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OBITUARY

Heinrich Reichert (1949-2019)

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Heinrich Reichert, Professor Emeritus at the University of Basel, Switzerland, passed away on the 13th of June 2019 after a prolonged illness. Heinrich described himself as 'a hedonist when it came to science' because he said it gave him great pleasure. It was this quality that made working with Heinrich thrilling and deeply fulfilling. Heinrich's long and versatile career spanned the breadth of neuroscience – from development, to evolution and behaviour. In his passing we have lost not just an astute scientist, but also an impassioned educator and an adventurer of science.

Heinrich in Veerapura, Karnataka, India in 2014.

Heinrich grew up in Southern California, to where his parents had moved from Austria. He did his schooling there, but moved back to Europe to study Physics, Biology and Chemistry at the University of Karlsruhe, before doing his Masters at the neighbouring University of Freiburg. These were stimulating years for Heinrich. Inspired by Seymour Benzer's work on genes and behaviour, he and colleagues established a behavioural paradigm for aversive learning in the fruit fly *Drosophila* – versions of this assay are standard in many laboratories today (Spatz et al., 1974). He continued on at Freiburg for his PhD in this productive period and collaborated extensively to combine electrophysiological recordings, genetics and behavioural approaches to understand the sensitivities of the photoreceptor neurons in *Drosophila*. These were also some of the rare years in recent history when it was possible to travel relatively easily from Europe to India by road. So, throwing life and science in a heady mix, Heinrich took a backpacking holiday from southwestern Germany, through Turkey, Iran, Afghanistan and Pakistan all the way into India in the middle of his PhD. Despite this long sojourn, he completed his PhD with three papers on visual perception and learning in *Drosophila* (Bicker and Reichert, 1978; Hu et al., 1978; Reichert and Bicker, 1979).

Heinrich was then on the lookout for new adventures. Jeffery Wine's lab, in balmy Stanford, and the electrophysiologically accessible neurons of the crayfish caught his attention. How do nervous systems generate the different components of a behaviour in an orderly fashion? Heinrich decided to tackle this question in the crayfish escape response and spent three intense years unravelling the circuitry underlying it. Crayfish escape threatening stimuli by a near-instantaneous flick of the tail followed by a rapid burst of backward swimming. The initial flick is mediated by the giant fibre neurons and the swimming by a central pattern generator composed of non-giant fibre neurons. Combining direct electrical stimulation of the giant neurons with tactile stimulation of the crayfish in various ways, Heinrich and Wine showed that activation of the giant fibres did not initiate swimming. This ruled out the possibility that an early circuit (giant neurons) activated the later circuit (the central pattern generator). They went on to show that the same sensory stimulus activates both the giant fibre and the non-giant fibre circuits, but with different latencies, allowing the robustly ordered sequence of events that constitutes the stereotypical escape response (Reichert and Wine, 1982, 1983; Reichert et al., 1981, 1982). During this time, Heinrich also made his initial foray into insect flight in a collaboration with Mel Robertson at the University of Alberta in Canada. Together, they identified segmentally homologous interneurons in the locust that were active during flight and argued that this segmental homology reflected an appendage-like evolutionary origin of the wings (the contrary idea was that wings were an extension of the thorax) (Robertson et al., 1982).

Even before he completed his time at Stanford, Heinrich was offered an assistant professorship in the Zoological Institute at the University of Basel, Switzerland. When he got there, he dove straight into solving the circuitry of locust flight, much like he had the crayfish escape response in Stanford. In Basel, his group shifted organisms, but the central questions remained the same – how do interneurons integrate sensory inputs to modulate motor outputs? Over the period of his habilitation (qualification as a Professor) at Basel, Heinrich's group made important contributions and published steadily – a salt-and-pepper mix of crayfish and locust stories around this idea.

He then moved to the University of Geneva where he found himself facing a new challenge. In Basel, Heinrich had been teaching undergraduate courses in German – a language he was fluent in. He now had to teach the same courses in French – a

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language he barely knew! But Heinrich had an uncanny flair for teaching. He could effortlessly distil complex ideas and weave them into conversational language. So, teaching in any language came easily to him. By this time, Heinrich was married to Dominique, herself a scientist, whose first language was French. In their first year of marriage, it was Dominique who helped Heinrich translate all his neurobiology lectures into French.

In 1991, Heinrich and Dominique moved back to Basel, where he was appointed an Associate Professor. This period saw a shift in Heinrich's science. An underlying thread in his work had been the question of evolution, and of how neural circuitry was established during development. So, in Basel, Heinrich's group began to look at the developmental origins of muscles and the nervous system in the grasshopper embryo. But it was soon clear that the grasshopper was not appropriate for this – this problem needed to be tackled in *Drosophila*. The way Heinrich told it, he only had a passive role to play in this decision – he was away on holiday, and when he came back, *Drosophila* had been smuggled into the lab. This was largely modesty. While Heinrich was certainly the sort of mentor who nurtured creative, independent pursuits from people in his group, he was also keenly aware of the workhorse that was *Drosophila*. Besides, there was a revolution underway. Following work by Michael Bate in the grasshopper, Corey Goodman and colleagues were beginning to look at the establishment of neural circuits during development and demonstrating the striking similarity in the ground-plan of grasshopper and *Drosophila* nervous systems. What was more, they were showing how genes coding for cell-surface proteins, transcription factors and signalling molecules were orchestrating its precise assembly. In Basel, Heinrich took this same approach and applied it to the central brain – a far more complex part of the nervous system that was, for all practical purposes, uncharted. But he stretched the argument further. If the circuits were evolutionarily conserved, maybe the genes that built them were too. Over the next few years, Heinrich's group showed that this was indeed the case. You could swap the coding sequences of genes between species as far removed as *Drosophila*, mouse, human and even corals and achieve functional replacements – in most cases, and for the most part (Nagao et al., 1998). The implications of this are deep: if the circuits are conserved, and so are the genes, it would suggest that these vastly different extant nervous systems shared common evolutionary origins.

