A MATHEMATICAL MODEL OF POPULATION DYNAMICS WITH PREDATOR'S BEHAVIORAL CHANGE INDUCED BY PREY'S BATESIAN MIMICRY

H. Seno[a] and **T. Kohno**[b]

[a]Department of Mathematical and Life Sciences
Graduate School of Science, Hiroshima University
Kagamiyama 1-3-1, Higashi-hiroshima, 739-8526 Japan
seno@math.sci.hiroshima-u.ac.jp

[b]Department of Mathematics
Faculty of Science, Hiroshima University
Kagamiyama 1-3-1, Higashi-hiroshima, 739-8526 Japan

In this work, we analyze a mathematical model of the population dynamics among a mimic, corresponding model, and their predator populations. The predator changes its search-and-attack probability by forming and losing its search image. We analyze a mathematical model consisting of the daily population dynamics with ordinary differential equations, the seasonal population dynamics with difference equations, and the annual population dynamics with difference equations.

We construct a mathematical model consisting of the daily population dynamics with ordinary differential equations, the seasonal population dynamics with difference equations, and the annual population dynamics with difference equations. Each predation season is composed with the daily dynamics repeated day by day in T days. The predator population size is assumed to be kept constant, given by P, independently of the model and the mimic population sizes. This means such an assumption that the predator is a generalist and has some other preys to keep the stationary population size, so that it can survive and sustain its population even if the model and the mimic population go extinct.

The predator cannot distinguish the mimic from the model, so that each predator searches and attacks them with common probability. Once a predator predates a model individual, it comes to omit both the model and the mimic species from its diet menu, and then not to search nor attack them in the same day. If a predator predates a mimic individual, it comes to increase the search-and-attack probability for the model and the mimic. The frequency of predators with higher search-and-attack probability and that with zero search-and-attack probability decreases by a rate between the subsequent days, because of the predator's losing (i.e., forgetting) the search image.

The reproductions in model, mimic, and predator populations are assumed to occur between the subsequent predation seasons. In other words, there is no reproduction of model, mimic or predator within the predation season, so that the model and the mimic populations monotonically decrease due to the predation during the predation season.

Analyzing our model system, we can get the result such that the condition for the persistence of model population does not depend on the mimic population size, while the condition for the persistence of mimic population does depend on the predator's ability of the search image formation.