

Effect of Global Warming on the Maturation, Spawning and Recruitment of Common Shellfishes Dwelling in Open-Exposed Rocky Areas

Contact person Hayashi Ikuo
Chief, Coastal Fisheries Promotion Section
Japan Sea National Fisheries Research Institute
Suido-cho 1-5939-22, Niigata 951-8121, Japan
Tel:+81-25-228-0451 Fax:+81-25-228-0655
E-mail:ihayashi@affrc.go.jp

Total Budget for FY2004-FY2005 20,953,000Yen
(FY2005; 8,980,000Yen)

Key Words Maturation, Spawning, Recruitment, Sea Water Temperature, Tsushima Warm Current, Japan Sea, Spatial-Temporal Change

1. Introduction

The Tsushima Current flows into the Japan Sea from the west off Kyushu Island, and reaches to Hokkaido Island after influencing the western and northern parts of the Japan Sea. This current does not have a greater influence on the surrounding environments than the Kuroshio Current in the Pacific, but it does have a particularly stable flow called the “Coastal Branch” which enters the Japan Sea through the East Channel of Tsushima Strait. As the coastal waters in the Japan Sea are not well-developed, the Branch has a direct effect on the coastal areas from the surface to a depth of 100 m and causes a cline of water temperature, with temperatures gradually decreasing as the flow goes further north. Furthermore, the natural environment has been maintained in a stable and comparatively good condition, particularly in rocky fishing grounds directly facing to open sea, which are not usually significantly impacted by human activities. Therefore, these areas offer an ideal field for long-term steady studies on the effects of environmental changes on marine organisms. However, in spite of that fact, there have been no investigations into the effects of global warming or water temperature change on marine animals living in shallow rocky areas.

2. Research Objective

The present study aims at evaluating the effects of global warming on common marine animals at present and in the future, by collecting spatial-temporal scientific information on their maturation, spawning and recruitment processes, which strongly react to a particular environmental factor, namely water temperature. Here, the coastal areas of a part of the East China Sea and the areas along the Japan Sea are regarded as one of the field facilities offering biological and physical experimental conditions. From these studies, contributions will be expected to include the prediction of future effects of the increase in water temperature and the proposal of a useful method in monitoring biological processes.

3. Survey Sites and Method

Study sites were specifically selected at the tip of peninsula and at off-shore remote islands along the coasts which are under the influence of the Tsushima Current. For the surveys on maturation and spawning processes, three herbivorous common gastropods, *Turbo cornutus*, *Omphalius pfeifferi* and *Astraliium haematragum* were collected at four sites: 1) Nomozaki in Nagasaki (E in Fig. 1), 2) Oki-Island in Shimane (C in Fig. 1), 3)

Awashima-Island in Niigata (B in Fig. 1), and 4) Oga Peninsula in Akita (A in Fig. 1) in the middle of month approximately from April to October in 2004 and 2005. About 25 adult individuals were chosen and their gonad development observed by calculating gonad index. For the recruitment, newly settled *T. cornutus* were collected with an underwater aspirating device at Nomozaki and Awashima in October of 2004 and 2005, and small *O. pfeifferi* were searched underwater with naked eye on gravelly bottoms of 1-2 m deep at Awashima in June and September, 2005. The direct underwater count of the spiny lobster *Panulirus japonicus* was made for post-settled pueruli and early settled juveniles at Nomozaki at irregular intervals from April to December in 2003-2005. Water temperature was measured at the four survey sites and supplementally at Iki Islands in Nagasaki (D in Fig. 1) at the entrance to the Japan Sea for the Tsushima Current, and Yura (F in Fig. 1) which locates at the opposite mainland side of Awashima.

4. Results and Discussion

(1) Maturation and spawning of three gastropods

Three species showed a similar seasonal fluctuation in maturation and spawning whereas their pattern showed geographically different in both years. In northern areas, maturation was well followed to the increase in water temperature and spawning occurred intensively in a short period. In southern areas, spawning became less intense and took longer with yearly high variations (Fig. 2, *A. haematragum* is shown as an example). Geographical comparison showed the differences in patterns of maturation and spawning between Awashima and Oki for the three species. These areas differed in water temperature during the periods of minimum and increasing temperature (Fig. 3). As this difference is only 2 or 3 degrees, it was inferred that a slight change of water temperature by warming may have a great effect on maturation and spawning patterns, particularly in northern areas. Among the three species, *A. haematragum* showed possibly more sensitive than the others, and the importance of this species as a monitoring species was noted.

