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Oyster Culture in Hokkaido, Japan

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Abstract: The Pacific oyster, *Crassostrea gigas* is the one of the most commercially important aquaculture species in the Japanese fisheries industry and is cultured in various Japanese coastal areas including Hokkaido. The Saroma Lake and the Akkeshi Bay with estuary, which face Ohotsuku Sea and Pacific Ocean, respectively, are major oyster production areas in Hokkaido with total annual production of about 700 tons a year. The seedling spat supplied from Miyagi known as Miyagi seedlings are widely used in Japanese oyster culturing. Therefore, when the catastrophic tsunami on March 11, 2011 damaged the Miyagi fisheries, many oyster culturing areas were heavily affected. Moreover, introduction of seedlings from geographically separated population have risks of invasion of diseases and alien organisms as hitchhiking species. Using seedlings that originated from local populations in each area is one of the approaches for decreasing some risks. For example, in the Akkeshi area, the artificial seedling spats collected from the locally protected adults are also used for aquaculture, which are marketed as the value-added oysters with shell "Kaki-Emon" and popular among consumers as local special products.

Key words: Pacific oyster (*Crassostrea gigas*), Miyagi seedlings, Saroma Lake, Akkeshi Bay

The Pacific oyster, *Crassostrea gigas* is the one of the most commercially important aquaculture species in the Japanese fisheries industry with harvest of around 200，000 metric tons a year, the same as the Japanese scallop *Mizuhopecten yessoensis* (Ministry of Agriculture, Forestry and Fisheries, Minister's Secretariat, 2012). Although a lot of scallops were exported to other countries including the United States, most oysters are consumed domestically. Oyster culturing in Japan is reviewed by Inui (2013). The Oyster is cultured using raft or long line hanging method. Hiroshima and Miyagi prefectures are the main production areas in Japan, and there are also many other production areas along Japanese coastal area. Most of these areas use oyster seedlings which are naturally collected in Miyagi using scallop shell collectors and are known as Miyagi seedlings. Therefore, when the catastrophic tsunami on 2011 damaged the Miyagi fisheries, many oyster farmers were heavily affected because of uncertainty of seedling supply (Tanabe, 2012)

Hokkaido, a northern island of Japan is one of the premier oyster culturing areas with production of 700 metric tons a year (Marinenet Hokkaido; http://www.fishexp.hro.or.jp/marineinfo/internetdb/index.htm), using primarily Miyagi seedlings. Hokkaido has two main production areas, Saroma Lake and Akkeshi Bay and estuary (Fig. 1). Saroma Lake and Akkeshi Bay face towards the Ohotsuku Sea and the Pacific Ocean, respectively. These areas have similar production scales and Oyster industry history. In the early days in Hokkaido natural oyster beds were very productive in these areas and the oysters were harvested from there (Inukai and Nishio, 1937). However, natural oyster resources were lost around

