Effects of high frequency internal waves on the formation of moon jellyfish aggregations

*Takashi Mano[1], Xinyu Guo[2], Naoki Fujii[3], Naoki Yoshie[2], Hidetaka Takeoka[4]

1. Graduate School of Science and Engineering, Ehime University, 2. Center for Marine Environmental Studies, Ehime University, 3. Institute of Lowland and Marine Reserch, Saga University, 4. South Ehime Fisheries Research Center, Ehime University

Several jellyfish species such as moon jellyfish are known to frequently form dense patchy aggregations. These aggregations cause some damages on human activities, for example clogging seawater intake of power plant and breaking fishing net. Furthermore, their large abundance is concerned to have some harmful effects on coastal ecosystem. However, not only forming mechanisms of patchy aggregation, but also three dimensional distributions of the aggregations have not been revealed. In this study, we conducted observations for moon jellyfish using scientific echo sounder in order to obtain a three dimensional distribution of its aggregations. We then assumed that internal waves might affect in aggregation formation because the high frequency internal waves, whose period is about 10~20 minutes, occurred frequently around the observation area. In order to confirm this idea, we performed calculations of particle tracking in a flow field for idealized internal waves and examined the aggregation mechanisms from calculation results.

Observations using scientific echo sounder (Sonic KCE-300, frequency: 120 kHz and 38 kHz) were carried out during the summer of 2013~2016 in the Hokezu Bay of the Bungo Channel, Ehime, Japan. The observed aggregations can be divided broadly into following three patterns: (1) dense and patchy aggregation, namely, elongated or spherical shape, and some of them had hollow structure in its vertical cross sections such as reported by Churnside et al. (2015). In other words, the three dimensional form of the elongated aggregation was like a tube as long as several hundred meters; (2) layer structure distributing in a broad area at the same depth of pycnocline; (3) wave structure within the vertical cross section.

Assuming that the jellyfish individuals are completely passive to surrounding flow, particle tracking calculations in the flow field induced by high frequency internal waves of observed period and wavelength in the Hokezu bay were carried out. As a result, while wave structure analogous to the aggregation pattern of (3) was represented, dense patchy structure such as the pattern of (1) could not be reproduced. Therefore, it is difficult to consider that the patchy aggregation was formed only by a flow field. Active swimming behavior of jellyfish must be also involved in the formation of aggregation. In addition, since the results of particle tracking calculation can also be considered to represent the distribution of zooplankton, it is also suggested that the patchy aggregation cannot be formed as a result of foraging behavior of jellyfish. In the future, we will configure a jellyfish swimming model based on field observations and combine it with particle tracking model in the idealized flow field in order to reveal the formation mechanisms of jellyfish patchy aggregation.

Keywords: moon jellyfish, aggregation, internal wave

