation. By contrast, skate sensation appears more specifically tuned to enable the detection of signals from prey as well as frequencies in the range of conspecific electric-organ discharges (signals from animals of the same species)", the authors say.

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How many are left?

If conservationists across the Himalayas can prove that counting the predators will help villagers more than killing them can, efforts to protect the snow leopard will succeed

ADAM POPESCU

Living at an extreme altitude amid the perilously steep mountains of the Himalayas and in a bitter cold climate, snow leopards are among the most difficult of top predators to study. Even after decades of sustained research, no one knows how many of these big and extremely elusive cats remain. Researchers from all 12 Asian nations that these cats call home are trying to remedy that with a five-year census using camera traps set up on remote mountains, radio collaring, and hair and scat identification.

The survey comes on the heels of a controversial decision last year by the International Union for Conservation of Nature to remove the snow leopard from its list of "endangered" species after 45 years. The IUCN reclassified the cat as "vulnerable", meaning the animal's risk of extinction is less urgent than experts had believed.

That change was based on estimates that more than 8,000 wild snow leopards exist across Asia but also on an extrapolation that some researchers say probably dramatically overstated the numbers and understated the cat's rate of decline. "We don't even know the true number of these leopards," said Tsewang Namgail, the director of the Snow Leopard Conservancy India Trust. "It's all guesstimates everywhere."

The concern for Namgail and others is that there isn't unified protection for the big cat across the countries, and even with the IUCN change, the viability of the spotted high-mountain cats remains in doubt because of human settlements, climate change and poaching. Removing leopards from the endangered list, he worries, may give the impression that they're safe.

Snow leopards exist in pockets in Afghanistan, Pakistan, Kyrgyzstan, Tajikistan, Uzbekistan, Kazakhstan, Nepal, Bhutan, Russia and Mongolia, and in larger numbers in India and China. The new survey, known as Paws (Population Assessment of the World's Snow Leopards), began this year in India, Pakistan, Kyrgyzstan, Mongolia, Russia and Nepal. But getting results won't be easy.

That's because unlike other big cats, snow leopards are specially evolved for cold heights. Snow leopards have the longest and thickest fur of any big cat, and a long, thick tail that they can wrap around themselves to stay warm.

A large nasal cavity and broad facial bones allow the leopards to breathe in very cold air and warm it for breathing, and a high concentration of red blood cells maximises oxygen intake, meaning they don't easily get tired while climbing mountains. In fact, they're comfortable at heights reaching 18,000 feet. All these features are essential for their survival and make them especially hard to track, even for the hardiest researchers.

But leopards are, to a degree, predictable — frequenting game trails and ridges and often spraying rocks to mark their territory. As a result, trackers can recognise scrape marks and install camera traps to identify individual cats based on their spots, which are as unique as fingerprints. The researchers just have to be sure-footed in icy conditions at high altitude and cross their fingers that the cameras hold up.

Fieldwork and support for Paws is coming from a mix of government and non-governmental organisations that have committed more than £4.5m in funds and in-kind assistance to design a snow leopard management plan. Paws plans to survey between 10 and 20 per cent of the forbidding range, according to Koustubh Sharma, a senior ecologist and international coordinator at the Snow Leopard Trust. He estimated that it will take about five years and the work of about 1,000 forest rangers, scientists and support staff to complete the project.

While there are relatively stable populations of the big cats in China and Mongolia, experts say, human development and climate change have created areas where snow leopards are thinly dispersed. Breaks in their range, whether caused by cities or habitat loss, can create islands of habitat that prevent movement and bottleneck genetic diversity. The discovery last year of three subspecies indicates fractured groups. Increased human encroachment on the snow leopard range was highlighted in a 2016 report that found that as many as 450 snow leopards are poached annually, mostly for traditional Chinese medicine and as trophy skins.

Warming climates also are altering snow leopard habitat. Glacial melt and overgrazing from livestock speed up mountain erosion and hinder plants' ability to regenerate, which gives herbivores fewer food options, thereby threatening leopards. When there are fewer food options, such as the blue sheep these cats prefer, leopards often come into conflict with humans.

In much of Asia, livestock accounts for as much as two-thirds of leopard diets. When leopards kill livestock, locals often kill leopards. The cycle is expected to worsen — loss of alpine grasslands and an advancing tree line could cut leopard habitat by 30 per cent, meaning more potential for intra-species conflict. In recognition of this, Panthera, which has deployed more than 500 camera traps across seven nations for previous research projects, has helped protect leopards as it counts them.

To reduce attacks on local livestock and get buy-in for the snow leopard project from local farmers, the group has installed netted pens in India and Tajikistan to keep out the cats and has vaccinated domestic animals in Pakistan in exchange for getting farmers not to kill snow leopards.

