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

Biological Sciences (Biology)

Title of Project : Molecular Mechanisms of Color Pattern Formation in Mimicry Controlled by Supergene.

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Research Project Number : 15H05778 Researcher Number : 40183933
Research Area : Basic biology: Evolutionary biology
Keyword : Evolutionary genetics, Morphological evolution, Comparative genomics

【Purpose and Background of the Research】

The color patterns observed in various animals work as protective mimicry, but the formation mechanisms are largely unknown. Some complex and adaptive traits such as mimicry are controlled hypothetically by "supergene" which is composed of flanking genes, but there is a little evidence for the hypothesis. Females of the swallowtail butterfly, *Papilio polytes* mimic color patterns and behavior of the unpalatable butterfly, *Pachliopta aristolochiae* (Fig. 1). We found that this Batesian mimicry is caused by a 130kb chromosomal region, which is fixed by chromosomal inversion. This region includes *dsx* involved in sexual differentiation and two additional genes, all of which possibly constitute supergene. To certify the idea, we aim to reveal (1) structure and function of the supergene, (2) mechanisms for emergence and stabilization of the supergene unit, and (3) structural comparison of supergene in the related species. We also clarify the mechanisms of mimicry caused by genome rearrangements, such as gene multiplication and transposition.

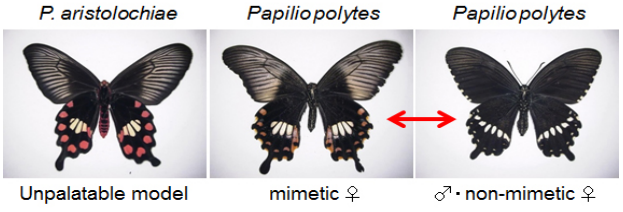

Fig. 1. Batesian mimicry of *Papilio polytes*

【Research Methods】

Focusing on the responsible region for Batesian mimicry in *Papilio polytes* (Fig. 2), we reveal the following points; (1) gene functions and expression profiles for *dsx* and two other genes in the supergene unit by a novel functional analysis (EMST method); (2) detailed structures of inverted regions in mimetic and non-mimetic chromosomes; (3) structures and functions of *dsx* and flanking genes in the closely related species to *Papilo polytes.* In addition, we also reveal the mechanisms of regulation for pupal protective coloration and larval marking pattern formation in Lepidoptera, which help to understand how the genome rearrangement contributes to emergence of the supergene unit.

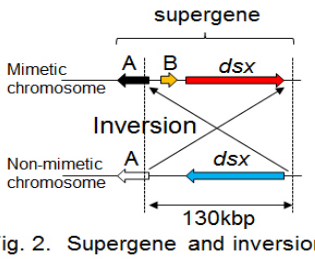

Fig. 2. Supergene and inversion

【Expected Research Achievements and Scientific Significance】

This project aims to reveal general structure and functions of supergene which is an unclarified concept in genetics for a long period. We have recently developed a novel functional analysis, which enables detailed functions of all candidate genes in a supergene unit involved in mimicry. This unique approach gains the lead to other projects for supergene. We anticipate that our project clarifies how supergene has been formed, evolved and stabilized during evolution, which will impact on evolutionary genetics and evolutionary biology in general.

【Publications Relevant to the Project】

・Nishikawa, H., Iijima, T. et al.: A genetic mechanism for female-limited Batesian mimicry in *Papilio polytes*. Nature Genetics, 47, 405-409 (2015).
・Yamaguchi, J., Banno, Y., Mita, K., Yamamoto,K., Ando, T. & Fujiwara, H.: Periodic Wnt1 expression in response to ecdysteroid generates twin-spot markings on caterpillars. Nature Communications. 4, 1857 (2013).

【Term of Project】 FY2015-2019

【Budget Allocation】 153,800 Thousand Yen

【Homepage Address and Other Contact Information】

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