Original Research Article
THE CULTIVATION OF SCALLOP (*Patinopectenyessoensis*) IN HOKKAIDO, JAPAN

ABSTRACT

This study aims to determine how the cultivation system, technology, and transportation are applied in the cultivation and sale of scallops in Japan. The method used in this research is a descriptive method and direct observation method at one of the family businesses of scallop cultivation in Ishikari, Hokkaido, Japan, hereinafter referred to as Company X, which this research is the result of an internship at the Company. This study concludes that the cultivation media used at Company X are onion bag nets, pearl nets, and lantern nets. The transportation system in the cultivation of scallops in Japan is divided into two, namely sea and land. The sea transportation system carried out by Company X is included in the open dry system transportation using two special ships measuring 9.7 and 12 GT equipped with Hydraulic Cranes for Shipboard Use (Marine Cranes) technology from the UNIC Ocean Crane company with the UBV500J series which is capable of lifting loads to 960 kg in one transport with the classification of truck-mounted cranes. As for the land transportation system, for the delivery of young clams in Company X, it is included in the exposure method by using a plastic container basket and covered with wet rice sacks to prevent dryness and the clams in the basket from biting each other.After that, the mussels are transported by freezer truck. The oxygen method is used to ship adult scallops using a freezer truck filled with oxygenated seawater.

Keywords: Cultivation, Japan, Scallops, Transportation

1. INTRODUCTION

The scallop (*Patinopectenyessoensis*) is a cold-water scallop that is widely distributed in the coastlines of Northern Japan, the North Korean Peninsula, and the Russian Far East [1]. Scallops (“hotate-gai” in Japanese), are cultivated in Japan for their good food quality and high productivity [2]. Over the past 30 years, scallop production has increased from less than 50,000 tons to 500,000 - 600,000 tons per year [3].

In order to sustain and achieve this level of harvest, the industry is evolving from a traditional wild fishery to an aquaculture-based one. The current development of the fishery is based entirely on intensive and directed efforts to collect wild scallop spat and then grow the spat to a marketable size using several culture techniques. Aquaculture mainly utilizes a combination of sowing culture and hanging culture techniques, with considerable success in both. Japanese scallop cultivation has developed into the most successful marine scallop farming enterprise in Japan [4]. Currently, more than 40% of scallop production in Japan comes from aquaculture [5]. The main region of scallop farming is Hokkaido (Lake Saroma, Sea of Okhotsk, and Funka Bay), where nearly 80% of production in Japan during 1991-2002 occurred [6].

Human needs cannot be obtained in any place, and human needs are not always in the same location or close to consumers, therefore transportation becomes a link between production areas, marketing areas, consumer areas, and raw material source areas [7]. In aquaculture, live fish transportation is moving aquatic biota in a living state by taking measures to maintain a high level of survival to the destination. The transportation of live fish is divided into two, namely transportation without water media or dry transportation and transportation using water media or wet transportation [8]. Therefore, in aquaculture, specifically scallop, transportation is a crucial factor that needs to be considered.

Based on previous studies, many have discussed the cultivation of scallops and the transportation system applied. This study aims to determine how the cultivation, technology, and transportation systems are applied in the cultivation and sale of scallops in Japan. It is hoped that this paper can be

used as a comparison and study material in the future development of shellfish farming in Japan, especially for the cultivation of scallops and transportation of marine fish commodities.

2. METHODOLOGY

The research was conducted from December 2022 to June 2023 in Hamamasu, Ishikari City, Hokkaido Prefecture, Japan. In this research, the method used is a descriptive method by exploring the literature such as the Directory of Open Access Journals, Research Gate, and Google Scholar. The keywords used for relevant discussion topics include scallop farming, transportation of scallop farming, scallop farming in Japan, and scallop shelling. This descriptive research was conducted without any treatment or manipulation of the research sample. The purpose of descriptive research is to reveal the characteristics of the subject [9]. In addition, using direct observation methods at one of the family scallop farming businesses in Ishikari, Hokkaido, Japan, hereinafter referred to as Company X, this research is the result of an internship at the Company. Thus, the theoretical framework can be organized by the subject matter..

