A MATHEMATICAL MODEL FOR A GROUP WAVE EMERGENCE WITH WAVING BEHAVIOR OF OCYPODID CRAB *Ilyoplax pusillus*

H. Seno[a] and **K. Tsutamura**[b]

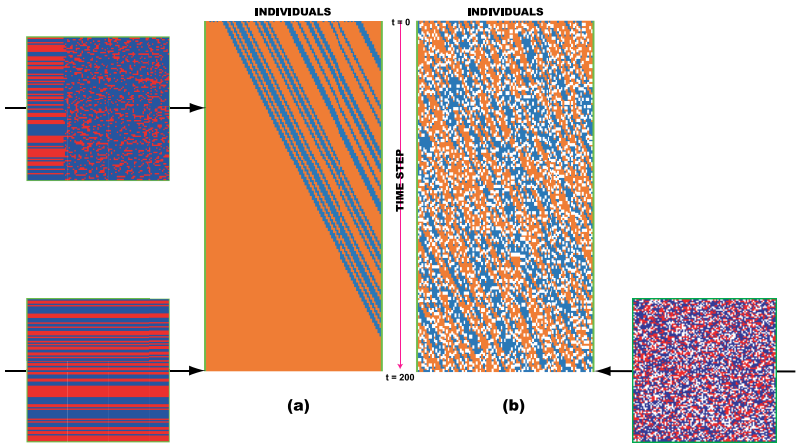
[a]Department of Mathematical and Life Sciences
Graduate School of Science, Hiroshima University
Kagamiyama 1-3-1, Higashi-hiroshima, 739-8526 Japan
seno@math.sci.hiroshima-u.ac.jp

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

Ocypodid crab *Ilyoplax pusillus* inhabits intertidal sandy-mud flats along the coast. Males show their chelipeds' "waving" behavior in the breeding season. Waving is regarded as an aggressive display against other males and an attractive display against females. *Ilyoplax pusillus* has been known from its globally quasi-synchronous waving pattern, that is, a spatial group wave emerged by an interaction between wavings of different males in space. As for such a group wave of *Ilyoplax pusillus,* no study has yet been conducted. In the present study, we try to get some theoretical insights about the mechanism of group wave's emergence, making use of a mathematical model with a cellular automaton.

In our model, each individual is located on the lattice point in the 2-dimensional square lattice space. In the initial condition, we give a "direction" and a state of waving to each individual: the chelipeds are raised or not. Each individual does not move. No individual exists at the boundary of the lattice space. One effective neighbor individual is chosen from the Moore type neighborhood, depending on the "direction" of each individual. When the effective neighbor's chelipeds are raised, the individual tends to synchronize its own waving, going to raise its own chelipeds simultaneously. With no effective neighbor, the waving is a perfectly periodic oscillation. Each individual has the "scooping" behavior, too. The individual stops the waving during scooping.

From numerical calculations of our model, the group wave does not emerge if any individual never performs scooping or if each individual perform scooping and changing its "direction" at random at each time step. The group wave emerges only when each individual performs scooping with a biased distribution of the "direction". From our results, we give a conjecture that some appropriate breaks of the interaction of waving due to scooping with a biased "direction" of individuals would be necessary for the group wave emergence in case of *Ilyoplax pusillus.*



Numerical calculations of our cellular automaton model. The direction of every individual is fixed to the left. (a) With no scooping; (b) With scooping. The temporal variation of the waving state is plotted for the individuals of the 50 th row in the 2-dimensional lattice space.