

The way light is extracted from the butterfly's system is more than an analogy - it's all but identical in design to the LED

When scientists developed an efficient device for emitting light, they hadn't realized butterflies have been using the same method for 30 million years.

Fluorescent patches on the wings of African swallowtail butterflies work in a very similar way to high emission light emitting diodes (LEDs). These high emission LEDs are an efficient variation on the diodes used in electronic equipment and displays.

In 2001, Alexei Erchak and colleagues at the Massachusetts Institute of Technology (MIT) demonstrated a method for building a more efficient LED. Most light emitted from standard LEDs cannot escape, resulting in what scientists call a low extraction efficiency of light.

Ingenious design - The LED developed at MIT used a two-dimensional (2D) photonic crystal - a triangular lattice of holes etched into the LED's upper cladding layer - to enhance the extraction of light. Furthermore, layered structures called Bragg reflectors were used to control the emission direction. These high emission devices potentially offer a huge step up in performance over standard types.

Peter Vukusic and Ian Hooper at Exeter have now shown that swallowtail butterflies evolved an identical method for signaling to each other in the wild. Swallowtails belonging to the *Princeps nireus* species live in eastern and central Africa. They have dark wings with bright blue or blue-green patches. The wing scales on these swallowtails act as 2D photonic crystals, infused with pigment and structured in such a way that they produce intense fluorescence. Pigment on the butterflies' wings absorbs ultra-violet light which is then re-emitted, using fluorescence, as brilliant blue-green light.

Performance-enhancing bugs - Most of this light would be lost were it not for the pigment being located in a region of the wing which has evenly spaced micro-holes through it. This slab of hollow air cylinders in the wing scales is essentially mother nature's version of a 2D photonic crystal. Like its counterpart in a high emission LED, it prevents the fluorescent colour from being trapped inside the structure and from being emitted sideways.

The scales also have a type of mirror underneath them to upwardly reflect all the fluorescent light that gets emitted down towards it. Again, this is very similar to the Bragg reflectors in high emission LEDs. "Unlike the diodes, the butterfly's system clearly doesn't have semiconductor in it and it doesn't produce its own radiative energy," Dr Vukusic told the BBC News website "That makes it doubly efficient in a way". "But the way light is extracted from the butterfly's system is more than an analogy - it's all but identical in design to the LED."

Dr Vukusic agreed that studying natural designs such as this could help scientists improve upon manmade devices. "When you study these things and get a feel for the photonic architecture available, you really start to appreciate the elegance with which nature put some of these things together", he said.

Meet your new evolutionary cousin, the sea urchin

By analyzing the newly sequenced genome of the spineless creature, an international team of scientists found just how much we have in common with them.

The research could lead to new drugs for human ills. “The sea urchin is surprisingly similar to humans,” said co-director of the sea urchin sequencing project George Weinstock, of Baylor College of Medicine. “Sea urchins don't look any more like humans than fruit flies, but about 70 percent of sea urchin genes have a human counterpart whereas only about 40 percent of fruit fly genes do.”

In a special report detailed in the Nov. 9 issue of the journal *Science*, research teams describe the genome of the purple sea urchin, revealing not only human-urchin similarities but also features such as the urchin's immune system, which far surpasses that of humans.

Spineless relatives. A sea urchin's pincushion look comes from a round inner shell, which is covered with spikes for spearing food and tiny tube feet used for creeping along the seafloor. They belong to the phylum Echinodermata, which includes starfish and sea cucumbers, whereas humans belong to the phylum Chordata, or all animals with backbones. Both the echinoderms and chordates belong to a larger group called the deuterostomes.

This relationship means sea urchins can serve as a model for understanding how the group of animals that includes humans split off and evolved different traits. For the genome project, scientists collected DNA from the sperm of a male California purple sea urchin, a species found along the west coast of the United States from Baja to Alaska.

After identifying 23,300 genes made from 814 million letters of DNA code taken from the California purple urchin (*Strongylocentrotus purpuratus*), the team of scientists found that 7,077 of them were also found in humans.

Long-lived - Analysis of the sea urchin genome—the first-ever chordate to be sequenced—revealed a surprisingly unique and complex immune system, which could explain their lengthy life spans of up to 100 years. “They live as long as we do, maybe longer, and thus must protect themselves,” Weinstock told LiveScience. “So an elaborate set of defense genes would be necessary. What was absolutely unexpected was the finding that they had expanded the innate immunity branch of the immune system.”