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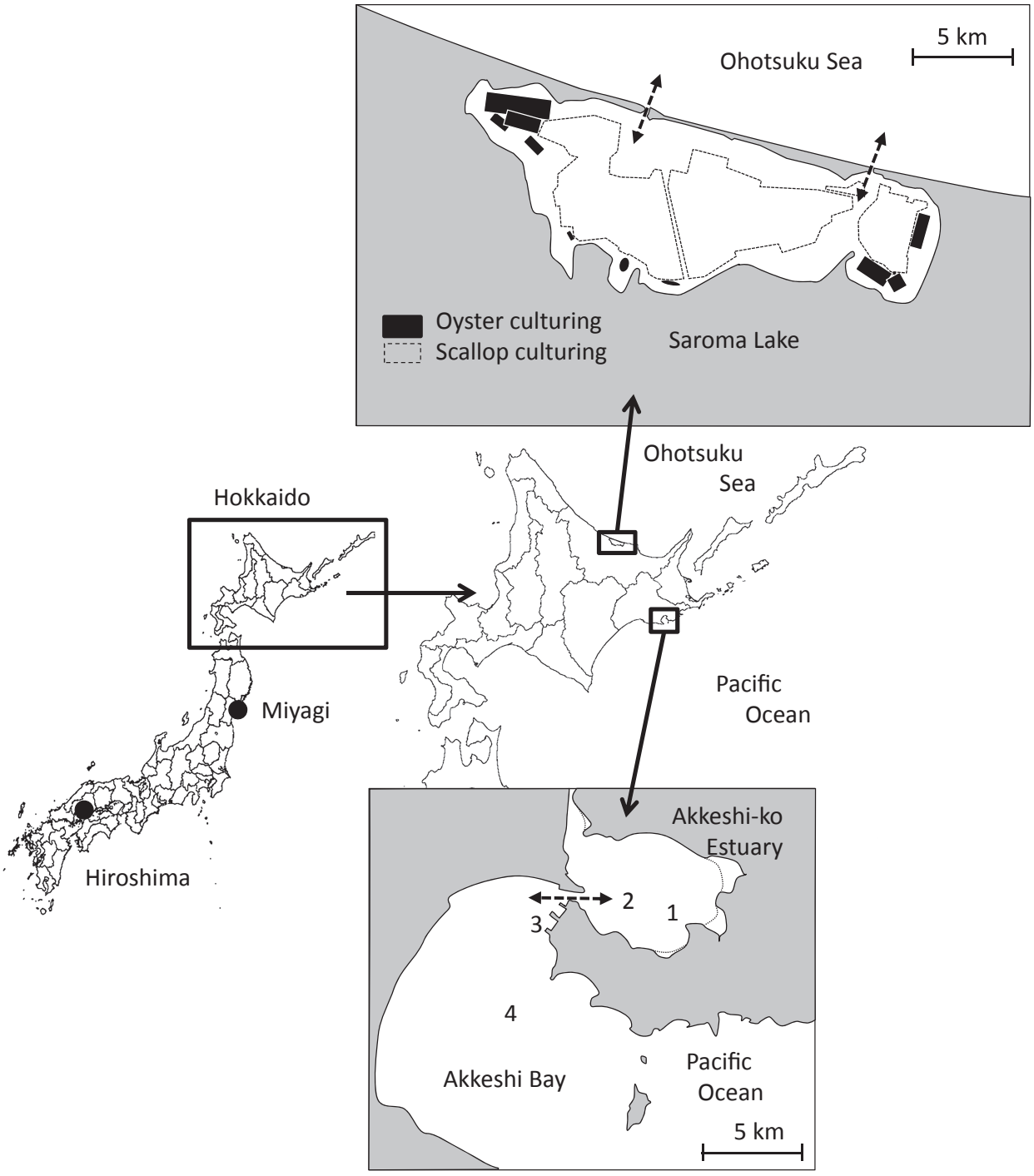

Fig. 1. Main Oyster culturing areas in Hokkaido, Japan.

the 1930s and since then the oyster industry has relied on Miyagi seedlings.

Features of oyster and scallop culturing in Saroma Lake

Ground and suspended culture of scallops are the main fisheries in the Abashiri Sub prefecture with Saroma Lake in Hokkaido where production reaches 150,000 metric tons a year. Most areas of Saroma Lake are utilized for scallop culture and unsuitable areas for scallop culture due to shallow depth and high water temperatures during summer are used for oyster culture (Fig. 1). In the lake, scallop culture is a major fishery (> 77% of total catch), however, most culture activities must be stopped

during winter due to lake freezing. Oyster fisheries contribute a little (< 1%) to increase the diversity of fisheries and reduce dependency on scallop culture, but oyster culturing brings jobs to farmers in winter such as shucking because oyster's in this area are mainly composed of age 1+ and so small oysters are shipped as a shucked product. Moreover, older fishermen have special feeling for oyster culturing because oyster fishing had been prospered in the lake until 1928 when the continuous channel was opened between Lake and cold Ohotsuku Sea and the oyster could not reproduce in stable (Nishihama, 1994).

Features of oyster culturing in Akkeshi Bay and Estuary

The most important feature of Akkeshi is the topography (Fig. 1), Akkeshi has two different ecosystem types; Akkeshi Bay and the Akkeshi-ko estuary. Akkeshi Bay faces the Pacific Ocean where a cold subarctic ocean "Oyashio" current flows, while the Estuary is shallow (average depth: 1.5 m). The continuous measurement of surface water temperature shows that the temperature in this Estuary increases earlier than in the Bay from spring to summer, reaching temperatures higher than 25 ℃. However, water temperature in the Bay is around 20 ℃ in late summer (Fig. 2). Culture experiments using single-seedling oysters showed variations of growth rate and nutritional condition index between oysters from the Bay and the Estuary. The ratio of flesh wet weight to whole body weight of oyster, which is one of the indices of oyster nutritional condition was lower in the estuary than the bay throughout the experiments (Fig. 3a and b). The specific growth rate of shell height was higher in the Estuary than the Bay in early summer (Fig. 3c and d). The early increase in temperature from spring to summer enhances oyster growth and maturation and early spawning occurs in the Estuary. These features of both culture areas are recognized by farmers and efficiently utilized. The fishermen use the Estuary as the warmer area for enhancing oyster growth and maturation with early spawning. Otherwise, the Bay has a greater surface area, water volume, and food availability than the Estuary, which contributes to improved body conditions of oysters before shipping seasons.

