Sending out the right signal

TRIM YOUR SAILS TO SUIT THE WIND IS ADVICE THAT NATURE FOLLOWS TO KEEP OUT OF TROUBLE, SAYS **S ANANTHANARAYAN**

With research continuing to throw up the counter-intuitive and unexpected, it is good to find that a part of nature behaves entirely as one would think it should. A method that creatures use to signal they are not a pleasant target to attack may need to be turned around to suit the changes in the individuals that read the signal. A study of the way larvae of the Wood Tiger, a moth common in many parts of the world, adapt to circumstances shows that this is exactly the case.

Perhaps the best way to keep out of trouble is not to be seen. A great many of the world's creatures have evolved to merge with their surroundings and become difficult to spot. Some do it so that they can better attack and capture prey, a great many do it so that the predator cannot see them. The chameleon is one that is able to adapt its skin colour, but many have evolved to disappear in different ways. The Draco lizard does this very well! But there are times in the life of a creature when what is important is not to stay out of sight but specifically to be seen. During the mating season, insects adopt the most striking patterns and colours, both to be easily spotted as well as to advertise that they are ready to mingle. It has its down side, no doubt, but now the priority is different.

There is yet another way to stay out of harm, and that is to be positively unattractive — as a meal. Some creatures have evolved to taste horrid, others to smell foul, and yet others are actually poisonous, or have a painful sting, which it is not worth the predator's while to suffer. But it is not enough just to be avoidable; predators who are looking for food also need to know about it. Creatures thus use the opposite of camouflage — bright, striking colours — to *advertise* their detestable but protective trait. The advertisement is then their primary defence, the fact that is advertised is the secondary. Examples of this kind of defence are the Granular Poison frog, which announces its noxious taste by bright red, or the Flamboyant cuttlefish, whose colours tell predators that it packs a painful sting, or the skunk, which is left well alone because of the stink it can raise and lets no one make a mistake, by its white and black body colour.


The granular poison frog — bright colours warn predators of noxious taste.


The Flamboyant Cuttlefish warns predators of its toxic sting but becomes less visible while foraging, and (right) the Draco lizard merges with the background.

But predators do not naturally know about the message that the colours or other advertising gimmicks wish to pass. They stay away only after at least one unpleasant encounter from which they learn that for all its colours this tidbit is no tasty mouthful. Hence, behaviour because it exposes the animal; in fact, calls for attention, and promises safety — only provided that the predator knows that this species should be left alone. If there are many predators that are yet to receive the lesson, it may be better to stay out of sight. But staying camouflaged and hidden all the time has a cost and may be a disadvantage if the predator population already knows which insects to avoid — and there must be a condition when one strategy wins over the other.



The skunk is easily recognised from afar, and (right) *Parasemia plantaginis* or the Wood Tiger Moth.

Johanna Mappes, Katja Ojal and Leena Lindstrom of the University of Jyvaskyla, Finland, and Hanna Kokko of the Australian National University, Canberra, report in *Nature Communications* their study of 688 caterpillar species and their rates of survival during the season of growth of predator birds. They find that the strategy of advertising is safer at the beginning of the season, when newly hatched birds are still in the nest, or at the end of the season, when there are no fledglings, but staying hidden is the safer way when young birds have just taken to wing and make a dash for every brightly coloured caterpillar they see.

"The study was of three types of caterpillar: one that was completely black, which was the one that was effectively camouflaged, then a type with a small orange patch, which was moderately conspicuous, and the last type was one with a large orange patch, which was more conspicuous. These types were chosen to represent three degrees of warning signals and also to match the variations in the appearance of the Wood Tiger caterpillar. Largescale field trials were then conducted in central Finland, from May to August, which is the season that starts before and continues during and after the nesting period of perching birds.

"The study showed that early in the season and again late in the season, it was the warning colours that were more effective at promoting survival than the black colour camouflage. These are the periods when there are less newly arrived birds and the predators are all educated about staying away. But in the middle of the season, when newbies are out in numbers, advertising invited attack and it was camouflage that ensured the best survival. The survival rate of the completely black larvae increased and peaked, to exceed that of the coloured species, at the middle of the season. And this pattern matched the data on fledgling times of the birds that were the main predators. But the survival of coloured species rose again towards the end of the season, which corresponds to 'declining naiveté' of the predators."