Whereas humans have an acquired immune system, in which our body must learn how to attach and destroy invaders once they enter the body, sea urchins are hard wired to detect foreign bacteria and viruses and begin an attack. This rich toolbox of sea urchin genes could lead to new drugs for combating infectious diseases. In fact, sea urchins carry genes associated with many human diseases, including muscular dystrophy and Huntington's disease.

Urchin senses - The sequence also helped scientists uncover complexities belied by the urchin's simple exterior. Sea urchins lack eyes and ears, but they sport genes associated with taste and smell, hearing and balance, the study found. “Nobody would've predicted that sea urchins have such a robust gene set for visual perception,” said Gary Wessel, a member of the Sea Urchin Genome Sequencing Consortium, of Brown University.

Some of the visual sensory proteins are clustered on an appendage known as the tube foot and is thought to aid processing of sensory information. “It is remarkable that the same sensory proteins are used in organs with such different structures in sea urchins and man,” Weinstock said.

It's not clear, however, how the spindly creatures use the vision proteins. “There is not a lot of light at the bottom of the ocean so it is not clear what they might be ‘seeing’,” Weinstock said. “This is certainly an area that will be studied intensively as a result of the genome project.”

Manatees may be smarter than we think

Back in 1902, a scientist examining the smooth, grapefruit-size brain of a manatee remarked that the organ's unwrinkled surface resembled that of the brain of an idiot.

Ever since then, manatees have generally been considered incapable of doing anything more complicated than chewing sea grass.

But Hugh, a manatee in a tank at a Florida marine laboratory, doesn't seem like a dimwit. When a buzzer sounds, the speed bump-shaped mammal slowly flips his 1,300 pounds and aims a whiskered snout toward one of eight loudspeakers lowered into the water. Nosing the correct speaker earns him treats.

Hugh is no manatee prodigy. Such sensory experiments, along with other recent studies, are revealing that sea cows aren't so stupid after all. Researchers contend that if the plant-eating beasts seem slow-witted, it is because they faced no threats to their survival before the advent of boat propellers.

“They're not under any selection pressure to evolve the rapid-type behavior we've associated with hawks, a predator, or antelopes, a prey. They look like very contented animals that don't have very much to do all day,” said Roger Reep, a neuroscientist at the University of Florida's College of Veterinary Medicine.

The experiments under way at the independent Mote Marine Laboratory, could help scientists protect Florida's manatees, an endangered species, from propellers and other dangers. At least 75 manatees have been killed this year in collisions with watercraft, according to the Florida Fish and Wildlife Conservation Commission.

Despite recent findings that suggest the animals hear well enough to avoid boats, researchers are not sure why manatees keep getting hit. They could be surfacing to breathe while sleeping, or they may have grown too accustomed to the sound of boats. At the Mote laboratory, the buzzer experiments are hearing tests in which the tones gradually grow shorter and softer. The researchers want to know: At what distance could Hugh hear a boat's propeller churning in the water? Could Hugh determine where the sound is coming from?

Scientists have long assumed brains with many folds — such as those belonging to dolphins and humans — are a sign of intelligence. But Reep argues the cause behind those brain folds is unknown, and smooth-brained manatees don't seem to be missing anything important.

“The brain looks just as complex internally as any other mammalian brain,” said Reep, co-author with Bob Bonde, a Florida biologist with the U.S. Geological Survey, of a book on manatee physiology. Hugh and his half-brother Buffett, both born in captivity, have spent many days since 1998 showing researchers what they can learn. The manatees have been trained to respond to whistles and stop at underwater targets. Scientists want to determine how well manatees distinguish colors and objects, and how sensitive their hearing and sense of touch are. Hugh and Buffett are rewarded with handfuls of sliced apples, carrots and beets for correct test responses. The manatees pull the food into their mouths with lips dexterous enough to untie knots.

In the vision tests, Buffett and Hugh do not see particularly well out of their tiny eyes, though it appears they do see color, an unusual trait for marine mammals. But even by manatee standards, Hugh seems to be visually impaired.

In manatee brains, the regions that process sight are quite small compared to auditory and tactile regions, according to Reep and Bonde. Researchers have discovered that manatee muzzles and bodies are covered with sensitive hairs that may help them detect underwater objects and current changes.

New human gene map shows unexpected differences By Patricia Reaney

LONDON (Reuters, 2007) One person's DNA code can be as much as 10 percent different from another's, researchers said on Wednesday in a finding that questions the idea that everyone on Earth is 99.9 percent identical genetically.

They said their new version of the human genetic map, or "book of life," fills in many missing pages and chapters to explain how genes are involved in common diseases. "This important work will help identify genetic causes of many diseases," Dr. Mark Walport, director of Britain's Wellcome Trust, said in a statement.

