8.3. Brain NOS activity regulates reproductive state-related behaviors in grasshoppers

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The gaseous neurotransmitter NO contributes to the processing of behaviorally relevant sensory information and the selection and coordinated performance of situation-specific behaviors, in both vertebrate and invertebrate species. An example suggesting that basal activity of the NO-generating enzyme NOS modulates general thresholds for particular behaviors is the control of grasshopper acoustic communication mediated by neural circuits in the central body (CB) of the brain. The CB of grasshoppers contains both NO-generating and NO-responsive neurons. Pharmacological studies on intact grasshoppers revealed that activation of NO/cGMP signaling pathways in the CB reversibly and dose-dependently suppresses sound production. Grasshoppers that are exposed to situations that do not promote sound production, accumulate high levels of citrulline in a subpopulation of NADPH diaphorase-positive neurons which is indicative of considerable NOS activity. Since brains of grasshoppers performing calling or courtship songs lack accumulation of citrulline, these neurons may release NO into the CB to inhibit sound production in unfavorable situations. Injections of NOS inhibitors into the hemolymph increased the amount of spontaneous and male song-stimulated sound production of female grasshoppers. Sound production in females is strictly correlated with high receptivity after prolonged periods without copulation and is modulated with periodic oviposition. NO/cGMP signaling may couple the reproductive state to neuronal functions that regulate the intrinsic threshold for mating-related behaviors.

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8.4. NO/cGMP system and biogenic amine system in agonistic behavior in the cricket

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Cricket fighting behavior provides good experimental model system to investigate the role of nitric oxide in the central nervous system. Dominant hierarchy is established after the agonistic behavior that is released by a perception of cuticular substances of opponent males. The dominant cricket showed aggressive behavior when it encountered other males whereas subordinate crickets showed avoidance. The loser's experience remains as an aversion to the fighting for 30–40 min. Decrease in biogenic amine levels in the brain emerged after the agonistic behavior. Octopamine and serotonin levels in the brain of subordinate animals were significantly less than those in the naïve and dominant animals. Aggressive intensity during agonistic behavior was mediated by NO/cGMP signaling in the brain. Pharmacological inhibition of NO/cGMP signaling pathway using NOS inhibitor or soluble guanylyl cyclase inhibitor increased aggressive intensity in a subordinate cricket. A NOS inhibitor and an inhibitor of soluble guanylyl cyclase significantly increased these biogenic amine levels in the brain. An NO donor, on the other hand, significantly decreased OA and 5-HT level in the brain. The results suggest that NO/cGMP signaling would regulate biogenic amine system in the cricket brain, which in turn mediates agonistic behavior among male crickets.

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8.5. A neuroanatomical guide of the cercal scape system of the wood cricket

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Many Orthoptera posses a pair of abdominal appendages, the cerci, involved in orientation and escape behaviours. The cercal system comprises the cerci, sensory hairs, the terminal abdominal ganglion (TAG), and the ascending units into the CNS. By means of optical, confocal, SE and TE microscopy, combined with general and selective neuronal marking, we analysed the organization of the TAG in *Nemobius sylvestris*. The core of the TAG has a clear framework provided by the nerve tracts, formed by groups of fibres running together in bundles. Between tracts lie fibrous areas, the neuropils sensu stricto. We identified nine longitudinal tracts in the TAG of *N. sylvestris*, two major and seven smaller ones. Cross sections of the TAG and mass fills revealed several small cells and 7 pairs of giant interneurons (GINs), organized symmetrically at each side of the TAG. The somata of GINs are located contralateral to their axons, with diameters between 20 and 45 μm. Dendritic trees of GINs overlap the projections from receptors. Neuronal fills from the cercus revealed two areas at each side of the midline: a posterior cercal glomerulus, where wind-sensitive sensory neurons terminate, and the bristle neuropil, where touch-sensitive neurons terminate. Axons from certain cercal sensilla ascend through the connectives to reach the metathoracic ganglion, As the axons pass through each segmental abdominal ganglia they project medial arborizations. The functional implications of the neuroanatomical organisation of the system is discussed. Supported by the CNRS, the Univ. de Tours and the European Community (CILIA project, FP6-IST-016039).

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