Biodiversity and Biomimetics: The role of life as a model in the 21st century

Biological variety is often associated with the discovery of new medicines and foods, but living organisms can serve as models for machines and materials, and as guides for engineering. In 1950's, the term *biomimetics*, was coined to refer to this field of study that uses designs from life. An early example**,** Velcro, was manufactured to be sticky like the seeds of the burdock plant. With contemporary research tools, biomimetic studies can produce extraordinarily sophisticated results. Over time nature has solved many problems and can be seen as a storehouse of research and development, waiting for our discovery. In February 2012, we can glimpse the exponential growth of this method:

Not all plants tolerate strong daylight, and their lack of mobility adds to their danger, driving species to create natural sunscreens. The energetic ultraviolet components of sunlight rip through DNA in plants as well as in people, causing tissue damage and sometimes death. Living things can salvage their DNA to some extent with special repair enzymes. Scientists at The Scripps Research Institute have identified the process by which special proteins in some plants sense excessive light and switch on the cell's defenses. These molecules have been studied previously, but their structure is now known to be new to science. The proteins split and activate when light hits them, and then turn on a set of genes that produce repair substances. Some of the oldest and most primitive plants on earth possess these mechanisms, developed in an era when earth lacked a protective ozone layer. **Plant UVR8 Photoreceptor Senses UV-B by Tryptophan-Mediated Disruption of Cross-Dimer Salt Bridges**. *Science*, February 2012.

No matter how skillful the predator, the prey develops equally clever defenses, some of which can be adapted to human advantage. Given the design of a piranha's tooth, it is surprising to find other fish sharing their Amazon habitat, but the arapaima fish is more than capable. A rare air breather, this living fossil fish defends itself with body armor. Its scales are overlapped and heavily mineralized on the outside. Underneath, multiple layers of fibrous collagen are built up in different directions. Because the fish must move and swim, the scales are hydrated, corrugated and flexible. Jacobs School of Engineering researchers found that in lab simulations, a piranha tooth will break on the fish scale, making it a model for materials useful in body armor, aviation and fuel cells. **Mechanical properties and the laminate structure of Arapaima gigas scales**. *Journal of the Mechanical Behavior of Biomedical Materials*.

Computer modeling of the motion of small living things can help reveal surprising locomotion tactics, such as those that are used by nematodes, parasites and other moving cells. One would assume that, faced with obstacles, parasitic cells, such as those that cause malaria, would move more slowly, navigating in a suspension such as the host's bloodstream. Nematodes, travelling through wet soil, are observed to test similar movements and are found to travel faster, by using the solid areas to loop around and propel themselves forward. **Experiments and theory of undulatory locomotion in a simple structured medium**. *Journal of the Royal Society Interface*, February 2012.

Even common organisms, such as the butterfly, have much more to tell us, when we study them with the latest high tech tools. Johns Hopkins engineers are studying butterflies with high speed cameras and 3D imaging to reveal the secrets of their maneuverability, eager to improve the design of micro aerial vehicles (MAV's). These little flying robots will continue to play a part in our world, being used in warfare, surveys and in search and rescue, saving lives and hopefully keeping the peace. Butterflies, whose wings may beat 25 times per second, were previously unobservable at this level. The remarkable insight is that they use body mass to change direction, much more effectively than was thought possible, given their light weight.

Life can enlighten physics as well as engineering. At Harvard researchers observed that the pointy scales (denticles) on sharks' skin improve the fish's forward motion by generating thrust, not just by streamlining and reducing drag. Laser studies of the fluid movements show surprising new patterns, suggesting further studies in fluid dynamics.