

## Biochemists study how animals switch the colour of emitted light

Martin Marek has been awarded an EXPRO grant from the Czech Grant Agency to investigate the transfer of bioluminescent energy in marine organisms.

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Not only terrestrial but marine organisms can produce and emit light. So-called bioluminescence helps them, for example, to communicate or attract food. [Martin Marek](#) from the [Loschmidt laboratories](#) of RECETOX at the Faculty of Science has studied this phenomenon in selected marine organisms for several years.

His research has the potential to inspire technological and industrial solutions and the design of environmentally friendly light sources with zero electricity consumption. The practical aspects of the project have been supported in recent years by a Proof-of-concept grant from the Masaryk University [Centre for Technology Transfer](#).

The enzymes responsible for bioluminescence are luciferases, which convert a substrate called luciferin into light in organisms. In recent years, Marek and his colleagues have succeeded in well characterising the molecular basis of the luciferase reaction in two marine invertebrates – the deep-sea shrimp *Oplophorus gracilirostris* and the marine organism *Renilla reniformis*.

### How organisms change the colour of light

"In the new project, we would like to focus on another phenomenon, the so-called resonant transfer of bioluminescent energy. This allows some organisms to change the colour of the light they emit in response to their environment. With the help of luciferase, these organisms chemically transform the substrate to produce a photon of visible light. However, the energy of this photon is used to excite a fluorescent acceptor protein, which then emits light of a longer wavelength than that received. Instead of blue, the organism thus glows green or yellow; for example," the biochemist described the phenomenon.

Scientists want to understand how bioluminescent and fluorescent proteins physically interact with each other during energy transfer and what their distance and orientation are. This is important for understanding the principle of non-radiative energy transfer, where proteins transfer energy through highly efficient dipole-dipole interactions. "The simple idea is that luciferase creates a photon, but in the process, the photon is so-called virtual. Before it gains any physical significance, it disappears because it transfers the energy to another protein, and only then does it emit light at a different wavelength," Marek said.

Moreover, he and his colleagues have already discovered that it is not just a simple matter of transferring energy and changing the colour of the emitted light. "Originally, scientists thought that fluorescent proteins were just passive energy harvesters, but we now know that they actively interact with luciferase and greatly enhance its catalytic abilities, the efficiency of the whole bioluminescence process."

Experts from the Loschmidt laboratories, therefore, want to analyse the structure of these macromolecular complexes, which combine bioluminescent and fluorescent proteins and want to visualise the entire energy transfer process. The findings will serve as a basis for designing genetically encodable, colour-tunable and energy-efficient bioluminescent tools for use in biotechnology and biomedicine, for example, in the diagnosis of certain diseases.

### **Produced enzymes**

Although Marek studies these processes in marine animals, he does not work directly with them. He uses the genes that code for the enzymes in the organisms he studies. The scientists then synthesise these in the laboratory and use structural biological and biochemical methods to create naturally occurring complexes of these enzymes, which they then analyse. "Once we understand the inter-relationships of the molecules in the complex, we can start to modify and try to improve these systems to look for applications in other areas," the scientist added.

He added that all organisms do not form complexes of molecules that link bioluminescence to fluorescence; for example, the deep-sea shrimp does not have them and thus emits only blue light. However, thanks to cooperation with other scientists, researchers in Brno have already identified other organisms to study this phenomenon.