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

Broad Section G

Title of Project : Spectral opponency in photoreceptors : neuroethological analysis

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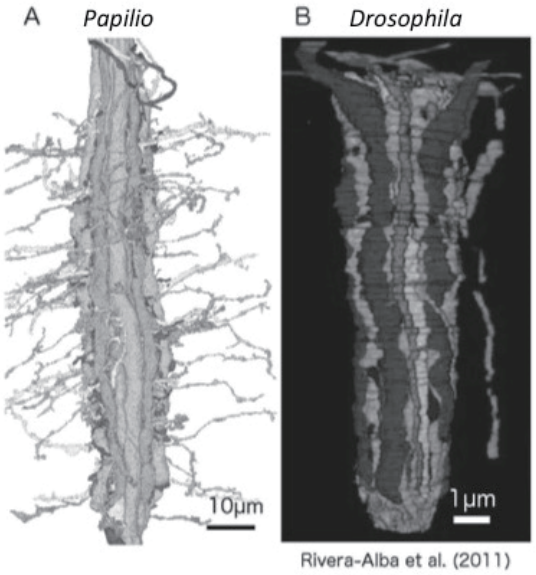
Keyword : insect, color vision, photoreceptor, lamina, spectral opponency

【Purpose and Background of the Research】

We focus on the interphotoreceptor synapses in the lamina to study mechanisms of insect color vision. The interphotoreceptor synapses are presumably inhibitory, which we first identified in the butterfly, *Papilio xuthus*. *Papilio* has six distinct spectral receptors in the eye, and has long been a model species for color vision study. What would happen if spectrally distinct photoreceptors mutually inhibit? What is transmitted to second order neurons? Such photoreceptor interactions are absent in the lamina of *Drosophila*, which is perhaps related to their limited ability of discriminating colors. We hypothesize that the interphotoreceptor synapses provide crucial elements for color vision, and will analyse their function in the *Papilio* lamina. We will also perform comparative functional anatomy of the lamina in a variety of insects to address the question how color vision has evolved.

【Research Methods】

We will take three approaches: *i*) spectral opponency in photoreceptors, *ii*) LMCs' spectral properties, the second order neurons in the lamina, *iii*) comparative anatomy of the lamia among insects. CRISPR-Cas9 method will be applied to produce genetically-modified *Papilio*, which will be compared with normal individuals to understand the basis of wavelength information processing in the lamina. The comparative anatomy will aim at collecting serial images sufficient for analyzing lamina circuit at the EM level. We will start analyzing the lamina of about 10 insect species where vision has been somewhat studied.



3D reconstruction of photoreceptors and LMCs in the lamina cartridge. Lateral processes are missing in *Drosophila*.

【Expected Research Achievements and Scientific Significance】

Color vision is wide spread among animals, and even insects often exhibit human-like color vision properties. However, insects' nervous systems are quite different from that of vertebrates, indicating that the similarity is due to convergent evolution. Pioneered by Karl von Frisch, study of insect color vision has been a main topic of neuroethology. Recent progress in this field is quite impressive in *Drosophila* where all the contemporary molecular biological techniques are available. However, color vision of these flies is quite limited, while butterflies are the champion animals in this regard. This project using butterflies will reveal the neuronal mechanisms underlying their sophisticated color vision, together with its evolutionary background, which would enlighten the essential parts for seeing colors.

【Publications Relevant to the Project】

- Arikawa. *J Physiol*, 16: 5457-64, 2017
- Perry *et al. Nature*, 535: 280–4, 2016
- Kinoshita, Arikawa. *J Comp Physiol A*, 200: 513-26, 2014
- Takemura, Arikawa. *J Comp Neurol*, 494: 663-72, 2006
- Takeuchi *et al. J Exp Biol*, 209: 2873-9, 2006

【Term of Project】

FY2018-2022

【Budget Allocation】

154,000 Thousand Yen

【Homepage Address and Other Contact Information】

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