Instead of showing single variations in human DNA that make people unique, the map looks at differences in duplications and deletions of large DNA segments known as copy number variants or CNVs, which can help explain why some people are susceptible to illnesses such as AIDS and others are not. "We're a patchwork of DNA sequences, gains and losses," Dr. Charles Lee of the Brigham and Women's Hospital and Harvard Medical School in Boston, Massachusetts told a news conference.

Scientists from more than a dozen centers around the world identified about 3,000 genes with variations in the number of copies of specific DNA segments. The changes can affect gene activity, including susceptibility to diseases.

The Human Genome Project mapped the billions of letters that make up the human genetic code. Scientists later refined the map by looking for single variations called SNPs or single nucleotide polymorphisms. The CNV map gives researchers a different way to look for genes linked to diseases by identifying gains, losses and alterations in the genome.

"We estimate this to be at least 12 percent of the genome, similar in extent to SNPs. This has never been shown before," said Dr. Matthew Hurles of Britain's Wellcome Trust Sanger Institute. He said that resistance to infection by HIV, the virus that causes AIDS, is determined in part by multiple copies of the gene CCL3L1, which cannot be seen on an SNP map.

NEW TOOLS - The scientists, whose findings are reported in the journals *Nature*, *Nature Genetics* and *Genome Research*, compiled the CNV map by comparing DNA from 270 healthy people in China, Japan, Nigeria and the United States.

The consortium identified 1,447 different CNVs that covered about 12 percent of the human genome. About 285 of them are associated with diseases, including schizophrenia, psoriasis, coronary heart disease and congenital cataracts. "With these new tools, we and our clinical colleagues are able to find previously undetectable deletions or duplications of the genome in a patient. The CNV map now allows us to identify which of these changes are unique to the disease," said Dr. Nigel Carter, of the Wellcome Trust Sanger Institute.

Genes important to the immune system and to brain development and activity tend to have many CNVs, the researchers said. These are functions that have evolved rapidly in humans. "I believe this paper will change forever the field of human genetics," said James Lupski, vice chair of the Department of Molecular and Human Genetics at the Baylor College of Medicine in Houston, Texas. "One can no longer consider human traits as resulting primarily from single base-pair changes or influenced only by SNPs."

The scientists set up an Internet database to encourage researchers around the world to share information on patients with CNV details.

Neanderthals may have given the modern humans who replaced them a priceless gift -- a gene that helped them develop superior brains, U.S. researchers reported on Tuesday.

And the only way they could have provided that gift would have been by interbreeding, the team at the Howard Hughes Medical Institute and the University of Chicago said. Their study, published in the Proceedings of the National Academy of Sciences, provides indirect evidence that modern Homo sapiens and so-called Neanderthals interbred at some point when they lived side by side in Europe.

“Finding evidence of mixing is not all that surprising. But our study demonstrates the possibility that interbreeding contributed advantageous variants into the human gene pool that subsequently spread,” said Bruce Lahn, a Howard Hughes Medical Institute researcher at the University of Chicago who led the study.

Scientists have been debating whether Neanderthals, who died out about 35,000 years ago, ever bred with modern Homo sapiens. Neanderthals are considered more primitive, with robust bones but smaller intellects than modern humans.

Lahn's team found a brain gene that appears to have entered the human lineage about 1.1 million years ago, and that has a modern form, or allele, that appeared about 37,000 years ago -- right before Neanderthals became extinct. “The gene microcephalin (MCPH1) regulates brain size during development and has experienced positive selection in the lineage leading to Homo sapiens,” the researchers wrote.

Positive selection means the gene conferred some sort of advantage, so that people who had it were more likely to have descendants than people who did not. Lahn's team estimated that 70 percent of all living humans have this type D variant of the gene. “By no means do these findings constitute definitive proof that a Neanderthal was the source of the original copy of the D allele. However, our evidence shows that it is one of the best candidates,” Lahn said.

The researchers reached their conclusions by doing a statistical analysis of the DNA sequence of microcephalin, which is known to play a role in regulating brain size in humans. Mutations in the human gene cause development of a much smaller brain, a condition called microcephaly. By tracking smaller, more regular mutations, the researchers could look at DNA'S “genetic clock” and date the original genetic variant to 37,000 years ago.

They noted that this D allele is very common in Europe, where Neanderthals lived, and rarer in Africa, where they did not. Lahn said it is not yet clear what advantage the D allele gives the human brain. “The D alleles may not even change brain size; they may only make the brain a bit more efficient if it indeed affects brain function,” Lahn said. Now his team is looking for evidence of Neanderthal origin for other human genes.