Observations were conducted to identify the stages of scallop aquaculture and the types of transportation in the scallop aquaculture activities at Company X, including conducting interviews with those directly involved in scallop aquaculture activities to find out the activity procedures of each transportation system. Then, measuring and documenting the equipment used in the implementation of these transportation activities. In addition, conduct a literature study to find out the basis of each treatment in transportation activities. Digital documentation processing using Oppo Camera, iPhone Camera, and Microsoft Word software from Microsoft Office 365 was used in the preparation of the report.

3. RESULTS AND DISCUSSION

3.1 Scallop Cultivation in Japan

Scallops are cultivated by hanging or sowing. They are transferred from the estuarine lagoon to the nearshore seabed when they reach 40-60 mm shell height after the "intermediate" culture stage. Scallops are cultured at a depth of 40 - 65 m and the cohorts are separated in four culture zones during 3 years of rearing culture [10]. In Japan, the sowing culture method has been practiced off the coast of the Sea of Okhotsk. This culture technique consists of several processes. First, scallop spat are caught in collectors suspended in the water column where spawning stock is kept. Next, the spat are reared in hanging cages until they reach a shell height of 30 to 50 mm and then released to grow in the sand. After three years, the scallops reach a marketable size with a shell height of about 120 mm and are harvested by dredging. With this farming technique, clam survival between release and harvest is estimated to average 50%, although there is variation between different years and farming sites.

In 2017, the total production of Hotate clam culture in Japan was 174,000 tons across Japan. The prefectures with the highest order of production were Hokkaido 84,900 tons, Aomori prefecture 84,300 tons, and then Miyagi prefecture which can be seen in Table 1 [11].

Table 1. Total production of scallop aquaculture in Japan (Year 2017)

Year	2017
Hokkaido	84.900
Aomori	84.300
Miyagi	2.800

3.2 Scallop Cultivation Media

The culture method used in most areas is the hanging longline method (Figure 1) [11]. During the culture process, scallops grow by feeding on phytoplankton in the sea. However, the size of the scallops to be delivered, the delivery time and the cultivation method vary depending on the sea area. The location and method for scallop cultivation are determined by the Fisheries Cooperative Association (Gyokyo) and are rules that must be followed.

The medium for cultivation varies as follows: (1) Mimizuri method, or ear-hung method, in which holes of 1.31 - 1.5 mm are drilled in the front half of the left valve through the notch of the right valve or through both front ears near the byssal notch; (2) Maru Kago or Lantern net: consists of short cylindrical units 50 cm in diameter and 15 cm high and framed with #8 vinyl-coated wire. The cylinders are connected linearly. Cages are made of 7' Bu' or 21 mm knotted polyethylene mesh and 5 mm hanging thread. Five to ten clams per unit are caged; (3) Poketto-kago or pocket net: 60 cm wide and 20 cm high and is made from double mesh and #8 vinyl-coated wire, by sewing two pieces of mesh facing each other into a purse shape. This creates a thin pocket mesh shape, consisting of 10-25 units. The nets are 7" Bu, the same as the lantern nets. Six scallop shells per slit unit are inserted; (4) Hausu-kago or cage house: a 15 cm diameter cylindrical plastic sub-unit divided into 12 rooms, 5 or 6 sub-units being one unit. Sometimes these units are hung vertically. One individual is placed in each room. These cages are used only in parts of the Sea of Okhotsk; and (5) Paru-netto or pearl nets: coarse nets are used for aquaculture. Although generally longline systems are used for aquaculture facilities, facilities called "sets" in Funka Bay are also used, where multiple longlines are connected together and concrete blocks, sandbags, or super anchors are used for fixation, and buoys are attached to the block rope and main rope and have a structure capable of withstanding storms [12].