Therefore, fishermen use these two areas properly, and Akkeshi oysters have some advantages to other culturing areas. But carrying capacity is limited by the topography of the shallow and small estuary. To avoid this problem, single-seed oysters are cultured in Akkeshi, which are suitable for farming in shallow areas. In the hatchery, larvae are collected from local adult spawns and settled on small oyster shell pieces individually as single-seedling oysters. The juvenile

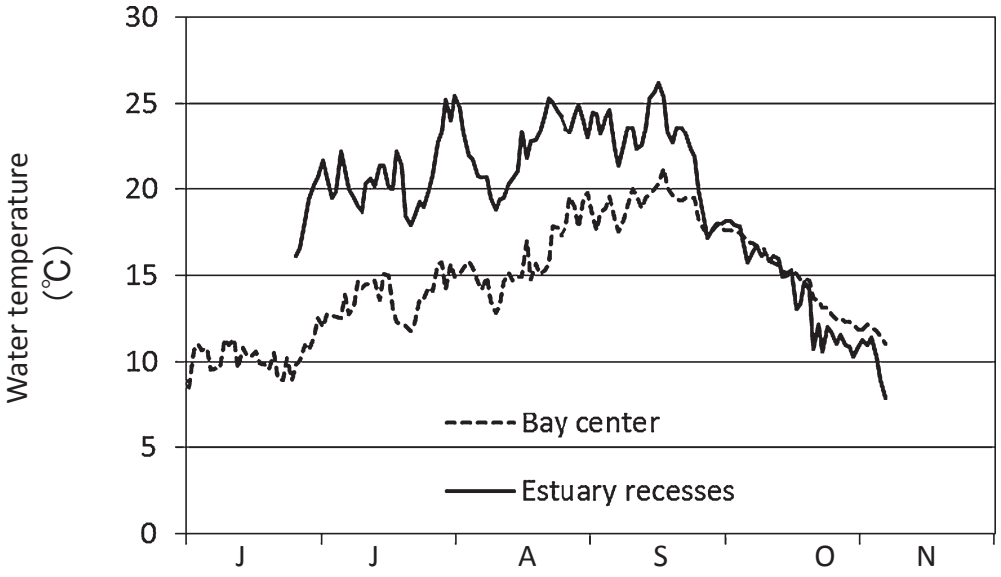

Fig. 2. Fluctuation of water temperature at Akkeshi Bay and Estuary, Japan during 2012.

