SPAT COLLECTION, GROWTH RATES AND SURVIVAL OF THE NATIVE OYSTER SPECIES, CRASSOSTREA CORTEZIENSIS AT SANTA MARIA BAY, MEXICO INDIGENOUS

Species Development/ Experiment/ 07IND03UH

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ABSTRACT

A trial was conducted to determine whether Crassostrea corteziensis spat could be obtained in sufficient numbers and successfully cultured during the early nursery stages at Santa Maria Bay, Sinaloa, Mexico, to test the feasibility of culturing this native species instead of C. gigas. Although spat was abundant, it did not exhibit significant growth during the early stages of the trial (October-February) but then grew more rapidly from March to May. Slow growth may be a function of low temperatures and an unusual lack of productivity in the Bay, postulated to be correlated to the El Niño phenomena. Although sufficient numbers of spat can be readily obtained, survival was also low (53%). Repetition of the trial during the summer months and when El Niño is not occurring. The need for bivalve hatcheries which can supply regional farmers is also indicated.

INTRODUCTION

Oyster culture on the coasts of the Gulf of California, Mexico is primarily based on an introduced species, the Pacific Oyster (Crassostrea gigas). A few exceptions exist where the native "Pleasure oyster" (Crassostrea corteziensis) is cultured, such as at Boca de Camichin, Nayarit. In the State of Sinaloa the federal government has been promoting oyster culture as one way to reduce pressure on the shrimp fishery, which is considered to be in crisis. As part of this initiative, C. gigas has been cultured for 8 years in Altata Bay, for 4 years at Santa Maria Bay, and other oyster culture programs are planned for other areas of the State. Although market studies have indicated that there is a strong local preference for the Pleasure Oyster over the Japanese oyster, culture of the former has not taken off, primarily due to the difficulty in obtaining seed, either through spat collection or hatchery production. C. gigas seed is more easily obtained from large hatcheries in the U.S., hence the dependence on this species in the Gulf of California.

In Nayarit where the Pleasure Oyster has been cultured for over 30 years, it grows to commercial sizes of 2-3 inches in length in about 9 months. It is also more abundant than in Sinaloa, and the Nayarit industry is able to depend on wild spat collection due to the abundant spat fall. In the more northern state of Sinaloa, the Pleasure Oyster is commonly found on the roots of mangroves in coastal lagoons of Sinaloa, but does not obtain large sizes, presumably due to competition for space and possibly due to the high densities in which it settles on the roots. Rodriguez-Dominguez and Perez-Gonzalez (2009) found that Pleasure Oysters which detach from mangrove roots and establish themselves on the estuary bottom grew faster than those which remained attached. The Sinaloa estuaries also tend to be higher in salinity and become colder in the winter than those in Nayarit where the Pleasure Oyster is abundant. Hence there was some question of whether C. corteziensis was an appropriate culture species for these more northern areas with different climatic and hydrological conditions. Spat collection had also not been attempted in the northern areas.

The range of C. corteziensis is from northern Mexico to Peru (Hertlein, 1951), being found most commonly found in the intertidal zone of estuaries and coastal lagoons attached to mangrove roots and other solid substrates (Stuardo and Martinez, 1975). It is found in salinities of 3 to 39 ppt, with mortalities occurring in lower salinities. Larvae have been reported in salinities between 21 and 37 ppt, although higher larval growth rates are found between 23-28 ppt. This species appears to tolerate temperatures ranging between 16-32oC, with optimal growth occurring between 28-30oC. Mortality reaches one-hundred percent when the temperature exceeds 34 oC (Caceres-Puig, et. al. 2007).

The growth rate for C. corteziensis varies with temperature, salinity, food availability and age. Chavez Villalba et al (2005) reported higher growth rates in spring and summer (0.063 mm/day to 0.266 mm/day) than in the autumn and winter (0.016 mm/day to 0.159 mm/day). Chavez Villalba et al (2008) found that growth rates were 0.222 to 0.234 mm/day in coastal lagoons with higher salinity levels, and increased to 0.304 mm/day in areas with aquaculture farm discharges and lower salinity (25 ppt). The same authors reported that daily weight gain was 0.153 g/day in areas where particulate organic matter (POM) was 31 g/L and was fell to 0.077 g/day where POM was 9.7 g/day. In some cases, this relationship between POM and bivalve growth rates may be not be observed since in coastal habitats POM consists of bacteria, detritus, nano-zooplankton, but generally only phytoplankton is the major source of nutrients for filter feeding bivalves (Dame 1996).

