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Biomimicry- When Imitation is not just Flattery…

It's commonplace to mock people by comparing them to imitating monkeys or as the English equivalent puts it, " Monkey see, monkey do!" Interestingly, this tendency to mimic is a trait that has been hardwired into the human being over years of evolution and it may not be such a reviled thing after all. Given the vast array of complex processes that nature has been nonchalantly bringing about for so many epochs now, scientists have realized that the solutions to many human problems have always existed in nature. Finding these solutions forms the basis of the science called biomimicry or biomimetics. Janine Benyus, the scientist widely recognized for her work in the field of biomimicry describes it as the "technology of biology" where nature is both lodestone and touchstone i.e. solutions to problems are found in nature and are developed using natural processes as a benchmark. In spite of how overwhelming the idea may seem, these solutions are found in the most common things. Literally, a walk in the park!

Stunned by the iridescence of the blue-green wings of the Green Swallowtail butterfly, researchers studied the structure of the wing and found that the colours resulted from cleverly manipulated light rays. The butterfly's wings consist of tiny scales made of alternating layers of chitin and air. Interplay of light and colours is achieved by the absorption and refraction of different wavelengths of light by these layers thus creating varied hues, without pigments/dyes.

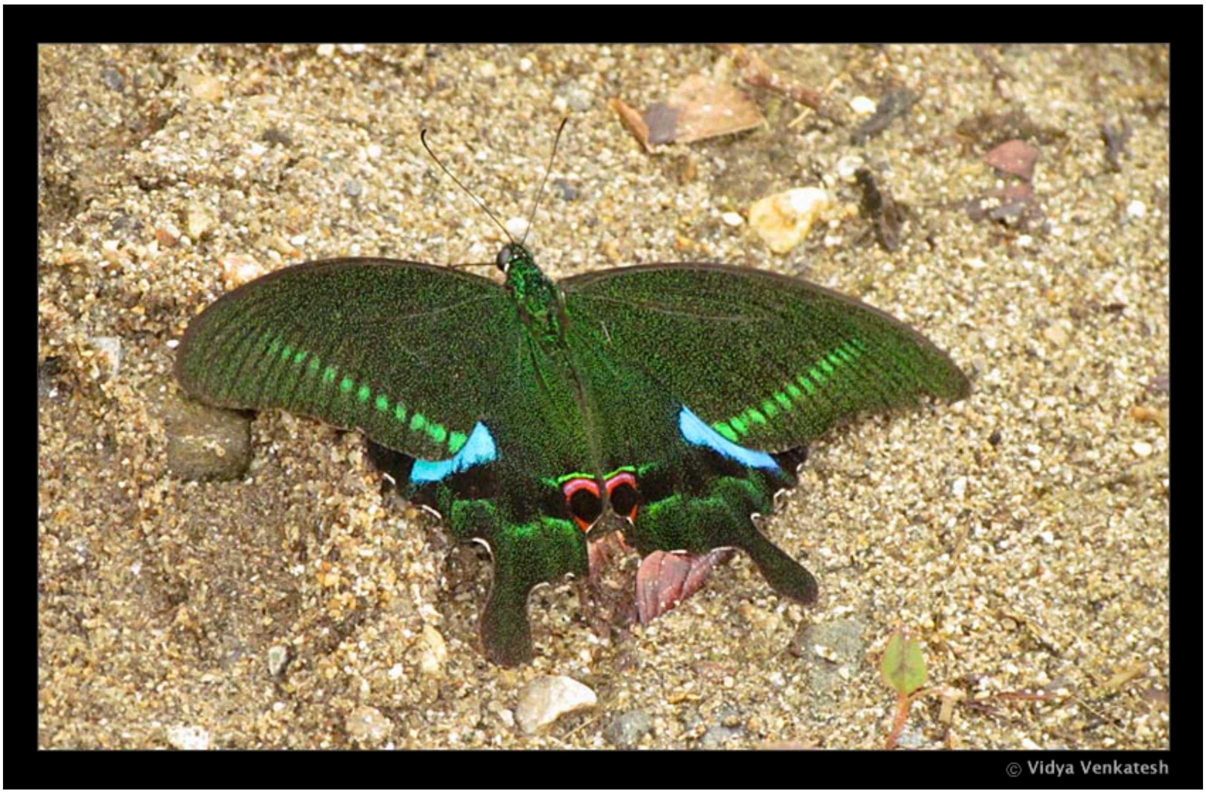

Image of a Paris Peacock, which is similar to the Indonesian Green Swallowtail

Moreover, it was found that the appearance of the colour changes when viewed through different instruments. This was thought to be a defence mechanism where the butterfly appears one colour to a potential mate and another to a predator. This property, called 'optical encryption', is believed to be of great value to detect and minimize forgeries; it can also be used in holograms.

From the butterfly, move on to the lotus. This sacred bloom is extolled as an example of purity arising from the impure. No old wives tale this-wherever the lotus grows, the surface of the plant remains unblemished, lacking the customary signs of one that has taken root in sludge.

Water doesn't adhere to the surface of the leaf

This proclivity for cleanliness lies in the texture of the leaf, which comprises tiny projections called papillae coated with a layer of epicuticular wax crystals, which repel dirt. Moreover, the ability of a surface to stay dry is directly proportional to its contact angle, which in the case of the lotus is very high.

