【Grant-in-Aid for Scientific Research (S)】
Biological Sciences (Biological Sciences)

Title of Project : Connectomics Analysis of the Neural Networks that Regulate the Behavior of *Drosophila*

Kei Ito
(The University of Tokyo, Institute of Molecular and Cellular Biosciences, Associate Professor)

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Research Area : General Neuroscience
Keyword : neural computation, connectomics, model animal, imaging, *Drosophila*

【Purpose and Background of the Research】

Output of reward- or punishment-associated learning and memory induces attractive or repulsive behaviors. However, little is understood about how signals from the learning centers are conveyed to the motor control centers to regulate such behaviors. The lack of detailed knowledge about the neural network architecture connecting these centers has made it difficult to address this problem.

The fruit fly *Drosophila melanogaster* exhibits a wide range of behaviors comparable with that of lower mammals in spite of its small brain size. Thanks to the sophisticated molecular-genetic techniques and extensive transgenic strain resources to visualize and to functionally manipulate specific neurons, it is a very powerful model system for comprehensive neural network analysis. In this project we will systematically identify neurons that connect learning and motor control centers, and reveal their roles in behavior control with sophisticated imaging and functional analyses.

【Research Methods】

Using more than 10,000 *Drosophila* transgenic expression driver strains established by us as well as by other groups, we will first identify neurons that arborize in the input/output regions of the leaning centers and dendritic regions of the motor control centers. Distributions of pre- and postsynaptic sites of these neurons will also be revealed to understand information flow. Combining these data, we will reveal direct and indirect connections from the leaning centers to motor centers.

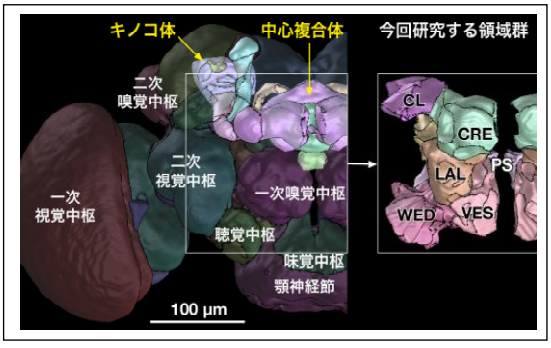

Figure 1　Components of the *Drosophila* brain

We will also investigate the activities of the identified neurons in relation to specific behaviors through imaging analysis with transgenic Calcium sensors, and reveal their roles in behavioral regulation by specifically blocking their neural activities using expression of transgenic toxins and by ectopically stimulating their activities with the expression of heat- or light-inducible ion channels.

【Expected Research Achievements and Scientific Significance】

Both in vertebrate and invertebrate brain sciences, conventional studies tend to focus on well-known brain regions with relatively simple neuronal architecture, leaving other regions uninvestigated in spite of their potential importance. This is the first attempt to shed lights on such less known, reticular parts of the brain. Systematic analysis of the neural networks and their functions should help understanding the way how associative learning centers should control animal behaviors.

【Publications Relevant to the Project】

・Ito.K., Shinomiya, K., Ito, M., Armstrong, D., Boyan, G., Hartenstein, V., Harzsch, S., Heisenberg, M., Homberg, U., Jenett, A., Keshishian. H., Restifo, L., Rössler, W., Simpson, J., Strausfeld, N. J., Strauss, R., and Vosshall, L.B; The Insect Brain Name Working Group. A systematic nomenclature for the insect brain. *Neuron*, **81**, 755-765, 2014.
・Ito, M., Masuda, N., Shinomiya, K., Endo, K., and Ito, K. Systematic analysis of neural projections reveals clonal composition of the *Drosophila* brain. *Curr. Biol*, **23**, 644–655, 2013.

【Term of Project】

FY2014-2018

【Budget Allocation】

128,400 Thousand Yen

【Homepage Address and Other Contact Information】

http://jfly.iam.u-tokyo.ac.jp/lab/
itokei@iam.u-tokyo.ac.jp