Growth rates in Nayarit for C. corteziensis have been reported to be rapid, with daily growth rates of 0.345 mm/day during the first seven months post-set. Growth rates are particularly high during the first two months (0.666 mm/day) of a study by Stuardo and Martinez, 1975) but were reduced to 0.333 mm/day during the following six months. In the Agua Brava Lagoon, Nayarit, it was found that oysters growing on mangrove roots had lower instantaneous growth rates (K=0.04 monthly) had than those which grew on the lagoon bottom (K=0.89 monthly) (Rodriguez Dominguez and Perez Gonzalez, 2009). In Navalato, Sinaloa (close to the study site), Gongora Gomez et al (2006) found growth rates of 0.195 mm/day and 0.138 g/day at temperatures of 21.3 oC and 31 oC and salinities of 31.7 ppt and 39 ppt, respectively.

Chavez Villalba et al (2005) calculated the following parameters using the von Bertalanffy model: $L\infty$ = 114 mm, K= 1.1 per year and tO = 0. A later study (Chavez Villalba et al 2008) used the same model to derive: $L\infty$ = 132.5 mm, K= 1.08 per year and tO = 0.

The objective for this study was to determine if C. corteziensis spat could be collected from mangrove roots in sufficient numbers to support small-scale farming which is often conducted by women of lower socio-economic levels who may not have the resources to purchased eyed-larvae or spat. Additionally, the feasibility of farming this species in this northern bay with higher salinities and lower salinities than the Boca de Camichin area would also be evaluated by tracking growth and survival rates. Training in oyster farming methods was also incorporated into the extension assistance provided during the research efforts.

METHODS

Study site

The Santa Maria Bay-Playa Colorado complex is a coastal lagoon comprised of three bays; Playa Colorado in the north, Santa Maria Bay in the central area and Calcetin Bay in the south. This is the largest lagoon (53,000 ha) in the State of Sinaloa and is bordered by the municipalities of Angostura and Navolato. It is located between 24° 25' and 25° 30' north and between 107° 35' and 108° 25' west (Figure 1).

