A Computational Model of the Adaptive Action Selection in Cricket Fighting Behavior by NO/cGMP Cascade

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NO/cGMP カスケードによるコオロギの闘争行動における適応的行動選択のモデル化

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One of the common goals in neurobiology and robotics is to understand how the nervous systems emerge adaptive behavior according to the external environments. To elucidate the underlying common principles, not only the analytical approach taken in biology but also the synthetic approach by systems engineering can be a help for progress.

Because of the simplicity of neuronal organization and identifiability, neurons of insects have a great advantage in understandings of its adaptivity. In this study, we discuss a model for fighting behavior of cricket *Gryllus bimaculatus* as an example. After fighting behavior between two male crickets , the hierarchy remains for a while, and the indominant cricket selects avoidance behavior against the dominant cricket. This shows that the pheromone behavior is modulated by its experience, and to investigate this switching mechanism of nervous system can be a clue to adaptive behavior selection.

Recent biological research has revealed the importance of nitric oxide (NO) as a neuromodurator in cricket fighting behavior. Gaseous molecule NO diffuses and NO signaling plays important roles to regulate synaptic transmissions in invertebrate animals. The components of NO/cGMP cascade in insects have been known as an important factor in formation of memories. Hence, we model the adaptive action selection in fighting behavior by NO/cGMP cascade.

Two assumptions are made in our model. Firstly, the amount of emergent NO can take two states (high or low), and pheromone of the other crickets sensed by the antennas will alter NO level to high. Therefore, NO works only as a switch, detecting the presence of opponents. Secondly, octopamine (OA) level is crucial for action selection, and the producing amount of OA is controlled by NO/cGMP cascade. Results of computer simulations show that the proposed model can explain adaptive action selection in cricket fighting behavior in some senses.