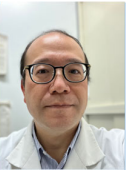


【Grant-in-Aid for Transformative Research Areas (A)】

Co-evolutionary emergence of extended phenotypes: Elucidation of the molecular mechanisms of extended phenotypes

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	Project Information	Project Number : 24A303 Keywords : Extended phenotypes, parasitism, symbiosis, evolutionary biology, ecology	Project Period (FY) : 2024-2028

Purpose and Background of the Research

●Outline of the Research

Conventional biology generally assumes that phenotypes (such as body shape and behavior) of an individual organism are determined by its own genetic information. On the other hand, there are many interesting phenomena in nature in which the genetic information of one organism can manipulate the phenotypes of other organisms. For example, a praying mantis parasitized by a hairworm jumps into water, or a lepidopteran insect larva infected with a baculovirus climbs to the top of the tree; these are examples of parasites or viruses manipulating the behavior of the host for their own benefits. Such a phenomenon should be realized through interactions between the operating and manipulated organisms based on their mutual genetic information across species. However, the molecular mechanisms underlying these phenomena are poorly understood. In this research project, we will focus on the phenotypic manipulation hidden in the interactions between a wide variety of organisms, and elucidate the delicate and diverse mechanisms of phenotypic regulation that are difficult to access through conventional biology. Through this understanding, we aim to establish a new academic field called “co-evolutionary molecular developmental ecology” that spans from the micro to the macro.

“Extended phenotypes” of endosymbionts

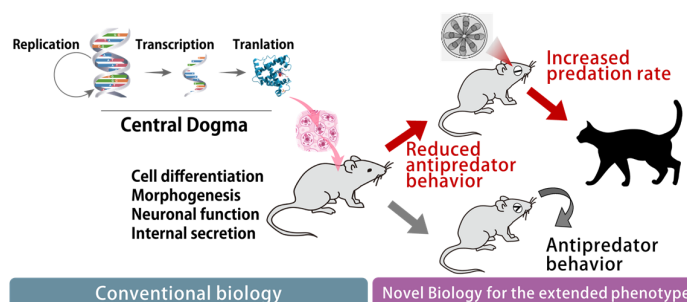


Figure 1. The extended phenotypes of endosymbionts. Behavioral manipulation of mouse host by *Toxoplasma gondii* is shown as a model.



Figure 2. Diverse examples of the extended phenotypes of endosymbionts

Expected Research Achievements

“Extended phenotypes,” which are the phenotypes created in another organism by the genetic information of one organism, have been attractive to not only scientists but also the general public, and there has been many reports on this phenomenon for a long time. However, many of these phenomena are observed in “non-model” organisms that are not amenable to molecular-level research, making it difficult to investigate the molecular mechanisms. In recent years, however, advances in various technologies have made it possible to study molecular biology and biochemistry in non-model organisms, and many Japanese researchers, in particular, have been leading the field.

In this research project, Japanese researchers who contribute to and challenge this field are gathering to conduct research on the extended phenotypes of hosts caused by endosymbionts that invade the inside of the host. Specifically, we aim to (1) identify effectors derived from endosymbionts, (2) identify host signaling pathways, and (3) elucidate the emergence of novel phenotypes.

Studies in this project fall into five categories:

- A01.** Behavioral manipulation,
 - A02.** Reproductive manipulation,
 - A03.** Morphological manipulation,
 - A04.** Developmental manipulation,
 - A05.** Mutualistic phenotypic modification,
- but they are organically related to each other.

In addition, we will try to understand phenotypic coevolution in interactions between organisms, addressing both parasitic and mutualistic relationships. Finally, we will elucidate the mechanism by which endosymbionts create host phenotypes and promote a new biology that extends to a hierarchy beyond individual organisms.

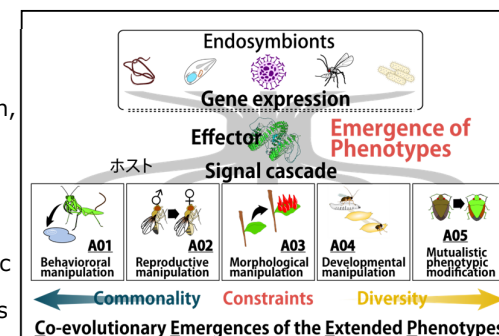


Figure 3. Overview of the research projects

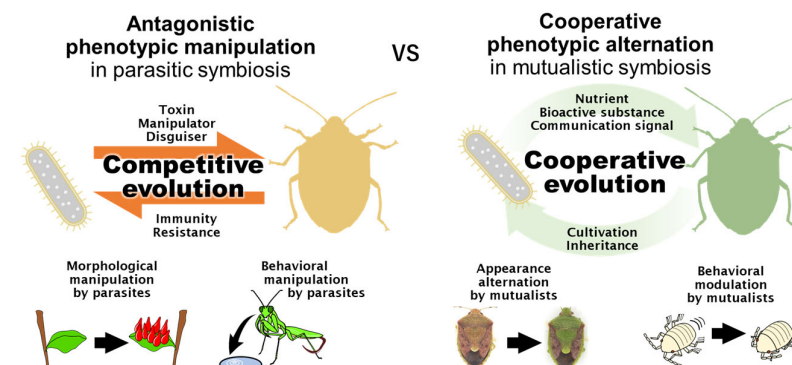


Figure 4. Commonality, diversity and constraints on the molecular mechanisms of the extended phenotypes

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