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Oyster Culture in North America History, Present and Future

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Abstract

There are five main species of oysters in North America. On the Atlantic Coast, the American oyster *Crassostrea virginica* is the most important, being cultivated in Mexico, in the United States and in Canada. The other species is the European oyster *Ostrea edulis* which exists in Canada and the north eastern part of the United States.

On the Pacific Coast of Canada, there are three species of oysters :the native oyster *Ostrea lurida*, the American oyster *Crassostrea virginica*, and the Pacific oyster *Crassostrea gigas*. The Pacific (Miyagi) oyster is the most important. In the market, it has replaced the native oyster that had been depleted by over fishing and water pollution. The Pacific oyster was first introduced into British Columbia waters about 1912 or 1913 from Miyagi Prefecture in Japan and is now established along the Pacific Coast of Mexico, the United States (including Alaska) and Canada.

In its new North American home, the Miyagi oyster has adapted to a diversity of natural habitats and culture methods. It also has shown an ability to withstand natural predation and a resistance to disease. After suffering heavy mortalities in conditions of high water temperatures and low water circulation, it seems to have adapted. Its introduction and successful implantation has played a large role in the survival of the oyster industry on the Pacific coast of America.

Given the public interest in cleaner environments and in healthy food from the sea, there may be a greater role to play for the Miyagi oyster in its new North American home.

Introduction

Oysters have been exploited for a long time in North America. In 1608, Samuel de Champlain found and tasted succulent oysters on Isle Saint−Jean, in the Gulf of St−Lawrence. This discovery led to a long relationship between francophone Canadian consumers and oyster producers from the Gulf of St−Lawrence, relationship that still endures to−day. (Lavoie, 1978). Isle Saint−Jean is now the Canadian Province of Prince Edward Island, home of the World famous Malpeque oyster.

Following the gradual colonisation of North America by the French, the British and the Spaniards,

and the subsequent creation of the United States of America and of Canada, natural oysters stocks on both coasts became depleted first by overexploitation, then by habitat degradation and pollution. Towards the middle of the 19th century, oyster culture started to be seen as a solution to save what was left of natural stocks and to fill the ever increasing market demand for oysters.

On the Atlantic coast of North America, the native American Oyster *Crassostrea virginica* responded well to aquaculture. On the Pacific Coast, the native Olympia oyster *Ostrea lurida* did not enjoy similar success. Attempts to establish the American oyster *Crassostrea virginica* had limited success. The Pacific Oyster *Crassostrea gigas* imported from the Miyagi Prefecture in Japan gradually established itself along a vast portion of the Pacific Coast, and became the dominant species.

This paper first presents a very brief history of oyster culture in North America to set the context. It then focuses on the Pacific oyster and briefly describes its present status in Mexico, the United States and Canada. A number of factors related to its successful implantation are discussed. The paper then describes current markets and trends and concludes with ideas about the future.

History

Three species of oysters occur naturally on the Pacific Coast of Canada : the native oyster *Ostrea lurida*, the Atlantic oyster *Crassostrea virginica*, and the Pacific oyster *Crassostrea gigas*. (Quayle, 1988). Records show that the native oyster was marketed in 1884. Efforts to cultivate it took place in the 1930s.; over time, its populations dwindled, possibly because of overexploitation and of deleterious environmental factors. The Atlantic oyster was introduced to several areas in 1903, but it failed to establish itself in any significant quantity except in estuaries of rivers flowing into Boundary Bay. By 1936, production of both native and Atlantic oysters had virtually ceased. (Quayle, 1969).

The Pacific oyster *Crassostrea gigas* was first introduced in Ladysmith Harbour and Fanny Bay in 1912−13. Natural oysters sets were found in Ladysmith harbour in 1925. These discoveries led to the first large scale transplants in 1926 when 2,000 individual oysters of 2−3 years of age were transplanted from Samish Bay, USA. The same year, 20 cases of seed were imported from Japan. Between 1929 and 1932, four million seed was imported. Seed importation from Japan had virtually ceased in 1961.

Five species of oysters are cultivated on the Pacific Coast of the United States : the native oyster *Ostrea lurida*, the Atlantic oyster *Crassostrea virginica*, the Kumamoto oyster *Crassostrea sikamea*, the European flat oyster *Ostrea edulis*, and the Pacific oyster *Crassostrea gigas*. The Pacific oyster is by far the dominant species, with a production level in the range of 5 million Kg of meat per year (Chew, 2003).

