Walking like an ant

It is not only how you look that counts, the way you move is important too

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When living things wish to be left alone, they find it useful to look like something unappetising or something that is likely to hurt. Looks, however, extend beyond colour and shape. Things are also recognised by how they get around.

There are many examples in nature where species which have no defences against predators have evolved to resemble related species that do. In most examples, however, it is through colour or skin patterns that the mimic species advertise similarity to another species. Paul S Shamble, Ron R Hoy, Itai Cohen and Tsevi Beatus from Cornell University, US, describe in their paper in the *Proceedings of the Royal Society*, an assessment of a species of spider, which makes use of features of movement, rather than colour, to pass off as a substantially dissimilar animal.

The evolution of animals to share features with other species, which predators have reason to avoid, was first studied by Henry Walter Bates, a British scientist who worked with Amazonian Butterflies. The Heliconid butterflies of the Amazon, also known as the Passion Flower butterflies, live in groups and shelter from the rain in shrubs of the Passion Flower. This plant has toxic leaves, which keep it safe from insects. But the caterpillars of the Heliconid have developed resistance and use the toxins in the leaves to make the butterflies themselves poisonous to eat! Snacking on a Heliconid leads to such discomfort that those who have had a taste steer clear thereafter.

What Bates found more interesting is a related butterfly species, which does not have this kind of protection. The related species has evolved to have wing shape and markings deceptively similar to the Heliconid butterfly. Predators that have learnt to avoid the Heliconid then also stay away from the related, but quite palatable cousins! This kind of "borrowed" protection, which has been found in many more instances, is known as Batesian mimicry.

A well-known instance is the Indonesian Papillio butterfly, whose females mimic other, foul tasting species. Another instance is of the Eastern Coral snake, a relative of the cobra and the mamba and found in some states of the US. This snake is venomous and has characteristic colouring to announce itself. But the harmless Scarlet King snake has evolved almost identical markings and stays safe in the shadow of its deadly look alike!

There has been much research into the genetic trail that leads to visual similarities and the groups of genes that control pigments in mimics and models have been identified. Environmental forces that induce genetic selection and evolution of mimicry have also been analysed. The Cornel University researchers observe that while these studies of protective mimicry have focused on static traits, like colour and patterns on the coats or wings of living things, the importance of their dynamic traits, or how the animals move, have also been recognised. Back in the 19th century, Bates had observed that butterflies, which evolve to have wings like related species also flit with a similar action and are indistinguishable in flight. Recent studies of how animal brains work to recognise things have also highlighted the role of movement as a visual clue, the paper says. However, it is only in recent times that the dynamic aspect of mimicry has been rigorously investigated, the paper says.

Although the benefits of being visually similar should lead to the resemblance of mimic species to the models being nearly perfect, it has been observed that the mimics are often only poor copies, a phenomenon known as "imperfect mimicry". The quality of perceivers' detection equipment has hence become important, as has the need to understand different aspects of visual appearance, including the dynamic, the paper says.

A common form of dynamic mimicry, the paper says, is the mimicry of ants. Ants have powerful defences, like strong jaws, a poisonous sting, chemical arsenal, general aggressiveness and nest-mates to help. Ants are hence a fine model to mimic and many species of spider have done so. Spiders, the paper says, although they lack the defenses, particularly the chemical weapons of ants, have their own tools of offence and are a feared lot. The family, Saltacidae, of jumping spiders, the paper says, are themselves the model for mimicry by other species. Moths and some flies sport patterns on their wings to appear like the spiders' legs and they wave their wings to give the impression of a spider raising its forelegs, to keep foes or competitors away.

What sets jumping spiders apart from others is their ability to make very quick jumps over distances many times their own length. The spiders have four pairs of eyes, for precise location of prey and they have a hydraulic system of powering their legs, for perfectly guided jumps, for hunting, and to escape attack. For all this, jumping spiders need to avoid predators too and to this end many varieties of spiders are known to mimic the movement methods of ants.