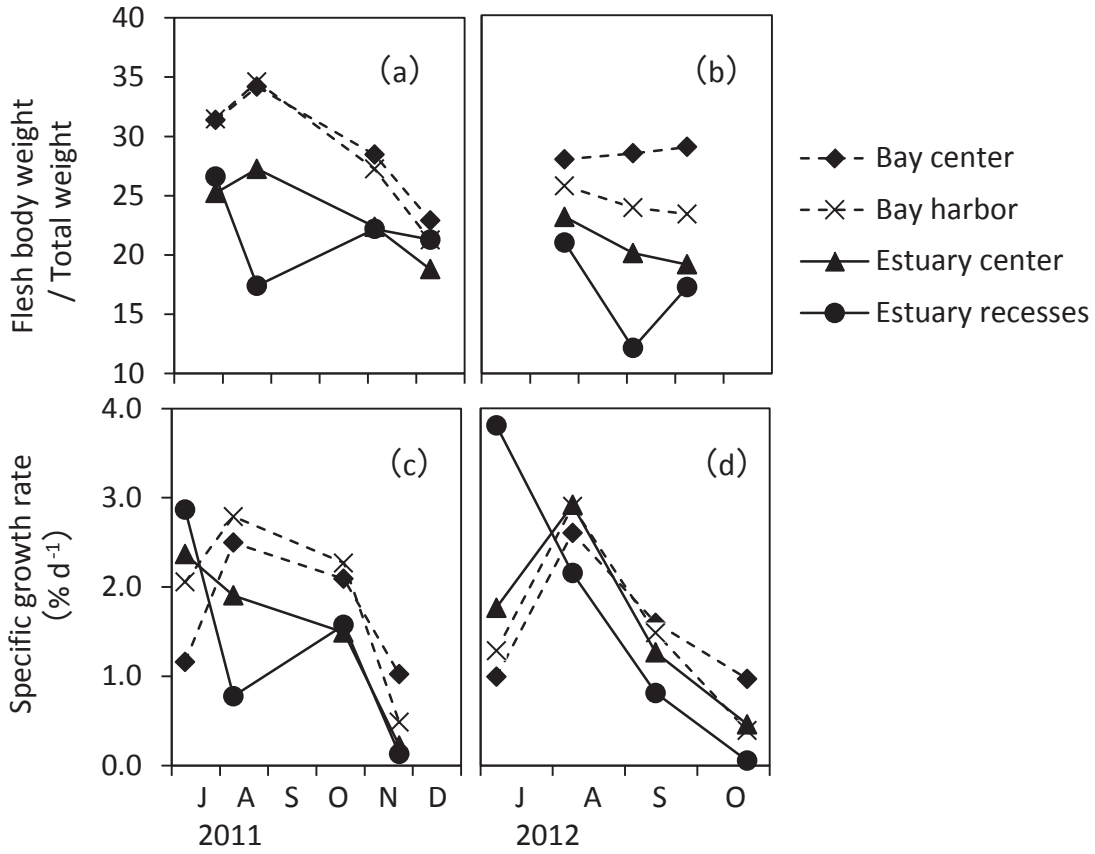

Fig. 3. Temporal and spatial variation in ratio of fresh wet weight to total weight to whole weight (a and b) and specific growth rate of shell height (c and d) of *Crassostrea gigas* in Akkeshi Bay and Estuary, Japan.

oysters are cultured in the bay and the estuary using baskets. By using basket rearing, more oysters can be cultured in shallow areas such as Akkeshi-ko estuary. And basket hanging keeps oysters in the water column away from pollution on the estuary bottom. Moreover, through basket hanging, single-seed oysters have deeper shell breadth than oysters on scallop shells. These oysters are marketed as value-added oysters with shell "Kaki-Emon" and are popular among consumers as local special products (Fig. 4). Akkeshi town is aiming to be known as "Oyster town" using single-seed oysters to promote tourism and sightseeing, and to develop brand strength of other fisheries products. However, the yield of single-seed oysters was lower than that of Miyagi-seedling oysters at the beginning of this culturing, because the standard culturing methods for Miyagi seedlings were not suitable for single-seed oysters. Therefore, the culture of single-seedling oysters does not increase as much as the research and promotional organizations expected, even today.

Fig. 4. PR poster of local premium oyster in Akkeshi "Kaki-Emon".

Problems facing oyster culturing in Hokkaido

Miyagi-seedling has been widely used in Japanese local production areas including Hokkaido because most of the seeding are naturally collected using scallop shells with low costs and a stable source provided by the specialized farmers in Miyagi prefecture. These Miyagi oysters have faster growth potential, and thus are preferred by many oyster farmers. Even though there is wide-scale use of Miyagi-seedlings throughout the area, genetic differences can be detected among some local/wild populations in Japanese local production areas (Usuki *et al*., 2002). The tsunami in 2011 exposed the risks of excessive dependence on Miyagi seedling supplies. Moreover, introduction of seedlings from geographically separated populations have risks of introducing diseases and alien organisms as hitchhiking species. For example, invasive ascidians were also recorded in some bivalve culturing areas in Japan. In particular, *Ascidiella aspersa* strongly affect the scallop culturing in Funka Bay, Hokkaido (Nishikawa *et al*., 2014). The paramyxean parasite, *Marteilioides chungmuensis*, has negative impacts on the oyster industry in some Japanese production areas with heavily infected oyster's showing abnormal tissue (Ito *et al*., 2002). Moreover, the potential transport of harmful algae together with bivalves has also been reported (Matsuyama *et al*., 2010). Using local seedlings is one of the approaches to decreasing these risks. After the Miyagi seedling crisis, the use of local populations is beginning in some production areas. However, similar to the experience in Akkeshi, it is necessary to improve culturing techniques and management for culture of local seedlings because they have different characteristics. Moreover, sales strategies of "local oyster" with premium price are also important to promoting use of local seedlings to compensate for additional cost and effort.

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