Mathematical study of cooperative behavior in social amoeba and plant-mycorrhizal system

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論 文 名　：　Mathematical study of cooperative behavior in social amoeba and plant-mycorrhizal system
（社会性アメーバと植物菌根系における協力行動の数理的研究）

区　　分　：甲

論　文　内　容　の　要　旨

All organisms interact with other organisms in nature. In this thesis, I focus on altruism of social amoeba and mutualism of plant mycorrhizal system in this thesis.

First study is altruism of social amoeba. When food is depleted in the environment, cells aggregate together to make fruiting body. Some of these cells become stalks, raising spores to aid in their dispersal. Differentiation-inducing factor-1 (DIF-1) is a signaling chemical produced by prespore cells and decomposed by prestalk cells. In this study, I modeled differentiation of cell types by DIF-1 and analyzed the evolution of the both sensitivity to DIF-1 and secretion of DIF-1. If a fruiting body is formed by multiple strains, the cells evolve to become less sensitive to the signaling chemical and produce more signaling chemical in order to reduce the risk of being exploited.

Second is mutualism of plant and mycorrhizal fungus. Plant interacts with mycorrhizal fungus in the roots. Plant gives carbohydrate produced by photosynthesis to the fungus. On the other hand, fungus allocates soil nutrition such as phosphorus to the plant. In this study, I analyzed optimal allocation of carbon by a plant to its mycorrhizal fungus, and the optimal allocation of phosphorus by the mycorrhizal fungus to the plant. I considered the resource allocation by both players that achieve the fastest growth of the whole system when it grows exponentially. As a result, both plant and fungus should allocate more to the partner when the resource provided by the partner is more important to its own resource acquisition. The ESS resource allocation by each player is equivalent to the one achieving the cooperative optimum.