Unlike other instances of Batesian mimicry, ants are no related species of spiders, but "are separated by significant differences in morphology, behaviour and hundreds of millions of years of evolutionary history," the paper says. The spider is a stocky arachnid with eight legs and two body segments while the ant has six legs, two antennae and three body segments separated by narrow constrictions. "Jumping spiders are solitary predators famous for visually driven behaviours. They typically stalk their prey carefully, leaping towards their targets from many body lengths away. Ants, however, are social, opportunistic foragers whose worlds are dominated by chemical cues," the paper says.

A basic difference between the cases of the spider-ant mimicry and instances of butterflies, snakes and some others would lie in dimensions and the speed of movements of the animals. Larger and slow-moving animals allow clear visualising. Close visual resemblance of a mimic to the model is hence essential. As ants are small and make swift, darting movements, however, a predator may find it difficult to form a well resolved visual image and would rely on the rhythm and trajectory of motion to identify and differentiate possible prey. This has been suggested as the reason that spiders have evolved to carry out movements that appear like those of an ant. The suggestion, however, has not been followed through with precise, high speed recording of the spiders' movements, to show that this is truly as case of protective, locomotor mimicry.

The Cornell researchers used multiple high-speed cameras to track and compare leg movements of freely moving animals in three dimensions. The cameras took pictures at the rate of 1,000 to 4,000 frames a second and made 27 recordings of *Myrmarachne formicaria*, a jumping spider that is considered one of the best examples of ant-mimicry, 15 recordings of ants and then 23 of spiders that did not mimic ants.

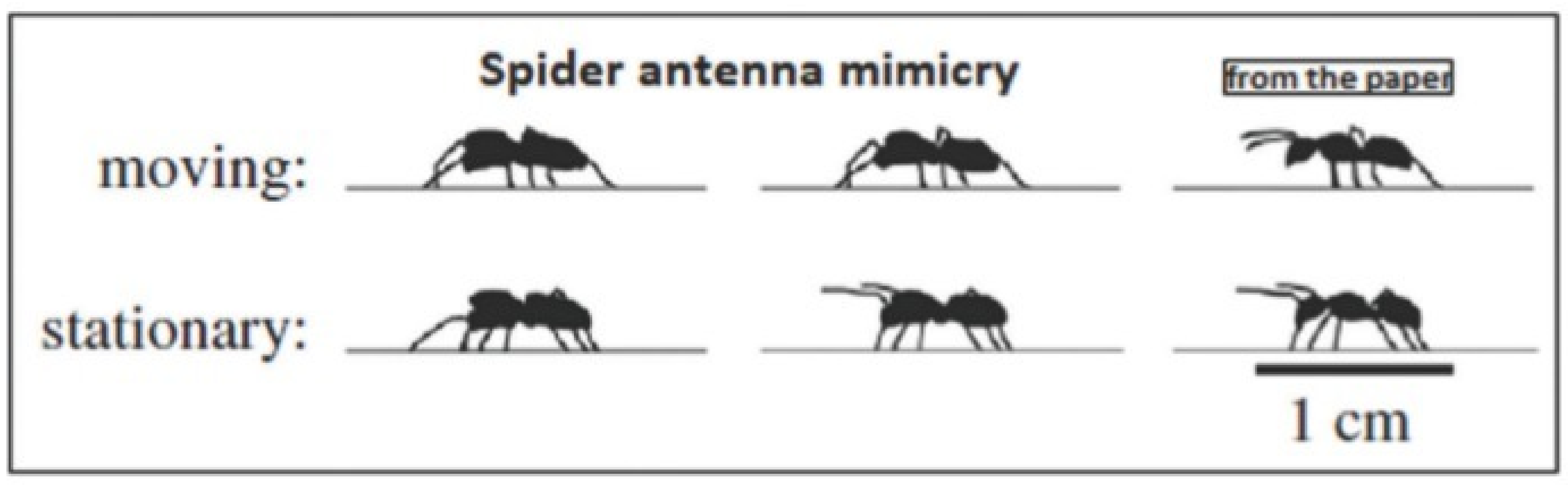
The results showed that "the movement of the ant-mimicking jumping spider, *M formicaria*, is similar to that of ants both at short, single-step timescales and at long, full trajectory timescales," the paper says. The mimic trajectories showed regular, curved, wavelike shapes, with a wavelength of about 10 body lengths. Ants following a trail also moved in the same regular, wave shapes, 10 body lengths apart. In following a pheromone trail, ants cross the trail, till it seems to fall off and then come back, again to cross till it gets weak and so on. While this is a path with a purpose for ants, the same path for spiders, which follow no trail, is clearly to "move like an ant". And further, while ants continuously held their two antennae aloft in front of the body, jumping spiders moved swiftly, in bursts, but when stationary, for about 100 milliseconds, they raised their front legs, "generating antennal illusion," the paper says.