In 1899, the possible importation of Japanese oysters was raised by the United States Fish Commissioners with the Imperial University of Tokyo. (Galtsoff, 1929). The University

responded that oyster from the beds located at Akkeshi Bay, Hokkaido would be best adapted for transplanting in North America. From 1902 to 1920, several transplants of oysters from various locations in Japan were made to Samish Bay near Bellingham, and other areas of Puget Sound, Washington State. (Steele, 1964). From 1924 to 1960, the Pacific Oyster Growers Association imported 1,012,638 cases of seed for distribution in the United States of Washington, Oregon, California and Alaska, and in the Canadian Province of British Columbia. In addition, 214,456 cases of seed were bought by non−members of the Association. There were no seed purchases in the years 1942−1946.

The Pacific oyster was introduced to Mexico in 1973 using seed purchased from a hatchery owned by the Lumi Indians in Marietta, Washington USA. Its culture gradually spread to the northern states of Baja California, Baja California sur, and Sonora.

Present status

Mexico

In Mexico, Pacific oyster culture takes place mainly in the northern States of Baja California, Baja California sur and Sonora. Oysters are grown in bags on racks, and on the bottom. Production was in the order 1622 tons in 2003 (US$ 2.4 M). The industry employs approximately 1,800 workers. Seed is imported from the United States. Since 1997, there have been mortality problems involving seed, juveniles, and adults mortality. One possible cause of these mortalities is the Gill Necrosis Virus (GNV).

Canada

In Canada, Pacific oyster landings amount to 81% of all shellfish culture harvest. (MAFF, 2004). Production amounted to 7,000 tons in 2003, with a landing value of C$ 7.6 M. Oysters are grown on the bottom, in bags, trays, and lines suspended from rafts. Some local seed is available from Pendrell Sound and Ladysmith Harbour, but spatfall intensity can be unpredictable. Most seed is imported from hatcheries located in the United States, mostly in Washington and California States. Most of the oysters are marketed as shucked meat. There is an increasing high−end market for half−shell oysters. Specialty products and markets are increasing in importance. Some high−end producers cannot meet demand. There are approximately 1,000 hectares of good intertidal oyster growing bottom owned by the Crown in British Columbia (Quayle, 1988). In addition, many oyster farms practice off−bottom culture. The system of long−term tenure provides an element of stability but leaves growers at the mercy of Government with regards to annual leasing fees and security of tenure over the long−term.

United States

The Pacific oyster has been the most important cultivated oyster in the United States since

1977. (Chew, 2003). The 2003 production was 4.5 million kg of meat, about 95% of the oyster production of the Pacific Coast. Most of the seed comes from hatcheries that can deliver the reliable supply required for production planning and infrastructure investments.
Washington State with over 61% of the landed value in 2003 is by far the largest producer. Favourable environmental conditions in good oyster growing areas like Willapa Bay, Oakland Bay and Samish Bay may explain part of that success. Another success factor is an administrative system that allows for ownership of tidelands (Beattie, 1982). Ownership provides stability of tenure and a stable cost base for business planning. In Washington State, it has also allowed growers to modify substrates to improve oyster productivity and to practice predator control.

Adaptations of the Pacific Oyster to the West Coast of North America.

Environment

The Pacific oyster had to overcome many challenges in order to occupy new territory on the North American Continent. First was the hardship of being harvested, packed and shipped across the Pacific Ocean. Several accounts of the gradual evolution of the shipping process are given by Steele (1964). Sometimes the seed was out of the water for more than one month between the time it was harvested and packed in Japan to the time it was replanted on seeding grounds in America.