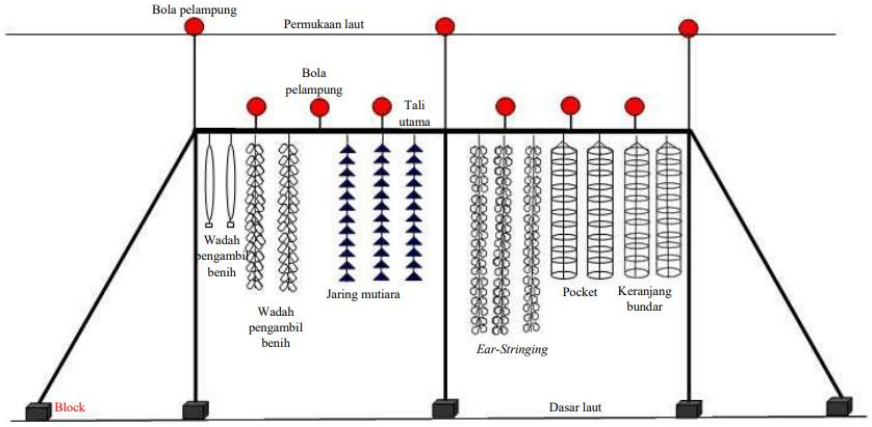


Figure 1. Scallop cultivation facilities at sea

3.3 Scallop Cultivation Cycle

The stages of scallop farming are simple in concept, consisting of collecting newly settled shelled larvae called “spat” in collecting bags and growing juvenile scallops in protected hanging cages (first pearl nets and then lantern nets) until they reach commercial size. An alternative way apart from this hanging culture after juvenile scallop spat (intermediate culture) is to sow 3 cm seeds from a pearl net in a protected sandy seabed area and dredge the shells after 2 - 5 to 3 - 5 years.

Spat collection nets are set up in stages from mid-April to early May to collect hotate mussel fry at sea. Then, the net will be lifted from the sea to remove the spat from the spat collection container, this process is carried out in July to August and is done in the morning. The spat will be hung in pearl nets at sea for one year until they reach a size of 3 - 3.5 cm, after which the scallops will be removed from the sea. Thereafter, the 1-year-old scallops are used for final growth, which is carried out in lantern nets or on prepared seabeds where the scallops enjoy lower densities than in the native habitat for faster growth rates and better weight gain [13].

3.4 Problems Associated with the Scallop Cultivation

Aquaculture problems, which often result in mortality, can be classified as problems caused by nature or aquaculture. Natural problems arise from predation, parasites and also environmental problems from wave action, unsuitable substrates and red tides. Problems caused by aquaculture are too many cages, attempts to improve poor seed quality and deterioration of water quality in the culture area [14].

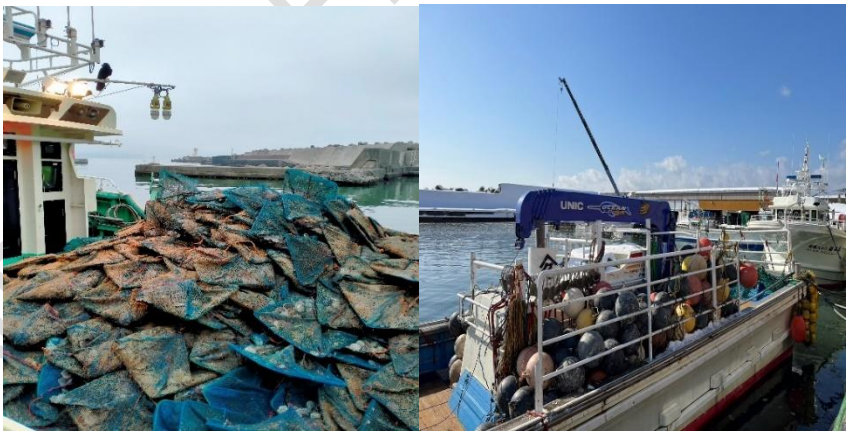
3.5Types of Scallop Transportation

3.5.1 Sea Transportation

At the harvest stage of scallop aquaculture, there is a sea transportation stage where scallops are transported from the aquaculture facility at sea to the landing site. At Company X, sea transportation transports harvested one-year-old scallops for shipment of young scallops and 3-year-old and 4-year-old scallops for shipment of mature scallops. Loading, unloading, and traveling should be scheduled at convenient times, and done as quickly as possible [15]. The transportation of scallops is carried out at the location of the rearing container nets that have been placed in the middle of the open sea, so special vessels are required for sea transportation. In Company X, two specialized vessels are used, which are 9.7 and 12 GT in size. In addition, the specialized vessels are equipped with Hydraulic Cranes for Shipboard Use (Marine Cranes) technology from the UNIC Ocean Crane company with the UBV500J series which is capable of lifting loads of up to 960 kg in one transport (Figure 2b). Based on a book issued by the Occupational Safety and Health Branch (2017) entitled Code of Practice for Safe Use of Mobile Cranes, this crane technology from the UNIC company includes truck-mounted cranes or cranes mounted on vehicles where the control engine is separate from the main vehicle [16].