The paper discusses how the 100 millisecond spells of antenna mimicry may be good enough to deceive many observing predators. Spiders, which are capable of walking with six legs, still use all eight legs except when stationary. This suggests that it is during these 100 stationary milliseconds, when observers can make out sufficient detail, that it would be best to mimic ant-like forelimb behaviour, the paper says.

Jumping spider

ant

Eastern coral snake and scarlet king, the mimic



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PLUS POINTS

Wet Moon

There may not be any cheese to eat on the Moon, but a new study suggests there are vast deposits of water to drink.

In good news for hopes of building a base there as humans begin efforts to colonise our solar system, researchers detected signs that the "bulk of the interior of the Moon is wet".

While water was detected in small quantities in material collected by astronauts who took part in the Apollo space missions, it was thought unlikely that the Moon would contain much water because of the way it was formed.

It is thought the Earth's natural satellite was created from the debris left by a cataclysmic collision between the early Earth and a Mars-sized object. The heat created by this impact should have driven off hydrogen needed to create H2O.

But, in the new study, scientific instruments detected tell-tale signs of the presence of water in most of the samples of material produced by volcanic eruptions on the Moon, the researchers reported in the journal *Nature Geoscience*.

One of the researchers, professor Ralph Milliken of Brown University, said, "The distribution of these water-rich deposits is the key thing. They're spread across the surface, which tells us that the water found in the Apollo samples isn't a one-off. Lunar pyroclastics (volcanic material) seem to be universally water-rich, which suggests the same may be true of the mantle."

Dr Shuai Li, of Hawaii University, suggested that the water might have survived the astonishing collision or could have been delivered to the Moon by asteroid and comet strikes. "The exact origin of water in the lunar interior is still a big question," he said.

But, whatever its source, it could make setting up a moon base considerably easier. "Anything that helps save future lunar explorers from having to bring lots of water from home is a big step forward, and our results suggest a new alternative," he said.

The independent

Sleeping with the 'enemy'

Weta might be saying no to interspecies ardour but human-induced environmental change is looming as a matchmaker. New research has been looking at a paradox, which animals at risk of extinction face — breeding themselves out of existence.

Sleeping with the "enemy" — hybridisation of an endangered tree weta — carries a message that at-risk animals' habitats and populations, need to be maintained. New Zealand-based Lincoln University's senior ecology tutor Mike Bowie, along with University of Canterbury colleagues, examined whether rare weta species are mating with more common species in the study.

The rare species can become genetically swamped by the genes from the more common one, rendering the former effectively extinct. They examined if the Banks Peninsula tree weta was breeding and producing hybrids with the more prolific Canterbury tree weta, with which it shares some habitats. They collected and tested 466 DNA samples for the study.

Natural hybridisation is an important part of the evolutionary process and can enable the exchange of adaptive traits between species or lead to the evolution of new species.

