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Editorial
The Journal of Experimental Biology Outstanding Paper Prize, 2006

The Editors of *The Journal of Experimental Biology* are delighted to announce the winner of the 2006 Outstanding Paper Prize. The prize was set up to inspire young scientists embarking on their scientific careers and is awarded to the first author of the year's most outstanding paper, as judged by the journal's eight Editors. This year's winner of the £500 prize is Marilou Sison-Mangus, from Adriana Briscoe's research group at the University of California, Irvine. Together with colleagues Gary Bernard and Jochen Lampel, Briscoe and Sison-Mangus encountered one surprise after another in their research into opsin gene duplication in butterfly eyes, in their paper entitled 'Beauty in the eye of the beholder: the two blue opsins of lycaenid butterflies and the opsin gene-driven evolution of sexually dimorphic eyes' (Sison-Mangus et al., 2006).

Sison-Mangus is delighted with her award, which has not only inspired her but also everyone in the lab. 'It has totally boosted my confidence in doing research' she says. Originally from the Philippines, Sison-Mangus studied marine science at the University of the Philippines, focussing on giant clam conservation, studying protein differences in the symbiotic algae that the clams depend on for food. She extended this study for her master's degree, researching how the algae respond to environmental disturbances. Already a keen environmentalist and physiologist, she wanted to learn more about molecular biology techniques. A move to the United States in 2002 with her husband provided her with the opportunity to learn those skills, and she joined Briscoe's lab as a technician in 2003. She enrolled for a PhD in 2004, working with Briscoe and her collaborators on the genetics of butterfly photopigments.

As a graduate student, Briscoe was inspired by Bernard's work on lycaenid butterflies and explains: 'I owe him an enormous debt of gratitude'. She wanted her laboratory to look further into the duplication of photopigment, or opsin, genes in butterfly eyes, as Bernard's work suggested that the lycaenid butterfly *Lycaena rubidus* had four photopigments in its eyes and not the usual three found in most other butterflies. This suggested that there were two copies of one of the opsin genes. On her arrival in Briscoe's lab, Sison-Mangus set to work cloning butterfly opsin genes, and found a duplication. But, says Briscoe, 'It was not what we were expecting'. She explains that out of the three pigments in butterfly eyes – ultraviolet sensitive, long-wave sensitive and blue sensitive – duplications are usually found in the genes for long-wave sensitive opsins. This duplication was in a blue opsin gene. Sison-Mangus recalls the excitement of finding this unexpected result, and recalls that this inspired the team to investigate further.

'First we wanted to determine how the genes were expressed in the animals' eyes' says Sison-Mangus. Bernard had already shown that male and female butterflies had different photopigment distributions in their eyes, and mapped the location of the pigments to find out where the duplicated blue opsin was being expressed. He found a blue opsin, tuned to a wavelength of 437 nm, in the dorsal region of both male and female eyes. He also found the duplicate blue opsin, tuned to 500 nm wavelength. This opsin was unusual in that its sensitivity was closer to a long-wave sensitive pigment (typically 530 nm) than to a blue sensitive pigment (typically 440 nm), explains Briscoe.

The next task was to pinpoint the duplicate opsin's position in the eye. The team already knew that an area of the retina called the dorsal rim has a unique anatomical organisation compared to the rest of the retina in other species of butterflies. It was possible that the unexpected photopigment distribution in the dorsal eye was caused by an expansion of this area in

Lycaena rubidus, Briscoe explains. Using transmission electron microscopy, Jochen Lampel scrutinised the anatomy of *L. rubidus*' eyes and found that the dorsal rim area had not expanded and was not responsible for the photopigment distributions the team saw.

Next, Sison-Mangus used RNA probes to find out exactly where the opsin genes were being expressed. She spent long hours looking at microscope pictures of tissue sections, each containing hundreds of cells, and pointing out which cells were lit up with specific probes. She admits that this was quite labour intensive, but the long hours paid off. Sison-Mangus found a unique pattern of gene expression in the male eye, which had never been seen before. The female butterflies also had a surprise in store; she found a receptor cell which expresses both blue and long-wave opsin. 'This breaks the 'one-photoreceptor, one-cell' rule', she says, 'I think it's amazing that they have developed these eyes'. Briscoe suspects that these butterflies have highly sensitive colour vision, which could have led to them evolving their colourful wings.

In the short term, Sison-Mangus is working towards finishing her PhD, and suspects that once she has finished in three years time she'll be doing a post doc. Currently, she is busy looking at the behavioural implications of the gene duplication; 'I really love this field, and would love to do a good job in vision work' she says. She is also still interested in marine biology and conservation, and thinks that she might return to that field one day, exploring the benefits that genetic studies have on the conservation of endangered species. She hopes that researchers will be able use the team's work to help with the conservation of the endangered lycaenid butterflies that she has been working with for the past three years, and which have thrown up so many surprises.

Sison-Mangus, M. P., Bernard, G. D., Lampel, J. and Briscoe, A. D. (2006). Beauty in the eye of the beholder: the two blue opsins of lycaenid butterflies and the opsin gene-driven evolution of sexually dimorphic eyes. *J. Exp. Biol.* **209**, 3079-3090.

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