Apart from relative survival rates at different times, the study also found a variation in the occurrence of larva colouring in all the species, according to the season. It was also found that colouring and signalling was a strategy with less than five per cent in all species, but incidence of colouring increased greatly during the season when predator birds were mostly "educated" adults, an instance of choosing advertising over concealment when conditions changed.

Even in normal times, it seems colouration cannot be a widely preferred strategy as there would always be a few uninitiated adults or a particularly hungry predator. The dynamics of how the use of one strategy or the other is chosen are also affected by another factor — the fake advertising by foreign species to piggyback on the protection that some bright colours confer. This is a behaviour used by many harmless insects and reptiles, to "pass off" as something dangerous, both for protection as well as for easy passage. When these instances grow in number, they are likely to be victims of accidental strikes — which would cause powerful unlearning of any lesson the predator had earlier received, or wrong learning by a novice predator. The protection conferred by colouring would then weaken and the fakes would get rapidly reduced in number, which would restore the value of colouring, and so on.

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CENTRIFUGAL PROPERTIES

TAPAN KUMAR MAITRA EXPLAINS THE FUNCTIONS OF LYSOSOMES

The concept of the lysosome originated from the development of cell fractionation techniques by which different sub-cellular components could be isolated. By 1949, a class of particles having centrifugal properties intermediate between those of mitochondria and microsomes was isolated by Christian de Duve and found to have a high content of acid phosphatase and other hydrolytic enzymes. On account of their enzymatic properties, in 1955 these particles were named lysosomes. At present we know of about 50 lysosomal hydrolases that are able to digest most biological substances.

Together with their main functions, lysosomes have been found in both animal and plant cells as well as in protozoa. One important property of lysosomes is their stability in the living cell. This is due to the fact that the enzymes are enclosed within a membrane and the whole process of digestion is carried out within the organelle. Most lysosomal enzymes act in an acidic medium, which is maintained by a proton pump that accumulates H^+ inside the lysosome.

The most remarkable physical characteristic of lysosomes is their polymorphism of size and internal structure. According to the current interpretation, this polymorphism is the result of the association of primary lysosomes with the different materials that are phagocytised (literally, "eaten") by the cell. At present, four types of lysosomes are recognised, of which the first is the primary lysosome; the other three may be grouped together as secondary lysosomes.

The primary lysosome or storage granule is a small body whose contained enzymes are synthesised by the ribosomes and accumulated in the endoplasmic reticulum. From there they penetrate into the Golgi region. The GERL region of the Golgi complex maturing face has been implicated in primary lysosome formation.

The heterophagosome or digestive vacuole results from the ingestion (by phagocytosis or pinocytosis) of foreign material by the cell. This body contains the engulfed material within a membrane, and the extent of the digestion that takes place depends on the amount and chemical nature of the material and the activity and specificity of the lysosomal enzymes.

Under ideal conditions, digestion leads to products of low molecular weight that pass through the lysosomal membrane and are incorporated into the cell to be reused in many metabolic pathways.

Residual bodies are formed if the digestion is incomplete. In some cells, such as the amoeba and other protozoa, these residual bodies are eliminated by defecation. In other cells they may remain for a long time and may have some role in the ageing process. (For example, the pigment inclusions found in nerve cells of old animals may be a result of this type of process.)

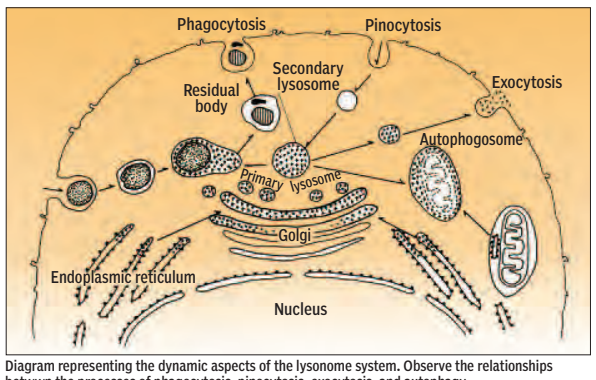

Diagram representing the dynamic aspects of the lysonome system. Observe the relationships betwwn the processes of phagocytosis, pinocytosis, exocytosis, and autophagy.