In the transportation process, the ropes hanging from the aquaculture facility are collected and hooked onto one large hook, which is then transported by a ship's crane and finally, when the bottom of the crane wire is released, the mussels slide down to the deck of the ship (Figure 2a). In one transportation process, the crane can lift 10-20 ropes with a weight of about 30-60 kg/rope. The scallops are then brought ashore to be processed. This sea transportation system is included in the open dry system transportation. Dry system transportation is a transportation system that does not use water as a medium, but the environment or container used is made moist [17]. Dry transportation systems apply the principle of conditioning aquatic biota in a state of low metabolism and respiration so that endurance outside their living habitat is high [18].

After the sea transportation is landed, the scallops will go through a cleaning process from parasites attached to their shells [19]. After the scallops are processed, they will be shipped by land to reach the consumers.



2a **2b**

Figure 2. (a) Nets that have been transported on the deck of a ship (b) UNIC Ocean Crane at Company X

3.5.2 Land Transportation

In addition to sea transportation, there is also land transportation of scallops that occurs during the process of delivering scallops to other parties, including consumers. The handling process in transportation activities is very important for fishery products, starting from the landing of the fish until it reaches the hands of consumers or the area of origin. There are two types of shipments made by

Company X, namely, shipping young scallops that are one year old with a size of 3.5 cm or more. In addition, shipments of adult scallops that are three years old with a shell size of 11 cm, weighing about 6 pieces/kg, and scallops that are 4 years old, weighing 3 - 4 pieces/kg.

Based on observations, land transportation for shipping young scallops at Company X uses plastic container-type baskets. The scallops are sold to fishing cooperatives in Sarufutsu and Esachi, and the cooperatives that purchase the scallops will release and grow the scallops into the sea, where they will be harvested after 3 years. The scallops delivered by this company are in their shelled form. Land transportation of young scallops in Company X is included in the exposure method using plastic container baskets covered with wet rice sacks to prevent dryness and the scallops in the baskets from biting each other. After that, the scallops are transported by freezer truck. All handling and transportation are done during the cold period. With this method, the survival rate of scallops can reach 80-90% [14].

In land transportation for the delivery of adult scallops at Company X, baskets are used first to handle and weigh the scallops. After that, the scallops will be put directly into the freezer hatch of the truck without using any container, the hatch has been filled with seawater. The adult scallops will be sold and shipped to South Korea. The land transportation of the adult scallops in Company X is included in the Oxygen method by using a freezer truck that has been filled with oxygenated seawater [14].

3a **3b**

Figure 3. (a) Young scallop shells to be shipped (b) Adult scallops to be shipped

Figure 4. Putting young scallops into the freezer truck for shipping

3.6 Factors in Transportation of Fishery Products

Based on notes on sea transportation observation activities, it is known that sea transportation activities must pay attention to the time of collection, the size of the wind blowing, and the number of scallops to be processed (Table 2). in his research stated that there are crucial factors in the transportation of live marine fish, namely sea transportation, fasting, cooling, and oxygen supply. Then, on land transportation, temperature fulfillment, anesthetizing media, decreasing salinity, fish volume ratio, and media and oxygen [20].

Table 2. Important Factors in Sea and Land Transportation

Sea Transportation	Land Transportation
Temperature Fasting	Temperature Fasting
Wind Speed	Container/Carousel
Weather (Transportation Time)	Temperature Control
Number of Fish	Fish Ratio/Volume
Oxygen	Oxygen

4. CONCLUSION

The cultivation media used in Company X are onion bag nets, pearl nets, and lantern nets. The transportation system in scallop aquaculture in Japan is divided into two, namely sea and land. The sea transportation system carried out by Company X is included in the open dry system transportation using two special ships measuring 9.7 and 12 GT equipped with Hydraulic Cranes for Shipboard Use (Marine Cranes) technology from the UNIC Ocean Crane company with the UBV500J series which is capable of lifting loads of up to 960 kg in one transport with the classification of truck-mounted cranes. As for the land transportation system, for the delivery of young clams in Company X, it is included in the exposure method by using a plastic container basket and covered with wet rice sacks to prevent dryness and the clams in the basket from biting each other. After that, the mussels are transported by freezer truck. For the delivery of adult scallops, the Oxygen method involves using a freezer truck filled with oxygenated seawater.

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