The presence of papillae reduces the area to which water droplets can adhere. Consequently, the water molecules form spheres and roll off the surface of the leaf. The uneven exterior caused by the crystals also reduces the surface area upon which dirt can cling. Whatever little does manage to latch on to the leaf is whisked away by water droplets as they scurry down the leaves. It was thought that this little bit of technological genius could be applied to other surfaces and it worked! A German firm, created a paint, whose micro-surface emulated the lotus leaf through the addition of Teflon and other such components that would mimic the surface of the lotus leaf and keep it clean.

Our next teacher is one of the many harbringers of dusk across the countryside and forest, where he can often be heard proclaiming his songs to the world. Although cicadas are more often heard than seen, do try to look for the little fellow. His wings, like the lotus and butterfly, are inspiring scientists to create surfaces that will remain dirt and bacteria free, thus negating the need to use detergents or chemicals thus helping the environment. The wings of the cicada comprise tiny structures called 'nano protusions' or pillars. Much like the lotus leaf, air collects between these pillars and pushes away dirt and water, thus keeping its wings spick and span. These pillars have also shown low tolerance levels for bacteria that land on them. The bacterium gets impaled upon the pillars and consequently is stretched across the walls until it tears. Researchers are working on creating a similar structure that can pierce rigid cell membranes of bacteria. The idea is to create a surface that contains two coatings: the first will prevent germs from sticking to it, and the second, like the wings, will collect and kill the castaways. Scientists are hoping that the development of such a coating can be used as a disinfectant, especially in public places where chances of contracting infections are heightened.

From a creature of the evening, consider one that has come to define darkness- the owl. Silly superstitions aside, these sentinels of the night are renowned for their ability to glide on silent

wings which helped a Japanese engineer quieten the sound barrier-defying noise created by the world's fastest train. Japan's famed Shinkasen trains that run at an average speed of 350 km an hour also created deafening booms that could be heard half a kilometre away. This noise was created by two factors:
1.Vibrations of the pantographs i.e. the structure on the train-top that enables it to harness power from overhead wires.
2. Movement of the train in and out of tunnels.

Nakatsu learned his lessons from the owl. When a bird is in flight, air rushes over the surface of its wing, forming vortices (spiral columns of air) that cause turbulence, which produces a sound. Likewise, air that passed over the pantographs was the culprit behind the turbulence- causing vortices that created the deafening noise of the Shinkasen. However, fortunately for the owl (and Nakatsu), the edges of its downward pinions are divided into minute serrations that break down these vortices, as they pass through the feathers. These pantographs were then designed to mimic the shape and structure of an owl's wing, which effectively reduced the noise.

Now remained the question of hushing the train through tunnels. It was found that as the train rushed through tunnels, a column of air built up at its head. On exiting the tunnel, the train pushed this compressed air outside. The consequent changes in pressure created the much-deplored blaring sound. Once again, an avian would provide this answer.

Common Kingfisher

Upon watching a kingfisher hunt prey, Nakastu noticed that it simply surged from air to water, without the slightest splash. Like the train, it moves from a region of varying pressures and unlike the train, does it with grace, and more importantly, stealth. The secret lay in the streamlined beak, which helped it dive quietly. So Nakatsu and his team designed the nose of the train to resemble the beak of the kingfisher. This effectively reduced the noise as well as electricity used while increasing speed.

The next example-that of temperature control- came to us through the termite. Termites are known to build large mounds that can reach heights of few metres. Termite mounds are a favourite with snakes too, because of the constant temperature of their interiors. As scientists found, this was an example of architectural genius. Termites of the species Macrotermina, feed on a special fungus that must be maintained at a specific temperature, which the termite manages to maintain without the aid of expensive and polluting gadgets.

Along the centre and the sides of the termite mound are a series of channels and shafts. Air within the mound that gets heated by the activities of the termites, rises up and is replaced by cold air that comes in from shafts on the side. The channels and shafts are constantly plugged and re-dug to ensure that air is properly circulated and temperature is maintained. Architect Mick Pearce decided to borrow this idea to build the Eastgate Centre at Harare in Zimbabwe to minimize energy costs in a region that experienced extremes of temperature. The centre consists of two buildings separated by an open space, covered in glass. Warm air within the building is carried up through ports in the ceiling to exhaust openings and is dispelled outside. This warm air is replaced by cold air that flows in from the open space and is sucked in through fans in the first floor and is then routed through the building via ducts. The building maintains a constant temperature without the need for expensive and polluting temperature control systems. A lesson worth learning here, isn't there?

The science of biomimicry is not merely limited to this: while some people may use a natural form as inspiration, others might use a method. Still others may look at imitating the collective process so that everything that is created is returned to its source. No matter what the level of inspiration, biomimicry teaches us that functionality and efficiency needn't come at the expense of sustainability. This method of functioning is no utopian fantasy but as nature shows us, is an established and practical reality. Many environmental problems such as pollution, climate change and the like have their origin in the lack of human foresightedness. Our machines belch out carbon and our plastic litters sea-beds and yet, we continue to put the environment and its inhabitants in the line of fire at levels that are yet incomprehensible to us. However, by looking to nature, there may perhaps be a way to continue our fantastic foray into the future without cataclysmic consequences. No monkey business this, don't you think?

-Kavya Chimalgi
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