

Plenary3

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Evolutionary and developmental underpinnings of insect polyphenisms

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Organismal phenotypes are not always determined by their genetic information but also changed by environmental factors during development. Phenotypic plasticity is known as an adaptive strategy for organisms to fit their phenotypes to surrounding environments. Some animals are known to express an extreme case of phenotypic plasticity, called “polyphenism”, in which alternative discrete phenotypes are expressed depending on environmental conditions. In these animals, there are multiple blueprints in their genomes, leading to different developmental pathways to produce discrete phenotypes that fit to corresponding environments.

In our laboratory, we have been working on the evolutionary and developmental mechanisms mainly in insects (and other animals), focusing on the developmental and physiological regulations in response to environmental changes. In this presentation, I will briefly introduce a part of our studies performed in termites and stag beetles, in which body size and allometry are changed depending on extrinsic factors such as social interactions and nutrition (Fig. 1).

In termite colonies, the caste polyphenism is seen, in which various types of individuals like workers, soldiers and reproductives appear depending on the social interactions. Our previous studies in the damp-wood termite *Hodotermopsis sjostedti* suggest that social interactions mainly via pheromonal communications affect physiological conditions such as juvenile hormone titer or insulin signaling, resulting in the gene expression of morphogenetic factors which lead the specific morphogenesis (ref. 1, 2).

In a stag beetle species that shows drastic size variation only among males, a beautiful coordination of sexual dimorphism and phenotypic plasticity is seen. Overall, I will introduce the fascinating phenomena seen in these animals and the recent results obtained by our developmental, physiological, molecular and genomic investigations (ref. 3).

1. Miura T (2005) Developmental regulation of caste-specific characters in social-insect polyphenism. *Evolution & Development* 7: 122-129.
2. Watanabe D, Gotoh H, Miura T, Maekawa K (2014) Social interactions affecting caste development through physiological actions in termites. *Frontiers in Physiology* 5: 127.
3. Gotoh H, Zinna RA, Ishikawa Y, Miyakawa H, Ishikawa A, Sugime Y, Emlen DJ, Lavine LC, Miura T (2017) The function of appendage patterning genes in mandible development of the sexually dimorphic stag beetle. *Dev Biol* 422: 24-32.



Figure 1. A termite soldier and a male stag beetle, both of which possess enlarged mandibles.