However, these outcomes are rare, especially when hybridisation results from human induced changes such as the introduction of exotic species, habitat modification and climate change, which may increase the rates of hybridisation beyond natural levels, Bowie said.

While the result shows the weta appear to be generally keeping their distance, and they remain distinct species, there are still risks, Bowie said. Extreme loss of habitat can cause changes to population densities, which increases the risks of hybridisation.

"Landowners should be encouraged to conserve native habitat including kanuka and old totara logs and fence posts where weta reside," he said.

It might already be too late

Is climate change the 'Great Filter' of human extinction? Scientists think it might be a compelling reason for why we've never found aliens

The sun sets over icebergs near Ilulissat in Greenland

KEVIN LORIA

Unchecked climate change would eventually lead to widespread devastation on Earth. Rising seas would inundate coastal cities like Miami in the US, searing heat would increase human mortality, and acidic oceans would become inhospitable to fish and coral, leaving behind little but rubbery masses of jellyfish.

These consequences of human activity could be the thing that prevents our civilisation from advancing much further. In a particularly extreme scenario, it could even wind up wiping us from the face of the Earth.

That may sound unlikely, but it's the answer some scientists are giving to a perplexing question — why haven't we encountered intelligent alien life?

We live in a galaxy with between 100 billion and 400 billion stars, each potentially surrounded by planets. Until recently, we thought there were about 200 billion such galaxies in our observable universe, each containing hundreds of billions of stars and trillions of planets — but new NASA research indicates there are probably at least 10 times as many.

Even if habitable planets are rare and life is exceedingly unlikely to arise, those mind-boggling numbers suggest there should still be other intelligent life somewhere in the universe. If just 0.1 per cent of potentially habitable planets in our galaxy harboured life, there would still be a million planets with life.

So, as the Nobel Prize-winning physicist Enrico Fermi famously asked of our alien neighbours, "Where are they?" Why haven't we heard from aliens or found any evidence of their existence? That question is known as the Fermi paradox, and there are several potential answers (most are fairly disconcerting).

One hypothesis is that before intelligent life manages to spread beyond its original planet to other nearby planets, it runs into a sort of "Great Filter."

As the philosopher Nick Bostrom explains, this idea suggests there are several "evolutionary transitions or steps" that life on an Earth-like planet has to achieve before it can communicate with civilisations in other star systems. But an obstacle or barrier may make it impossible for an intelligent species like ours to get through all those steps. That would explain why we haven't heard from or seen any other life.

Bostrom writes, "You start with billions and billions of potential germination points for life, and you end up with a sum total of zero extraterrestrial civilisations that we can observe. The Great Filter must therefore be powerful enough - which is to say, the critical steps must be improbable enough - that even with many billions of rolls of the dice, one ends up with nothing - no aliens, no spacecraft, no signals, at least none that we can detect in our neck of the woods."

Climate change caused by the development of advanced civilisation could very well be that filter in our case. David Wallace-Wells suggested this possibility in a recent feature for *New York magazine*, "In a universe that is many billions of years old, with star systems separated as much by time as by space, civilisations might emerge and develop and burn themselves up simply too fast to ever find one another.

"Peter Ward, a charismatic palaeontologist among those responsible for discovering that the planet's mass extinctions were caused by greenhouse gas, calls this the 'Great Filter', 'Civilizations rise, but there's an environmental filter that causes them to die off again and disappear fairly quickly,' he told me. 'If you look at planet Earth, the filtering we've had in the past has been in these mass extinctions.' "The mass extinction we are now living through has only just begun; so much more dying is coming."

Scientists are currently debating whether we are now in the midst of the Earth's sixth mass-extinction event or approaching it. Either way, the situation is dire - the existential risks posed by a worst-case climate-change scenario are real.

If those risks become serious enough to act as humans' Great Filter, it may be too late for us to communicate with anyone else in our universe.

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