Abstract:

The first synaptic relay of olfactory information processing is the antennal lobe of insects. Here, local interneurons compute the olfactory information coming from the antennae and form synapses exclusively within the antennal lobe. The projection neurons represent the principal output neurons of the antennal lobe and transfer the preprocessed olfactory information to higher order neuropils, such as the mushroom bodies and lateral horn in the protocerebrum. For the antennal lobe to process information in a context specific manner its neurons are diverse in morphology and electrophysiology. Further, to adapt to environmental changes the olfactory information needs to be modulated. To unravel this complex framework it is crucial to characterize the ionic currents of central antennal lobe neurons and therewith their electrophysiology. Additionally, it is important to understand how neuromodulators, such as biogenic amines, can influence these electrophysiological properties of single cells and thereby regulate information processing in the network. An important biogenic amine in insects is octopamine, which has been shown to regulate olfactory information in the antennal lobe (Rein *et al*., 2013; Roeder, 1999, 2005).

The first part of this thesis addressed the distinct physiological phenotypes of projection neurons and interneurons in *Periplaneta americana* by studying their functional properties of their $I_A$, a current pivotal for regulating neuronal firing. Whole-cell recordings of projection neurons and interneurons revealed striking neuron type specific differences in the $I_A$ kinetics. Further investigation showed that these neurons are differentially sensitive to the $I_A$ subtype blockers α-dendrotoxin and phrixotoxin-2, which have been shown to affect the *Shaker* and *Shal* mediated $I_A$. These experiments indicate that each neuron type has a different composition of $I_A$ subtypes presumably promoting their individual physiological phenotype. Current clamp experiments were performed to analyze the relevance of the $I_A$ for firing properties.

The second part of this thesis focused on investigating the octopamine mediated effects on the electrophysiological properties of the local interneurons type I. Previous experiments showed that octopamine can modulate odor responses by increasing the number of action potentials during odor stimulation. Consequently, investigation of the octopamine mediated effects on electrophysiological properties of single isolated type I local interneuron was central to understand the mechanism underlying the change in odor response. Here, perforated patch-clamp experiments were performed by which could demonstrate a strong octopamine mediated effect on the excitability of these type I local interneurons. The application of 3 μM octopamine increased action potential count, reduced action potential threshold and modulated the postinhibitory excitation of these neurons. Pharmacological experiments with the β-octopamine receptor blocker mianserin were conducted in order to identify the involved receptor type and signaling pathway. The increase in excitability by

octopamine was absent in the presence of mianserin thus indicating an β-octopamine receptor mediated pathway.