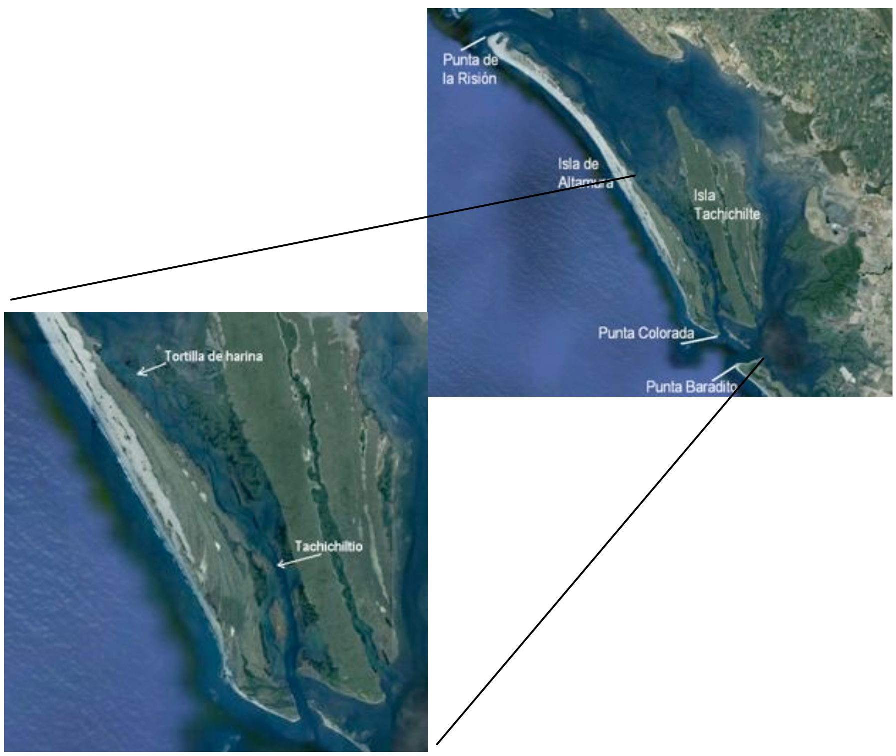

Figure 1. Location of oyster culture sites in Santa Maria Bay, Sinaloa, Mexico.

In the extreme north and south of the system are extensive areas of mangroves, as well as isolated patches that border the Talchichilte, Saliaca, de los Pajaros and Altamura islands. The total mangrove area is 2118 ha (De la Fuente and Carrera, 2005), making this one of the largest concentrations of mangrove in Mexico.

Santa Maria Bay is separated from the Sea of Cortez by an extensive sand barrier island (Altamura) which has three channels, two towards the northern end and one at the south. The northern channels are between Punta Perhihuete, Islas del Rancho and Punta la Rision, forming two mouths which are approximately 3.5 km wide. In the south, the channel is between Punta Colorado and Punto Baradito with a width of approximately 3.5 km. These channels lend themselves to a nearly constant exchange of water between the bay and the Sea of Cortez. Tachichilte Island is located in the interior of the Bay and has a series of shallow sand flats. There is a channel between Tachichilte Island and Altamura Island where currents coming from the northern and southern mouths meet. This area is called "Tortilla de Harina" by the local fishers. The oyster culture site is located slightly south of

Tortilla de Harina. The strong currents in this area provide for constant water exchange in the oyster farming area.

Spat collection and culture
Juvenile C. corteziensis were collected from mangrove roots in the Tachichiltio area on October 19, 2008. For the experiment, 640 spat were used. These had an average weight of 9.91 g when collected and were placed in Nestier trays suspended on a long line (Figure 2). Oyster weight and survival was monitored over a 7 month period. Data on temperature, salinity and chlorophyll a were also collected on a monthly basis. The trays were cleaned regularly to keep them free of biofouling.

Figure 2. Culture and monitoring of *C. corteziensis* spat. CRSP student Saul Lopez Sanchez is shown caring for the oysters and collecting data.

RESULTS

Oyster weight did not increase significantly between October and February, varying between 9.9 and 10 g (P > 0.05). Oysters began to grow after February and achieved a final weight of 21.7 g in May, with an average growth rate of 0.128 g/day (Figure 3).

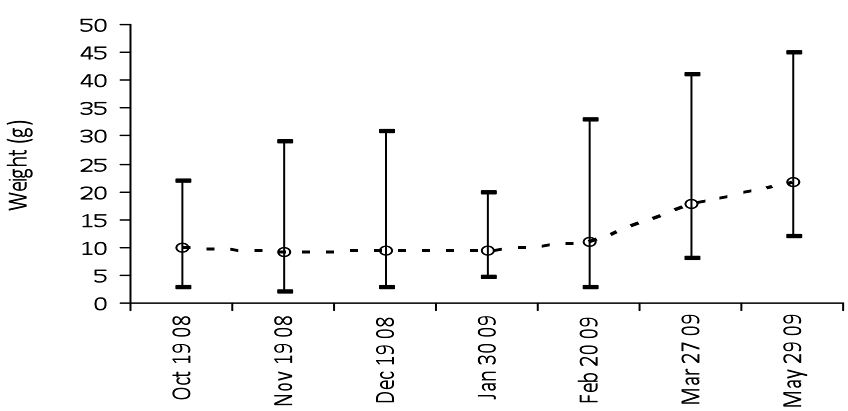

Figure 3. Growth of C. corteziensis spat cultured in Nestier trays at Santa Maria Bay, Sinaloa, Mexico.

The lack of growth between October and February coincided with a decrease in water temperature from 28.5 °C in October to 19 °C in February. The resumption in growth after February coincides with the increase in temperature which began in February (Figure 4).

