By Stefan Andrei, Science Editor

How to Copy Nature

Natural composites are better

Living organisms have amazing abilities. Toddlers fall and hit their head, older children fall from trees or bikes, sportsmen experience violent fractures, car drivers experience various accidents and we escape in most cases without much damage being done to our bodies. This mix of strength and resistance on relatively low weight is found everywhere in nature. Small trees take toots in cleavages in concrete and rock which they widen as they grow as vigorous trees. Trees can stand storms that break down electricity posts and destroy houses. Woodpeckers 'dig' holes in wood experiencing forces applied to their heads that would smash any normal brain. The skin of crocodiles and alligators makes bounce spears, arrows and even bullets. In the last decades, advanced technology allowed people investigate the secrets behind these traits, many hidden inside the cells. This also permitted us to copy and apply these patterns, in a science called biomimetics, for new materials and technologies that mark a new technological revolution in the human history. For example, for the same weight, a bone is harder than steel. This is due both to the bone's shape but the key element is on the inner bone, at molecular level. For example, the composites are solid materials achieved by combining two or more chemicals for achieving a new substance with superior qualities to the initial components. One example are the glass fibers, made of glass and plastic, a synthetic material employed for making boats, fishing canes, bows, arrows, and other sport items. They are achieved by combining extremely thin glass fibers in a plastic material for insertion, which can be liquid or gelatinous. When the plastic hardens, it results a light, hard and flexible composite. But the man-made composite are inferior to those found in nature. The human and animal composites employ instead of glass or carbon fibers a fibrous protein called collagen, that confers strength to skin, intestines, cartilages, tendons, bones, and teeth (except the composites from the enamel). Plant composites have at their base another fiber: cellulose. Collagen-based composites are amongst the most advanced known materials. For example, the tendons, which bind muscles to bones. Their strength is given not only by the collagen-based fibers, but also on the remarkable pattern through which the fibers are woven together. The forearm tendons resemble a bundle of twisted cables, similar to those used for suspended bridges. Each cable is on turn, another bundle of thinner twisted cables. And this one a bundle of twisted molecules ...Even if man-made composites are inferior to natural ones, graphite and carbon based composites allowed the development of new components for planes and spacecrafts, sport items, cars, yachts and light prosthetic materials...Whale bubbler is another amazing natural material: a floating mechanism, an excellent isolating material in the cold seas inhabited by whales, and the best food reserves for the long migrations (the same fat amounts produces 2-3 times more energy than sugar and proteins). But the bubbler is also extremely elastic, similar to rubber. The acceleration achieved by the elastic return of the bubbler, which is compressed and stretched with every fluke beat, can save 20 % of the energy consumed during the period of continuous swimming. These properties were explained relatively recently by the fact that half of the bubbler's volume is represented by a complex collagen web, which wraps any cetacean. A natural composite "hunted" for long by the scientists is the spider's silk. It is five times stronger than the steel and extremely elastic, stretching by 30 % more than the nylon. Still, it does not vibrate like an elastic web for circus jumps because otherwise it would throw away spider's food. It was calculated that a fishing web made of spider silk would stop a passenger plane. There are spider species that can produce even 7 types of silks! Imagine what we could do if this silk could be industrially made: better security belts, sutures, artificial ligaments, light fibers and cables, and so on. And all this, non-toxic! (no need to mention that many plastic can induce cancer, fertility problems, and other health issues). Studying a fossil fly preserved in amber, scientists saw that the insect's eyes were crossed by some networks which they believed helped the fly capture more light, especially when the light fell under high incidental angles. Subsequent experiments confirmed this. This could be applied of the glass of the solar panels, which could generate more energy, and would eliminate the need for tracking systems, which are expensive and head the panels continuously towards the sun. Nature is also far ahead at the chapter gear box. The fly has a gear box that does connect the body (engine) to, in this case, wings. The fly has a gear shift working in three speed levels, allowing the

insect to change speed during the flight. The gear shift represents in fact a second pair of wings, turned minute, and controlling the movement of the fore wings. Squid, octopus and jellyfish have a propulsion jet that allow them to speed up in the water. But these "jet engines" have properties that people could not copy: they are soft, do not break, resist to deep depths, and work effectively and noiseless, allowing a squid chased by a predatory fish to reach speeds of 32 km (20 mi) per hour, and even jump a few meters out of the water. Have you ever wondered about the history of Velcro? Their inspiration came from the little hooks of the thistles, and required the Swiss engineer George de Mestral 8 years of research starting with 1957 to develop it. Many other amazing traits found in nature are still a puzzle that once solved could revolutionize our lives: the light cold emitted by fireflies and some algae; how can arctic fish and frogs become active again after freezing during the winter; how can seals and whales stand so much without breathing and dive repeated times to impressive depths without experiencing the decompression disease; how can cuttlefish and chameleons change colors and hummingbirds cross the Gulf of Mexico with just 3 grams of fuel?