(2) Recruitment of *T. cornutus*, *O. pfeifferi* and *P. japonicus*

There was no size difference for newly settled juveniles between Awashima and

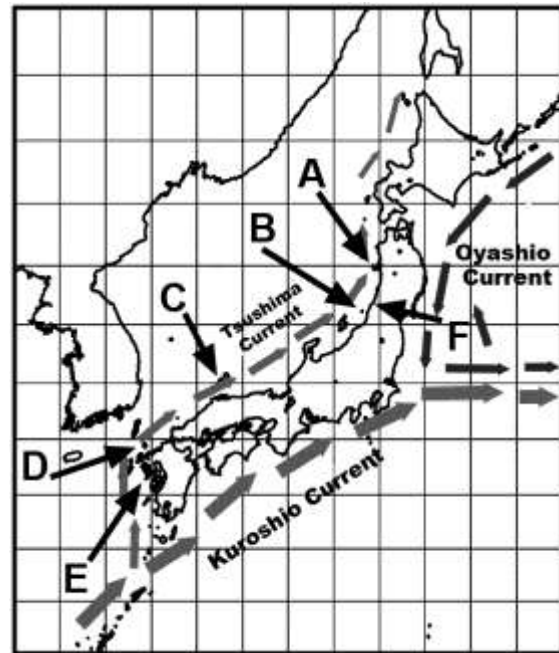


Fig. 1. Survey sites. A: Oga Peninsula, B: Awashima Island, C: Oki Island, D: Iki Island, E: Nomozaki, F: Yura

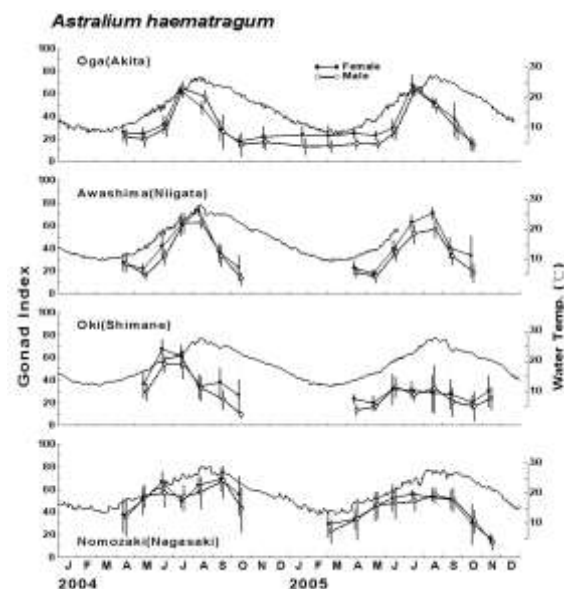


Fig. 2. Seasonal changes in gonad indices for *A. haematragum* at the four survey sites.

Nomozaki in both years, but the yearly difference was apparent at both sites. This suggested that settlement occurred in a similar period in spite of different pattern in spawning season and intensity. The density at Awashima in 2005 increased several folds higher than those at Awashima in the previous year and Nomozaki in both years (Fig. 4). It was inferred that this low density at Awashima in 2004 were attributable to the great influence by the typhoon in August of 2004. At Awashima, *O. pfeifferi* showed a single size class during June and September in spite of the rather long spawning season. This indicated that the only individuals spawned in a certain period recruited. *P. japonicus* was observed to start recruiting when the water temperature reached above 18-20 degrees. The recruitment occurred in December during a period of slight re-rise of water temperature. As the recruitment usually does not occur in this period, this indicated a possibility of a prolonged period of recruitment if the water temperature rises from autumn to winter.