Heinrich's second and far longer association with India came at this point – though it wasn't Heinrich himself who initiated it. Robert Lichtneckert, who was doing his PhD with Heinrich at the time, was looking at the early embryonic patterning gene *empty spiracles* (*ems*) in the development of central brain when he stumbled into the olfactory circuit. *ems* seemed to be involved in both the central and peripheral neurons of the olfactory circuit – a system whose development Veronica Rodrigues had been studying in Mumbai. Lichtneckert wrote to Veronica, and so began a collaboration that lasted beyond *ems* and the olfactory system, beyond Veronica's life, and even beyond *Drosophila* biology. Veronica fell ill shortly after this. It was to the credit of both Heinrich and Veronica that the science on which Robert Lichtneckert, Beate Hartmann, Abhijit Das and one of us (S.S.) collaborated continued seamlessly. Heinrich would visit the National Centre for Biological Sciences – Tata Institute for Fundamental Research (NCBS-TIFR) in Bangalore (where Veronica had since moved) twice, sometimes three times, a year for prolonged periods. He had become an integral part of the community. When Veronica passed away two years later, Heinrich became the adopted co-mentor of many of Veronica's PhD students and he generously took them on. He naturally connected with students, which made his presence on campus invaluable – and not just for Veronica's students. It was a common sight to see Heinrich in the bustling, sunny NCBS canteen, surrounded by students from different labs, sharing meals and science alike. Working with him was an absolute pleasure – he brought clarity to complex data and let the path ahead emerge from there. He was generous with his time and his intellect and met with everyone and anyone who wanted to discuss their work with him, without making any demands.

In Bangalore, Heinrich's office was across from that of K. S. Krishnan, a cell biologist of the synapse and an Emeritus Professor at NCBS-TIFR. The two shared a common love for nature, particularly the ocean. Krishnan, an avid birder, was running an extraordinary project on isolating and characterising the diverse peptides that constitute the venom cocktail of marine cone snail species from coastal India; Heinrich was an avid scuba diver – a 'birdwatcher of fish', if you will. For decades he had been diving regularly in the Maldives and the Red Sea. In fact, for many years Heinrich, with others in his lab who were also certified divers, ran a marine biology course that took students to the Maldives to monitor coral reef ecosystems, looking particularly at the effect of and recovery after photobleaching. He also organised and taught two experimental marine biology courses at the marine stations in Roscoff and Banyuls in France every year, and neurobiology courses in Trieste and Cambodia. Krishnan and Heinrich's common interest sparked a much larger project for India – a proposal for a new marine biology institute. Unfortunately, Krishnan passed away quite suddenly in 2014. But Heinrich threw all his efforts behind this idea. For two years, the Swiss man became part of an Indian delegation to establish formal collaborations with the French Centre National de la Recherche Scientifique (CNRS) and Université Pierre et Marie Curie (UPMC) and their three marine stations in Roscoff, Banyuls and Villefranche. He also travelled extensively within India and explored its islands to assess ideal locations for this new Indian marine institute. As India now considers budgetary allocations for this proposal, we owe Heinrich deeply for his generous, unselfish and tireless support of it.

Heinrich's passing is a tremendous loss to developmental neuroscience. In the last few years before his retirement in 2015, his lab had begun to systematically take apart how the brain was built – in modules constituted by stem cells and their lineages. They were examining the genes that contributed to the identities of these stem cells, and therefore to the establishment of circuitry in the brain, as well as how faults in this programme could result in disease states such as in cancer. His science over the years constitutes a body of work that has greatly advanced our understanding of the brain, its construction and function. He has written textbooks in English and German that are considered essential reading. But Heinrich's passing will be a loss to science for much more than that. In the current research environment that places high demands on the proxies of academic success, Heinrich exemplified success without dwelling on such proxies. As a mentor, this stripped the experience of science down to why we pursue it in the first case – the desire to understand something. As a collaborator, this meant a committed, unguarded pursuit of a common goal. Heinrich was a true intellect, a Renaissance human of the 21st century. His approach to science bore the same quality as his appreciation of music, literature, art, languages, or even cuisines. Yet he had no pomp and spoke only of what others did, never placing his own contributions at the centre. He was as willing to engage in discussions with students as he was with stalwarts; he equally appreciated quality street food of questionable provenance as he did fine dining; and he was always

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ready to roll up his sleeves to get something done. Heinrich will be sorely missed by developmental biologists and his friends alike. We who have benefited so much from his generosity and caring mentorship now have the enormous task to pass on this culture of science that he so carefully cultivated.

Heinrich is survived by Dominique and their three sons, Thomas, Marc and Paul.

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