

## Biology

### Evolution of Marine Green Algae and Heterogametes

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#### Background of Research

As exemplified in sperm and egg, when there is a size difference between the male and female gametes (heterogametes), the small-sized male gametes that can be produced in large quantities from limited resources (sperms) compete over the large-sized female gametes that can be produced only in limited quantities (eggs). In 1871, C. Darwin named such a situation as sexual selection in his work, *The Descent of Man and Selection in Relation to Sex*, stating for the first time that, unlike natural selection that equally affects the males and females, the morphological (weapon or eye-catching designs worn only by males) or behavioral (courtship dance performed only by male Japanese cranes) differences observed between the males and females of living creatures are at the basis of evolution.

Since that time, the question of “why did the egg become smaller than the sperm?” has long been one of the most basic and important study themes in evolutionary biology as it is indispensable for deriving an answer for the most fundamental issue in life, that is, why the male and female are different. Ever since that time until now, a number of highly renowned theorists in the western countries constantly have challenged the unraveling of this mystery through their theoretical study.

#### Achievements of Research

The biggest reason why this historical study theme has long been limited to the bounds of theoretical study is because today there is no primitive living creature whose gametes are not different in size between the male and female (homogametes), and therefore it has not been possible to observe the process of evolution from homogamete to heterogamete. Against this background, I have been promoting my study focusing on the variety of existing mating systems in the contemporary marine green algae ranging from complete homogametes to extreme heterogametes. As a

result, I discovered the close correlations of the behaviors, mating system, and environmental factors of habitat (particularly water depth) of the gametes of phototactic characteristics which are attracted to light and of chemotactic characteristics which are attracted to certain kinds of chemicals, for which I was awarded the Ecological Society Award from the Ecological Society of Japan. In the study process I discovered sexual pheromone (chemical substances that are excreted from the female gamete to attract the male gamete) for the first time in the world in the marine green algae. In the theoretical study based on the experiment data, I was able to explain why the mating system has been developed the way it has in this biotic community. The series of research results has been published as a work from Cambridge University Press in England.

#### Prospect of Research

In my laboratory, we have recently been successful in overcoming all technical problems related to clarifying through experiment using marine green algae the issue of the “relation between the resources quantities and survival rate of a zygote wherein a female and male gametes are combined (whether or not a larger zygote has a larger possibility of survival)” which has still not been experimentally proven despite its importance emphasized by the theoretical study throughout history. Having said that, now we are ready to carry out quantitative experiment so that the gap between the theoretical study and experiment data can be filled up.



**Fig. 1: Female gamete of *bryopsis plumosa* whose sexual pheromone was discovered for the first time in the world**