Predators and pests

Upon arrival, the seed had to adapt to new temperature, salinity and circulation regimes. It also had to cope with predators and pests from its new habitat like Dungeness crab *Cancer magister*, the Red Rock crab *Cancer productus*, the Graceful crab *Cancer gracilis*, four species of sea stars, 2 species of ducks, etc. In addition, some of its natural predators came from Japan with the seed in early shipments, before Canadian and American authorities developed and implemented control measures in cooperation with Japanese authorities and seed growers (Quayle, 1988). Such are the flatworm *Pseudostylochus ostreophagus*, the parasitic copepod *Mytilicola orientalis*, and the Japanese oyster drill *Ocenebra japonica*

Reproduction

The Pacific oyster is a very fecund bivalve. Its reproductive organs can form at least 50% of the body volume (Quayle, 1988). It also seems to have an ability to respond to its environmental conditions by having more males when food is scarce and more females when food is abundant (Chew, 2003)

Diseases and mortalities

Diseases were another challenge. In 1960, a disease occurred in an area of Baynes Sound ranging from Henry Bay to a point approximately 3 miles south of Denman Island, British

Columbia. This disease, subsequently named the Denman Island disease, killed 30% of the oysters in its initial outbreak. (Quayle, 1988). Beginning in the mid 1960's and through the early 1970's, during the Summer months mortalities as high as 60−80% were observed in certain growing areas of the United States (Chew, 2003). Several studies found no causing disease organisms, but determined that these mortalities were associated with warm water temperatures and low water circulation. Perdue et al (1981) found that oyster were usually fully ripe when mortalities occurred, and that their other tissues had virtually no glycogen reserves. It was speculated at the time that that lack of glycogen was a consequence of the high fecundity of the Pacific oyster. Since these Summer mortalities greatly diminished by mid to late 1970's, it would appear that the oyster, through natural selection, had adapted its own physiology to the conditions of its new supported habitat.

Competition with the native oyster

Since its introduction, the Pacific oyster has gradually occupied most of the good oyster growing inter tidal areas that were formerly occupied by the native oyster *Ostrea lurida*. This may have been facilitated by the depleted state of native oyster populations at the time of the Pacific oyster introduction, but there appears to be other factors. Metabolic competition has been proven scientifically (Chew, 2003). Competition for food has also been considered. It was suggested that the superior filtering and feeding ability of the Pacific oyster limits the available nutrients from phytoplankton to the detriment of the native oyster. The suggestion makes ecological sense, but it has not been proven (Chew, 2003).

Human competition

Human competition takes several forms. Recreational uses of the near shore waters for sports such as sailing and water skiing conflict with surface long lines and culture rafts. Recreational shellfish harvesters may wander on leases at low tide and, willingly or by ignorance, take or damage oysters on private leases. Wealthy recreational property owners tend to resent the sight of oyster culture rafts, the boat traffic and the noise generated by culture operations. Many believe that aquaculture operations nearby have a negative effect on the value their shore property. Diesel engines running continuously to run accelerated growth devices called "flopsies" attract the anger of shore residents who profoundly resent the constant noise pollution.

Industrial competition can take the form of physical habitat deterioration, water pollution or both. The most often cited source of damage is sulphite waste from pulp and paper mills. Damages from that cause range from outright mortalities to a decline in animal growth and in the quality of the meat. One example from Samish Bay, Washington State: Seed oysters which used to grow to market size in two years took five years to reach market size after their growing area was affected by pollution. Meat yields went from 80−120 oysters per gallon to 130−200 oysters per

gallon.(Steele, 1964). Although much progress had been made in recent years, much remains to be done.

Fecal contamination of the water in growing areas does bring various types of closures and restrictions on growing and harvesting filter feeder shellfish, including oysters. Sources of this contamination include individual dwellings, industries, farms, wild animals, and municipal sewage systems.

The Future

Research

In Canada, a number of new funding initiatives often based on research networks or partnerships are emerging. (DeJager, 2005). These offer an opportunity for research institutions and industry to team up and join their effort towards finding solutions for problems or pushing forward with cutting edge technologies. In British Columbia, the Malaspina University College is expanding its research facilities to launch on a new research program to support and advance aquaculture.

USA research is too diverse and abundant to enumerate in the context of this short paper. As an example, the Hatfield Marine Science Center of Oregon State University has a project called the Molluscan Broodstock Program to develop improved Pacific oysters. The specific goal is to genetically select oysters that are fast growing and disease resistant. Other examples are the very good program of the College of Ocean and Fishery Science of the University of Washington and the excellent research tradition initiated by Dr Kenneth Chew over many years of research at U. Washington.