(3)Fluctuations in water temperature

Based on the data at the six sites in 2003 and 2004 due to the fragmental data in 2005, water temperature was low in 2003 and high in 2004 as a whole, and the spatial-temporal fluctuation differed between both years (Fig. 5). This is considered to be very important when the comparison of maturation, spawning and recruitment is made. Time series analysis was made for comparatively long data set at Awashima and Yura, namely an isolated island and a part of mainland close to each other. The results indicated that both sites showed a similar trend in yearly fluctuation but Awashima was lower in summer and higher in winter than Yura. This

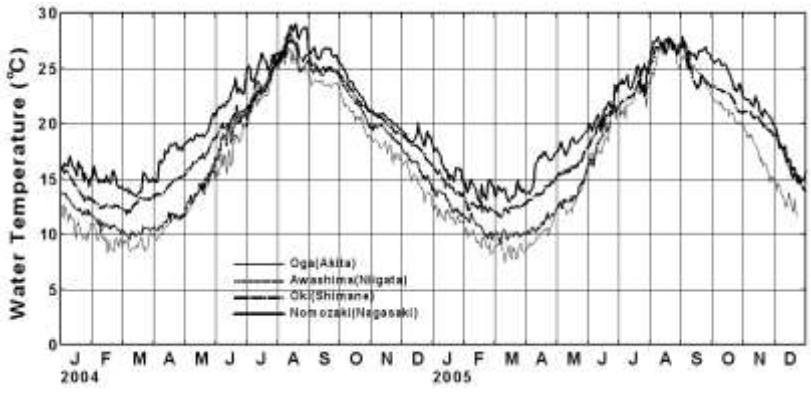


Fig. 3. Daily mean water temperatures at the four sites in 2004 and 2005.

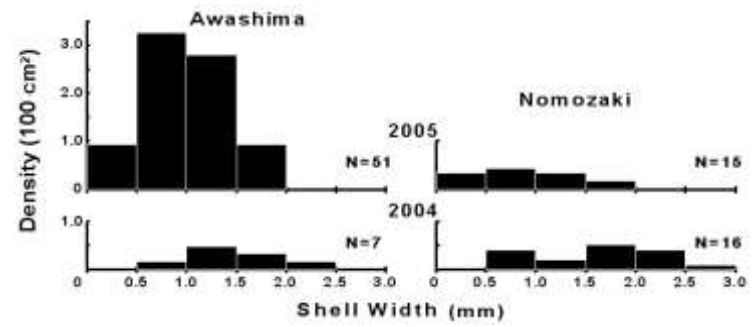


Fig. 4. Size frequency distribution of newly settled *T. cornutus* collected in October of 2004 and 2005.

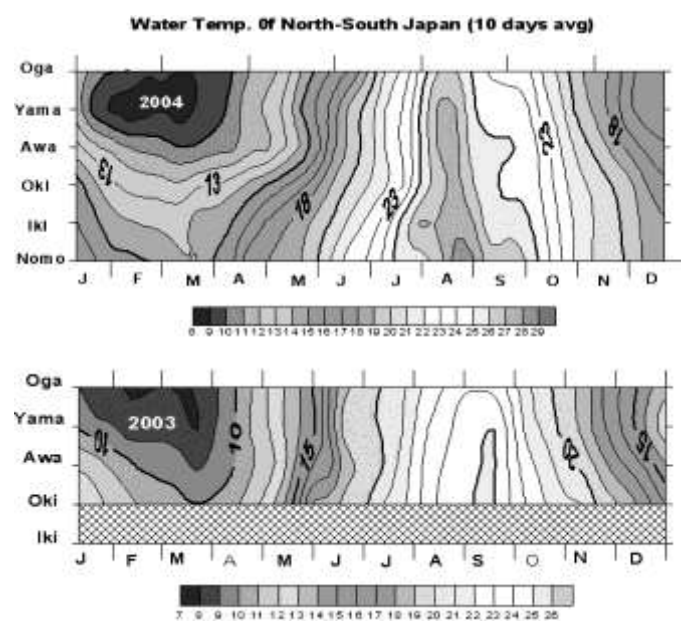


Fig. 5. Spatial-temporal fluctuation in water temperature based on the data at six sites

suggests that the choice of location for the survey on the maturation and spawning well agreed with the assumption as a start. As data on water temperature is only available for a short period so far, the need for both more extensive biological information and long-term measurements was reconfirmed.