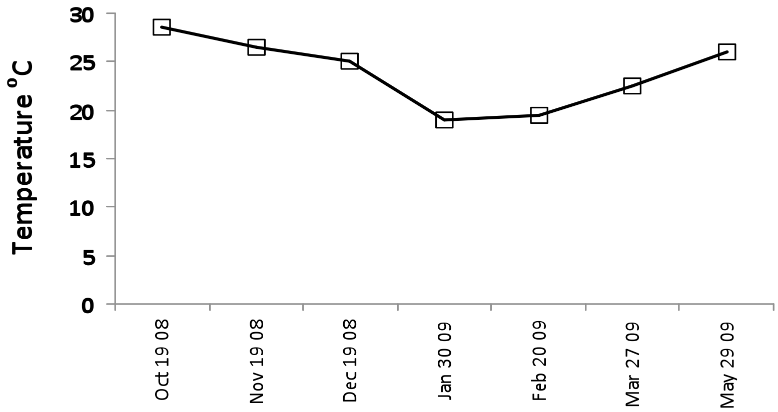

Figure 4. Surface water temperatures at oyster culture site in Santa May Bay, Sinaloa, Mexico.

During the period in which the oysters demonstrated little growth (October to February), chlorophyll a levels rose from 0.09 µg/L to 0.23 µg/L. From February to May, chlorophyll a levels decreased from 0.23 µg/L to 0.18 µg/L, at the same time that oyster growth rates were increasing (Figure 5).

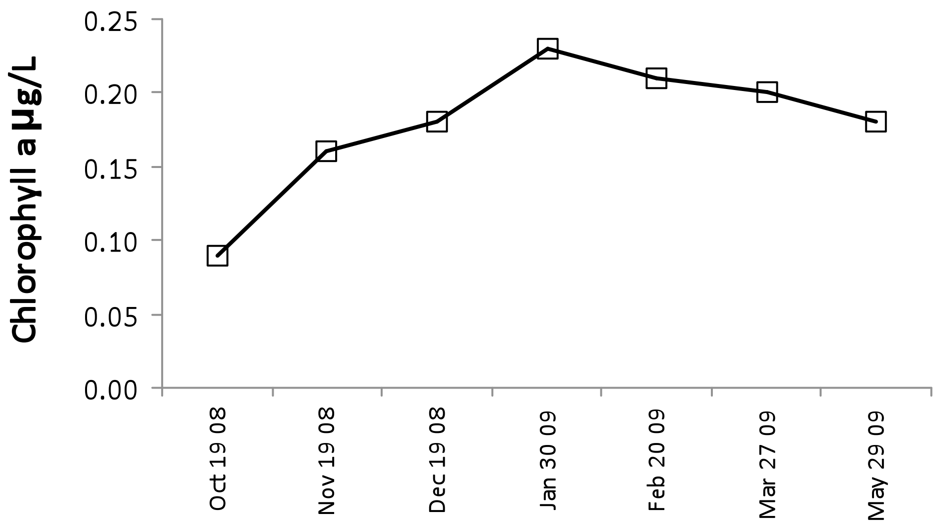

Figure 5. Chlorophyll a concentrations at oyster culture site, Bahia Santa Maria Bay, Sinaloa, Mexico.

Salinity varies between 36-36.5 ppt during the October-May period (Figure 6), indicating that some evaporation was occurring since salinity in the Bay was greater than that of the ocean.

