

OBITUARY

Michael Francis Land FRS, 1942–2020

Dan-E. Nilsson

Michael Francis Land – known to his colleagues and friends as Mike – was born in Dartmouth, UK, on 12 April 1942 and died from respiratory disease in Sussex on 14 December 2020. For more than 50 years, he remained one of the most influential vision scientists. His field of study was extremely broad, covering the eyes and visually guided behaviour of an exceptionally wide range of creatures from all corners of the animal kingdom. He pioneered many fields, contributed to the birth of visual ecology and wrote several celebrated textbooks. He was elected a fellow of the Royal Society in 1982. For many years, he was a JEB Editorial Board member, a frequent reviewer, and he published numerous papers in JEB.

Mike's father was a professor of mathematics at Hull University, renowned for popularizing mathematical formalism such that anyone could understand it. Mike inherited this gift and turned it into an art form. Better than anyone, he could make conceptually difficult visual physics appear almost self-evident, and he continued throughout his long career to make biologists understand and appreciate the physical foundations of vision.

He graduated in Zoology at the University of Cambridge in 1963 and went on to do a PhD at University College London, resulting in the discovery of unique mirror optics in the eyes of scallops. Much later, he returned to mirror optics and found other and different versions in the eyes of deep-sea crustaceans. More remarkably, he independently discovered the amazing mirror optics in compound eyes of prawns and crayfish in 1980. This was a conceptually new type of imaging, which explained why these crustaceans have compound eyes with square facets. Mike was unaware that a German scientist, Klaus Vogt, had made the same discovery. When Mike published his discovery in *Nature*, he found out that he was scooped by only a few months. So typical of Mike's personality, he graciously gave all the credit for the discovery to his competitor.

After completing his PhD in 1968, Mike took up an assistant professorship at the University of California, Berkeley, where he made amazingly elegant studies of vision in jumping spiders, and forever changed our understanding of invertebrate vision. One of his many discoveries was the mobile retina found in each of the main eyes of jumping spiders, which he studied through a cleverly built ophthalmoscope. He found that these animals are able to change their gaze to inspect interesting objects. From the anatomy and optics, he also predicted that jumping spiders have colour vision, which was confirmed much later.

After Berkeley, Mike returned to the UK in 1971 to help John Maynard Smith establish neurobiology at the University of Sussex. Starting as a Lecturer in Neurobiology, he was promoted to Reader in 1977 and Professor in 1984. During the 1970s and the 1980s,



Mike Land contemplating discoveries after a long day on board the British Research vessel RRS Discovery, 1987, in the Atlantic outside West Africa.

there was a burst of papers attempting to establish physical theories for visual performance limits. Mike did not contribute to this burst, but apparently thought carefully about it in the light of his work on the eyes of scallops and jumping spiders. The results of his thoughts appeared in a massive chapter in *The Handbook of Sensory Physiology* in 1980. Although the theories published previously on visual performance limits were not wrong, Mike presented a complete theory that was much simpler and far more elegant, making his 1981 chapter one of the most influential papers of all time in vision science. This paper still forms the very bedrock of vision science that supports all work on visual performance.

Mike's talent for seeing the simple foundations of biological phenomena is evident also in his work on how flies pursue moving targets in flight. Together with Tom Collett, he worked out how flies adjust their flight when tracking moving targets. Later, when comparing tracking manoeuvres of flies with eye movements in animals and humans, he realised that they had revealed very general principles of how animals track moving targets. This realisation triggered Mike to construct an innovative device for investigating human eye movements. This device was worn by subjects and could track their point of gaze on a video as they performed various activities such as driving a car, playing a piano or making a cup of tea. In 2009, all this pioneering work on eye movement resulted in a celebrated book, 'Looking and Acting', co-authored with his former student Ben Tatler.

I met Mike in person for the first time in Canberra, Australia, in 1983 when I came there as a postdoc to the Department of Neurobiology at the Australian National University. In those days, Canberra was an international melting pot for vision research. Mike was there as a senior visiting professor and it only took a few weeks before we had found common ground and started a collaboration on the optics of butterfly eyes. The team also included a young student, Joe Howard, who knew how to deal theoretically with the wave-optics phenomena we found. Joe and I quickly learned from Mike how to make progress by continuously updating a conceptual

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Mike giving one of his unforgettable lectures (Bäckaskog Castle, Sweden 2004).

model. Together, it took us less than a month to unravel the unexpected new principle of afocal apposition optics, which makes butterfly eyes unique.

Mike continued throughout his career to reveal interesting cases of vision from many corners of the animal kingdom, often integrating the findings into a larger perspective of general principles. Together with Tom Cronin and Mike's student, Justin Marshall, he initiated the flourishing field of study on the spectacular visual system of the mantis shrimp.

Much of Mike's many research directions in vision science are covered in his autobiography, 'Eyes to See', which I can enthusiastically recommend – it is a great read.

Over the almost 40 years I have known Mike, we have collaborated on numerous projects, one of which was the book 'Animal Eyes', which was in its second edition. We had planned for a third edition, but Mike's deteriorating health put a stop to it. In December 2020, he passed away from complications of respiratory disease. A scientific giant has left us, but many future generations of scholars will be familiar with his name.

Apart from science, Mike is remembered for a multitude of other talents. He had a strong interest in rare plants and gardening, he played several ancient woodwind instruments and was an accomplished choir singer. Friends and colleagues remember his entertaining and kind personality, his humour and his wit. He is survived by his wife Rosemary, and children Adam and Kate and their families.

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