The autophagic vacuole, cytolysosome or autophagosome, is a special case, found in normal cells in which the lysosome contains and digests a part of the cell itself (eg, a mitochondrion or portions of the endoplasmic reticulum).

The intracellular secretion of primary lysosomes is coupled to another system of extra-cellular origin that is generated by endocytosis, the collective name for several phenomena related to the activity of the plasma membrane. Endocytosis includes the processes of phagocytosis, pinocytosis and micropinocytosis, by which solid or fluid materials are ingested in bulk by the cell. (Texocytosis is the reverse process, by which membrane-enclosed products such as zymogen granules are released at the plasma membrane.)

Phagocytosis (from the Greek *phagein*, to eat) occurs in a large number of protozoa and among certain cells of the metazoa. In protozoa, phagocytosis is closely linked to amoeboid motion. An amoeba ingests large particles, including micro-organisms, by surrounding them with pseudopodia to form a food vacuole within which digestion takes place. In metazoa, rather than serving for cell nutrition, phagocytosis is generally a means of defence, by which particles that are foreign to the organism (eg, bacteria, dust and various colloids) are disposed of.

In both protozoa and metazoa, the process of phagocytosis involves two distinct stages. First the particle adheres (is adsorbed) to the cell surface, and then it actually penetrates the cell. In some cases it has been possible to dissociate these two events; for example, at low temperatures bacteria may adhere to the surface of a leukocyte without being ingested.

Pinocytosis (from the Greek *pinein*, to drink) is a mechanism by which proteins and other soluble materials are incorporated into the cell. This can be demonstrated easily using proteins labelled with fluorescent dyes. The presence of the protein seems to act as a stimulus to pinocytosis and the uptake of protein is surprisingly high. Micropinocytosis is a related mechanism that can be observed only in the electron microscope.

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Focus on case studies

ANKITA MAKRI REPORTS ON URBAN SUSTAINABILITY RESEARCH WITH A LOCAL FLAVOUR

There's something incongruous about travelling for several hours by at least three modes of transport to attend a conference about sustainable cities in the middle of the countryside.

But the International Conference on Urban Regeneration and Sustainability, held recently near Siena, Italy, promised substantial presence from the developing world and a diverse programme covering sustainability from the technical to the political through the work of architects, scientists and engineers.

Irene Moreno Millan, coordinator of the event that was organised by the UK's Wessex Institute of Technology and the University of Siena, told me this wasn't atypical. There was funding for sustainability and environmental issues in the developing world these days, she said. Notably, several delegates from Malaysia and South Africa were linked to government — sometimes an elusive aim, even for larger meetings.

I found there a refreshing absence of grand narratives of mega cities and global urbanisation trends which are, understandably, the undercurrent of many discussions about cities and sustainability. Here there was a focus on case studies — and so a chance to discover gems of insight from local research.

On the first day, what jumped out was a link between solid waste management and child education. A small study by Vincent Nakin, of Walter Sisulu University, and colleagues, which included interviews with 30 people living around a waste dump in South Africa's OR Tambo district municipality in the Western Cape area, found that children often ran away from school to scavenge the site for raw materials that they could sell.

In another session, Malaysian civil engineer Muhd Fadhil Nuruddin talked about research into using microwave-incinerated rice husk ash to reduce the cement content — and so the carbon footprint — of concrete.

Several years worth of research went into this, he said, but commercialisation hinged on convincing an often conservative construction industry.

But perhaps the most provocative contribution came from a PhD student whose talk was tucked away at the very end of the second day. In an energetic presentation, Shilpi Singh said urban issues were a relatively recent academic interest in India — and went on to question whether planning as currently done in parts of the country was the way to create sustainable cities.

Singh, from the Jawaharlal Nehru University in New Delhi, focused on the example of gated communities in the city of Gurgaon, where she said a divide between the "old" underdeveloped settlements and a "new" area with high-security high-rises could be seen as the latest manifestation of social segregation. Such developments flouted existing planning laws, she explained — and as a result they restricted mobility, privatised public land and services, excluded people of a certain class and attracted informal, unpaid and underage employment.

