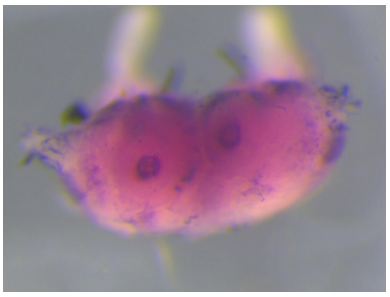
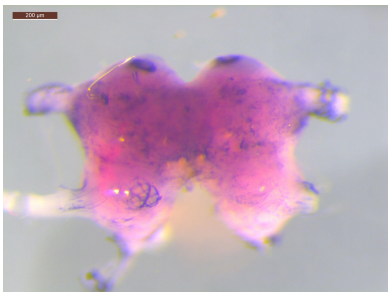
The role of the Toll receptors and their Spätzle ligands in the compensatory plasticity mechanism of the Mediterranean field cricket *Gryllus bimaculatus*

Sarah Lührmann, 2023

Neuronal plasticity describes the ability of the nervous system to rewire in an activity-dependent manner. This is a function that is limited beyond a critical period of development in the central nervous system (CNS) due to a combination of cell-intrinsic properties of neurons and extracellular growth-inhibitory factors (Nagappan et al. 2020). As the auditory system of the Mediterranean field cricket *Gryllus bimaculatus* is able to demonstrate compensatory plasticity following injury even into adulthood, it has been identified as an ideal model system to study neuronal regeneration in the mature CNS. Crickets depend on an intact auditory system to mediate phonotactic behaviours in order to escape predators and attract mates. Ears located on their tibial forelimbs respond to frequency differences and transform them into nerve signals that are carried to a cluster of nerves called the prothoracic ganglion. From there, neurons located bilaterally to the prothoracic ganglion channel these signals up to the brain. When the forelimb ear is removed, these ascending neurons lose their connection to the auditory input. In response to this loss of signal, a compensatory response occurs in which dendrites of the deafferented cells sprout across the midline (an inhibitory divide that is normally not crossed) to form synapses with the contralateral, intact afferents that still receive auditory input. Such re-connection to the unimpaired side compensates for the loss of auditory input from the removed forelimb ear and restores auditory function within four to six days post-injury.

In order to elucidate the mechanism underlying this phenomenon, the Horch lab has previously created phylogenic trees to investigate the evolutionary relationship of relevant proteins in different insects. Thereby, the temporal and spatial expression of the so-called Toll receptors and their Spätzle ligands piqued interest. Previous literature suggests that Toll and Toll-like receptor (TLR) signalling might function homologously to the way Neurotrophic factors (NTF) function in humans. As mediators of activity-dependent plasticity, NFTs are secreted proteins that function to regulate the formation, potentiation and maintenance of synapses as well as cell death. Establishing that Toll receptors have trophic-like functionality in crickets could clarify whether neurotrophic signalling plays a key role in the modulation of post-injury morphological plasticity in the mature CNS. Thus, over the course of the summer, we employed a molecular technique called In-Situ Hybridisation that allows for the precise localisation of specific nucleic acid sequences in a target tissue. In this case, we sought to characterise the expression of Toll 2, 6.2 and 7 in the prothoracic ganglion, the neurogenic tip of the mushroom body of the brain (a region of interest due to its involvement in memory formation of invertebrates) and the developing limb buds of cricket embryos. Expression in these regions would indicate a potential involevement of the respective protein in regenerative growth and could warrant further examination. A clear ring-like expression of Toll 7 was detected in the brain in the last year, followed by previously unsuccessful replication of such results. However, our research this summer succeeded in visualising the ring-like expression of Toll-7 in the mushroom body of the brain, thus reaffirming its relevance to the compensatory plasticity mechanism (seen below).





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