First Nations

The First Nations of the United States and Canada who lives along the Pacific Coast have a long-standing interest in shellfish harvesting and production, as part of their cultural and ceremonial heritage. The Lummi First Nation has operated a shellfish hatchery since the 1970's. More recently the Suquamish Indian Tribe of the Port Madison Reservation located in Kitsap County, Washington State has engaged in a culture revitalization project through bivalve aquaculture including oysters (Barry and Williams, 2004). In Canada, First Nations have organized into the Aboriginal Aquaculture Association to assist in the development of First Nations aquaculture (Harry, R., 2004). Traditionally, First Nations have been pre-occupied with respect for the environment and with long-term sustainability. Their emerging force may over time increase oyster supply in the market place. It may also bring a renewed interest in clean growing areas for oysters along the Pacific Coast in the United States and in Canada.

Public support

There is increasing recognition that shellfish culture is environmentally benign and may indeed be beneficial. Recently, support has been coming from such public advocacy bodies as the Audubon Society, the Monterey Bay Aquarium's Seafood Watch, and Eco-Fish. In addition, Courts of Law and Government Departments have started to recognize the value of shellfish culture and rendered decisions favourable to the industry. An example is a US$ 20,000 penalty imposed on forestry giant Weyerhaeuser Company by the Washington State Department of Ecology for a fecal coliform release which closed oyster harvest in July 1997.

Bivalve shellfish culture in general, and oyster culture in particular, ought to be better known and understood by the general public and by politicians for its numerous benefits to the environment. A bivalve farm is a self-regulating biomass. If overloaded beyond the carrying capacity of local waters, shell growth and meat quality suffer; farmers will adjust the biomass to maintain quality and financial returns. An oyster farm removes suspended solids from the water column; what is not digested by oysters is precipitated in the form of pseudo-feces. Oysters remove nitrogen and other nutrients from their environment, and reduce eutrophication. Oysters help control and prevent algal blooms. Finally, oyster beds increase biodiversity by providing support, shelter and food to a variety of small invertebrates and fish.

The Future

Challenges

Governments can help oyster farmers, but they can also hurt them. Tideland tenure is not a problem in Washington State because oyster farms belong to their operators. In Canada, tidelands are owned by the Government which leases them to growers. Leases can be cancelled; leases may not be renewed upon expiry of initial terms. Lease costs can change at the discretion of government officials. These uncertainties tend to limit investments and can leave growers at the mercy of rule changes over which they have no power.

First Nations are showing a renewed interest in shellfish culture. Their success may increase the volume of product available with a negative effect on prices, unless a corresponding marketing effort increases demand at the same time as supply. First Nations often put much emphasis on environmental preservation. Their increased presence in the field may well bring improved conservation measures which would benefit oyster growers.

Bivalve shellfish farmers can do a better job of integrating their operations into local ecosystems. Shellfish farms located in beautiful remote areas often find themselves in opposition to recreational or retiree property owners who value the beauty of the scenery and the peaceful setting. Oyster farmers are increasingly challenged to make their operations blend with the surrounding environment, to control their industrial refuse, to avoid any pollution, including noise. Dialogue is needed to conciliate these conflicting interests.

Growers would benefit from a better cohesion among themselves to defend their interests with government officials, and to engage in market development and public relation efforts.

Opportunities

Multi-species culture already generates diverse sources of income streams. Hatcheries already produce seed of several species. There may be an opportunity to farms shellfish in conjunction with fish farms to improve both the environment and financial returns. As the oyster meat market shows sign of saturation, product diversification from meat only to a mix including half-shell and specialty products offers an option to generate an diversified revenue stream. The human population of America's Pacific Coast is very diverse in its origins and cultural backgrounds. The pursuit and development of market niches to serve diverse ethnic groups is another opportunity. Finally, the full extent of the high-end markets has not been fully explored. There may just be a market for a reliable supply of very young, very small, deep cup, meaty Pacific oysters out there…

Conclusions

The Pacific oyster *Crassostrea gigas* has adapted very well to the North American West Coast. Its success was greatly helped by the knowledge of scientists from the Imperial University of Tokyo and the persistent entrepreneurship of early growers in North America. Japanese oyster seed producers and shippers working together with the Pacific Oyster Growers Association ultimately made the introduction the success we see today.

From its introduction to Washington State of the USA and to the Canadian Province of British Columbia at the beginning of the last century, the Pacific oyster has provided food and generated wealth to countless people. Its vitality, resilience to adverse conditions, its resistance to diseases, its ability to feed heavily and its reproductive capacity make it a choice candidate to further expansion throughout the World.

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