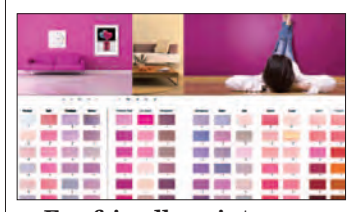
I asked Singh whether the lack of urban research that she pointed to early in her talk was part of the problem. Up until the late 1970s, she said, practically every development plan in the country focused on villages, then seen to embody Indian identity. So, looking back, one found very little literature to guide urban planning in an Indian context.

She told me that urban studies as a field had only started growing in the past decade or so. But what's mainly emerging was in the social-political and cultural side of things. An understanding of "planning as planning", in the more technical sense, was still to be worked on.

"You compensate by reading up on literature (from) across the world." But this was limited, she said. "India has its own specific identities. Caste plays a very dominant role — so you cannot pick up something that talks about class and race as main factors… and put it up in India where caste and religion become the main factors. The context becomes very different and you need to look at the (local) specificities."

SCI DEV.NET

PLUS POINTS



Eco-friendly paint

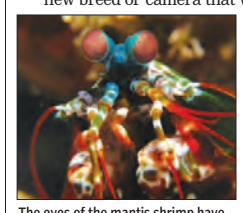
Using nanotechnology to chemically manipulate functional paints and coatings at the molecular level, I-CanNano has created paints that have a high resistance to impact/abrasion, are water-repellent, 99.99 per cent anti-fungal/bactericidal, 311 per cent elastomeric and offer high UV protection. "Today," says Dr Arup Chatterjee, former IITian and first generation entrepreneur, "it is the world of NT and not IT."

The products have been certified by the Paint Research Association as 99.99 per cent bacteria-free and called green (eco-friendly) paint. They are also low cost compared to any other paint available in the market. While any technological product always tends to cost more, I-Can Nano is affordable because of technology developed by the Innovation Centre for Applied Nanotechnology, a pioneer in the field of nanotechnology worldwide.

I-CanNano has joined hand with BCC Shipping and Shipbuilding in a big marine project and also in R&D and, apart from its manufacturing plant in Kolkata, it has also developed a big manufacturing facility in Chennai and is planning a unit in Maharastra shortly. Inspired by Abdul Kalam, ex-President of India and renowned scientist, I-CanNano has adopted his vision of "affordable nano technology for common man".

Shrimp's eye-view

The special compound eyes of the mantis shrimp are the blueprint of a new breed of camera that will detect cancers and visualise brain activity, according to scientists at the University of Queensland in Australia. Using miniscule polarisers instead of the usual colour filter arrays, these sophisticated digital cameras see the polarisation of light rather than the colour — and that means it will be able to see previously unseeable things such as cancer tissue.


The eyes of the mantis shrimp have inspired new cancer-detecting cameras.

This groundbreaking technology is inspired by the mantis shrimp which has eyes that "use light polarisation to detect and discriminate between objects". Professor Justin Marshall, who works at the University's Queensland Brain Institute, said that cancerous tissue reflected polarised light differently from healthy tissue. It was this difference that the mantis shrimp could identify. "Humans can't see this (light polarization), but a mantis shrimp could walk up to it and hit it," he said.

The project is a collaboration involving scientists in the USA and UK and has been funded by The Australian Research Council, US Air Force Office of Scientific Research and the Asian Office of Aerospace Research and Development.

Turmeric & the brain

Turmeric, a spice commonly used in curries, could help the brain heal itself, new research has suggested. A report in the journal *Stem Cell Research and Therapy* found a compound in the spice may hold the key to repairing the brains of people with neurodegenerative diseases such as Alzheimer's.

A team in Germany say aromatic turmerone promoted the proliferation of brain stem cells and their development into neurons during laboratory tests on rats. Rats were injected with the compound and scientists from the Institute of Neuroscience and Medicine in Julich scanned their brain. They

examined the effect of aromatic turmerone on endogenous Neutral Stem Cells found within adult brains – which go on to develop into neurons and play an important role in recovery from neurodegenerative diseases – and found that the turmeric compound boosted the proliferation of rat foetal NSCs by up to 80 per cent, and increased the speed at which they matured.

Dr Laura Phipps, from Alzheimer's Research UK, said, "This early-stage study highlights the effects of aromatic turmerone in rat brains, but the findings are a long way from determining whether this compound could help fight diseases like Alzheimer's.

HEATHER SAUL/THE INDEPENDENT