Evolution and diversification of sexually dimorphic traits in the false blister beetle Oedemera sexualis

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論 文 内 容 の 要 約

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論文題目

Evolution and diversification of sexually dimorphic traits in the false blister beetle *Oedemera sexualis*
（フタイロカミキリモドキにおける性的二型形質の進化と多様化）

Insects account for more than half of species living on the earth, and their external morphology is extremely diverse. Thus, elucidating the mechanisms of insect morphological and species diversification leads to a better understanding of the origin of biodiversity. Such a study is especially important in the modern era when biodiversity is being lost.

Sexual selection is responsible for the exaggeration and incredible diversity of male sexual traits in animals. Male adaptation to sexual competition can inflict costs to the female, resulting in evolutionary conflicts of interests between the sexes, i.e., sexual conflict. Sexual conflict is predicted to fuel sexually antagonistic coevolution; adaptations in one sex are harmful to individuals of the other sex, selecting for counter-adaptations in the other sex. The theory of sexual conflict also predicts diversification of male manipulative and female resistant traits via chase-away evolution with

multiple evolutionary equilibria or optima. Sexually antagonistic coevolution is now recognized as a central process of evolutionary diversification, with the potential to shape various interactions between the sexes. In addition to these processes, sexually selected traits can also diverge rapidly in response to a balance between natural and sexual selection, i.e., a balance between the survival costs associated with bearing the trait and the benefits in reproductive success. This process is influenced by environmental factors that can vary spatially. However, this process has been confirmed only in limited cases (e.g., male coloration in guppies inhabiting environments with varied predation risk).

A major source of spatial environmental variation is latitude, which correlates with temperature, precipitation, and seasonality and has been shown to influence various types of traits. Variation in body and trait sizes among populations has also been attributed to factors that may covary with latitude. As seen in latitudinal variation in body size, the effect of latitudinal environmental gradient on sexual traits may also vary among organisms. However, very few studies have examined the dependence of sexual selection and/or sexual conflict on latitudinal environmental gradient.

In this thesis, I examined the hypothesis that the evolution via sexual conflict is influenced by natural selection that occurs in relation to local environments, and it leads to diversification of sexual traits. To this end, I conducted a series of comparative and experimental studies using the false blister beetle *Oedemera sexualis* (Coleoptera: Oedemeridae), which showed prominent sexual dimorphism in

the hind legs.

In Chapter 2, I examined latitudinal variation in male and female sexual traits in 22 populations of the false blister beetle *Oedemera sexualis* in the Japanese Archipelago. Morphometric analyses revealed that male and female body size, length and width of the hind femur and tibia, and allometric slopes of these four hind leg dimensions differed significantly among populations. Of these, three traits showed latitudinal variation, namely, male hind femur was stouter, female hind tibia was slenderer, and female body was smaller at lower latitudes than at higher latitudes. Hind leg sizes and shapes covaried significantly between sexes, suggesting coevolutionary diversification in sexual traits.

In Chapter 3, I examined sexual dimorphism in body size and hind leg sizes in a more detailed manner using 3 representative populations based on distance measurements and elliptical Fourier analysis. As a result, significant differences in the degree of sexual dimorphism for body and hind leg sizes were found among the populations. Differentiation in male hind femur shape was conspicuous especially in femur width. Evaluation of scaling relationships showed that male hind femur width was constrained in its growth at large body sizes in all the three populations. The upper limits of the growth of hind femur width were corresponded to the population means of the trait, while basal size and growth rate did not differ among populations, suggesting that variation in growth limit is responsible for the observed geographical variation of the sexual trait.

In Chapter 4, I confirmed the presence of sexual conflict by examining a female fitness under different frequencies of mating. Then, I conducted an inter-population cross experiment using two populations (Amami and Yambaru) to examine the hypothesis that inter-population differentiation in the sexual traits was a result of sexually antagonistic coevolution. As a result, I confirmed the assumption of the inter-population cross experiment that difference in the suites of sexual traits concerning male manipulation and female resistance between Amami and Yambaru populations was qualitative (i.e., not a quantitative difference in the degree of escalation): Amami males wait for female mating acceptance but Yambaru males mate coercively; and Amami females reject males by abdominal curl-up but Yambaru females do by struggling. As expected, imbalance between male manipulation and female resistance resulted in increased mounting and mating rates in inter-population crosses. Contrary to an expectation, however, no traits were associated with mounting and mating success.

Finally, I summarized the results of my thesis and proposed a direction of further studies. The present results supported the hypothesis that the evolution via sexual conflict is influenced by natural selection that occurs in relation to local environments, and it leads to diversification of sexual traits (Chapter 2–4). I found latitudinal variation (the male hind leg was bigger and the hind femur

relatively wider, while the female hind leg was bigger and the hind tibia relatively slenderer at lower latitudes than at higher latitudes) and covariation between sexes of sexually dimorphic traits (Chapter 2), inter-population variation in limitation against the enlargement of traits (Chapter 3), and qualitative differences in mating behaviors that may resulted from sexually antagonistic coevolution as revealed by increased mounting and mating rates in inter-population cross experiment due to imbalance between male manipulation and female resistance (Chapter 4). These results suggested that the sexually antagonistic co-evolution is influenced by natural selection that occurs in relation to local environments, and it leads to diversification of sexually dimorphic hind legs in the false blister beetle *Oedemera sexualis*. Thus, this thesis is expected to provide a novel insight into the mechanism of biological diversification. Further studies to assess the impact of both natural and sexual selection acting on insect morphology will contribute to generalization of the existing theories concerning sexual trait in organism and enhancing understanding the evolutional mechanisms of biological diversity.