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Editorial

The gratifying persistence of Invertebrate and Comparative Neuroscience

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Neuroscience continues to be a major growth area in the biological sciences and because of its eclectic nature it draws techniques and ideas from many other scientific disciplines. It extends from Brain Surgery and Neuropsychology all the way to Neuroethology and Neuroecology and covers everything in between.

Fundamental research in basic neuroscience has been fertile ground for the generation of general principles in the neurosciences, starting with the comparative work on the structure of neurons by Ramon y Cajal and the excellent comparative anatomy carried out by JZ Young on *Octopus vulgaris*, the demonstration of the ionic bases of the action potential using the squid giant axon by Hodgkin et al, in the late 1940s and early 1950s and electrical transmission at giant motor synapses of the crayfish by Furshpan and Potter in 1959.

However, for many of us working on model biological systems particularly in basic neuroscience (comparative neuroscience and Neuroethology for example), the decline in research funding from government agencies has been clear over several decades. Apart from the personal disappointments of individual scientists in the long term this will have a negative effect on the generation of key concepts in neuroscience. Over the years a number of Nobel Prizes in Physiology and the Medicine have been awarded to neuroscientists who have used invertebrates in some or all of their studies, including Eric Kandel in 2000, who studied learning and memory in *Aplysia californica*. In 2002, 2006 and 2008 the prize went to those studying the nematode round worm *Caenorhabditis elegans* whose nervous system consists of only 302 neurons and whose genome has been completely mapped, demonstrating the utility of invertebrate preparations.

In the last twenty to thirty years the reductionist approach to studies of cellular neuroscience has been eased by the development of biologically active fluorescent compounds for molecular and structural studies and of viable slices of various parts of mammalian brains. In addition the whole-cell patch method has provided a revolution in electrophysiological recording from small single cells, rather than having to use sharp electrodes to record from the rather larger cells often available in invertebrate preparations such as the sea hare *Aplysia*. With these technical advances in mind, why is it that there is a persistent interest in comparative neuroscience and the use of invertebrate preparations?

Apart from the fact that invertebrates are cheap (often free) and easier to maintain than vertebrate preparations, there is much less bureaucracy involved because at present no license is required for their use, with the notable exception of *Octopus vulgaris* in the European Union and Australia. Invertebrates present a huge variety of body forms and offer many approaches to our understanding of basic neuroscience. For example, invertebrate preparations have been used for studies on membrane biophysics, motor pattern generation, anaesthesia, behavioural plasticity, developmental biology, memory, genetics, synaptic physiology and ageing among others.

Synaptic plasticity forms the basis for all adaptive changes that are required by an animal to survive in its ever changing environment, though the underlying cellular, synaptic and molecular mechanisms remain largely elusive. This lack of fundamental knowledge in the field of neuronal plasticity is due to the intricate nature of neuronal connectivity patterns and the complex nature of the behavioural repertoire in most vertebrate animals. Thus many workers have opted to develop simple model systems in which behavioural, cellular, synaptic and molecular mechanisms mediating synaptic plasticity, within an identified neuronal circuit can be examined from a single cell to single gene level. For example in the pond snail *Lymnaea stagnalis* a neuronal network that controls respiratory behaviour has been characterized and shown to interact with locomotor, cardiac and feeding systems, all of which are suppressed by activity of a whole body withdrawal interneuron, that stimulates the protective response by which the animal withdraws into its shell. Synaptic connections within this circuit are highly plastic. The precise environmental and trophic factors that modify synaptic plasticity and the mechanisms underlying these plastic changes remain largely unknown, but preparations of this sort provide us with an unparalleled opportunity to define the cellular, synaptic and molecular mechanisms underlying behavioural plasticity at a resolution that is unapproachable elsewhere.

Long may invertebrates be used for fundamental curiosity driven research.

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