More than 50 per cent of the human population in the animal's range is engaged in farming and herding, and more than 40 per cent lives below the poverty line. And when attacks on livestock happen, people may not think about helping a vulnerable species as much as about retribution — in a town near the Srinagar, villagers recently stoned a leopard to death after it was found by herders in a pen surrounded by dead goats.

Yet some have found opportunity in living near snow leopards. As pens have reduced leopard predation by as much as 95 per cent in some areas, says Namgail, a space has opened for snow leopard ecotourism.

For instance, in Ladakh, in the northern Indian border state that abuts China and Pakistan, snow leopards exist at a density of about four to six per 100 square kilometres versus less than one elsewhere in the range.

This abundance is attracting both tourists and scientists. Savvy local herders have turned their homes into hotels as people arrive in search of snow leopards. Villagers act as spotters, offering hikes to camera traps or a chance to see the cats, sometimes from the side of the road and the warmth of an SUV.

Homestays can bring in $500 to $2,000 a year, with 10 per cent of proceeds pooled into a village's communal savings to improve habitat, protect pastures, turn valleys into reserves and improve education. In fact, burgeoning scientific and ecotourism business has created a different worry — that a warming climate may reduce the number of cats and make it harder to attract visitors.

"Without snow, it's very hard to track shan," says Tsewang Norboo, the owner of the Snow Leopard Lodge, using the Ladakhi word for snow leopard. "We need them."

Despite the challenges, Namgail sees progress. A decade ago, when Namgail tried to convince Ladakhis that leopards could put money in their hands, "villagers laughed at us", he says. If the Indian biologist and his colleagues across the Himalayas can prove that counting leopards can help villagers more than killing them can, Paws will be a success.

For snow leopards to have a better chance of long-term survival, they need the help of the people living beside them, he says. "There's no other way."

Courtesy The Washington Post
The Independent

PLUS POINTS

Health warning

Graphic images of rotted teeth and health warnings on the side of sugary drinks could help deter young people and make them opt for healthier options, a new study suggests.

Labels similar to those on tobacco products including health warnings about diabetes, obesity and dental problems as well as nutritional information, turned young adults off sugar-sweetened drinks, the research found. The study makes a "compelling" case for labels on drinks, and other sugary products, to be implemented globally, said professor Anna Peeters, lead author from Deakin University in Australia.

"The question now is what kind of impact these labels could have on the obesity epidemic," Peeters said. "While no single measure will reverse the obesity crisis given that the largest source of added sugars in our diet comes from sugar-sweetened drinks, there is a compelling case for the introduction of front-of-pack labels on sugary drinks worldwide."

The research, which will be presented at the European Congress on Obesity in Vienna, Austria, examined responses from around 1,000 Australians, aged 18 to 35. They were divided into five groups and asked to choose from a selection of 15 drinks, including sweetened and unsweetened options.

The sugary drinks were either unlabelled, or included one of four labels — a graphic warning showing an image of crooked teeth, a text warning, information about the number of teaspoons of added sugar, or a health rating.

Participants were 36 per cent less likely to purchase sugary drinks that included a graphic warning compared to those without a label, and one per cent less likely to buy those with sugar information on the packaging, the research found.

They were 20 per cent more likely to choose healthier alternatives when Health Star Ratings were displayed on all drinks compared to the group without labels. The system is currently used on food products in Australia and New Zealand.

The independent

More effect than cause

The human brain is disproportionately large. And while abundant grey matter confers certain intellectual advantages, sustaining a big brain is costly — consuming a fifth of energy in the human body. It is an oddity that has long flummoxed scientists — while most organisms thrive with small brains, or none at all, the human species opted to sacrifice a degree of body growth for more cerebral capacity.

The human brain, they suggested, expanded mainly in response to environmental stresses that forced our species to come up with innovative solutions for food and shelter, and pass the lessons on to our offspring. The finding challenges a popular theory that the thinking organ grew as social interactions between humans became more and more complex, a research duo wrote in the journal, *Nature*.

In fact, the inverse may be true. "The findings are intriguing because they suggest that some aspects of social complexity are more likely to be consequences rather than causes of our large brain size," said paper co-author Mauricio Gonzalez-Forero of the University of St Andrews in Scotland, "The large human brain is more likely to stem from ecological problem-solving and cumulative culture than it is from social manoeuvering."

From our ape-like Australopithecus ancestors to modern Homo sapiens, the human brain has tripled in size. But feeding such a big brain has been suggested to come at the cost of slow body growth in childhood — leaving our young dependent and vulnerable for longer than other animals.

But why did human brains grow more than those of other animals living in challenging environments? Probably because of culture — the ability to learn skills from others rather than having to figure everything out for ourselves!

The straits times/ann