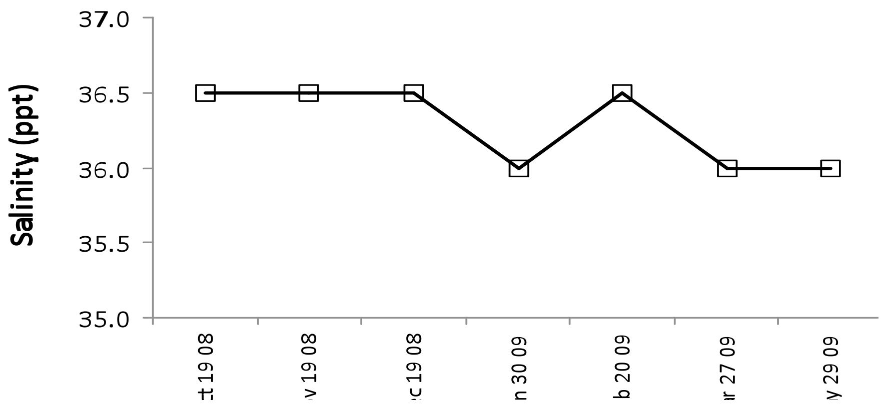

Figure 6. Salinity at oyster culture site, Santa Maria Bay, Sinaloa, Mexico.

Oyster survival at the end of seven months was 53% (Figure 7).

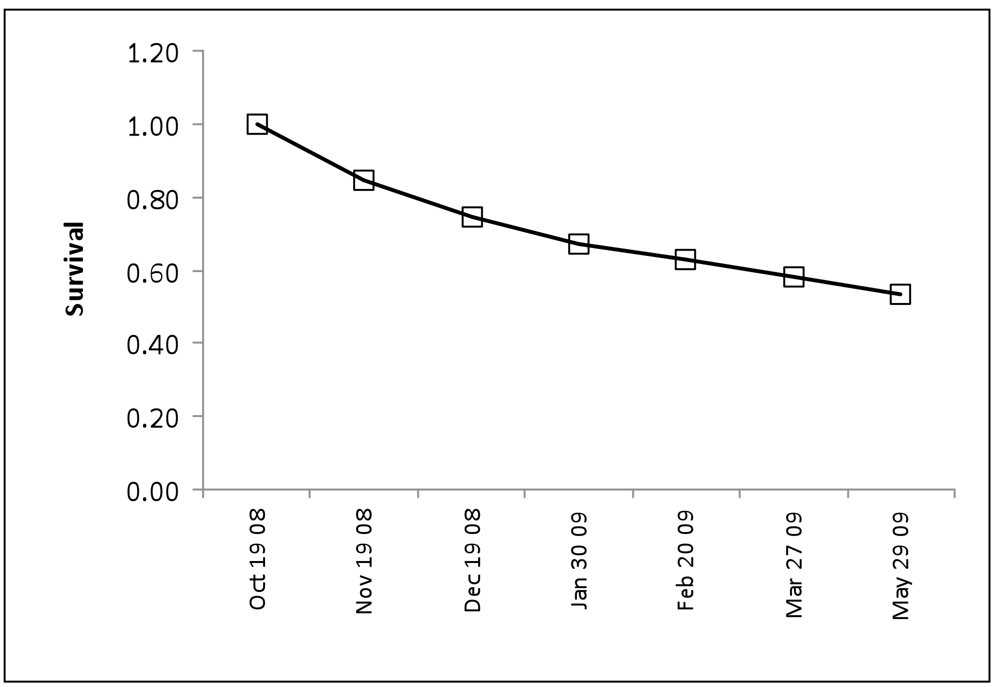

Figure 7. *C. corteziensis* spat survival at Santa Maria Bay.

DISCUSSION

During the culture period, water temperature varied between 19 oC and 28.5 oC, but the highest temperatures were during the beginning of the experiment. Subsequently, temperatures were lower than 26.5 oC which represent suboptimal temperatures for growth of this species according to the results of Caceres-Puig et al (2007) who showed that the highest growth rates are obtained between 28 oC a 30 oC. The temperatures in January (19oC) and February (19.5 oC) were close to the lethal limit for this species (16 oC).

Another factor in the slow growth may have been the low chlorophyll a concentrations (0.09 to 0.23 μg/L), whereas in other years, typical chlorophyll a levels range between 1-3 μg/L (Galindo Reyes, 2000). These adverse factors may have been related to the beginning of the El Niño phenomena which began during the summer of 2009 along the coast of Sinaloa (http://www.ciifen-int.org/). Other anecdotal information points such as a similar decrease in growth rate for farmed C. crassostrea gigas and a very poor wild shrimp harvest point to changing conditions in this usually highly productive bay.

In spite of lack of growth during the first four months, the growth rate later rose to 0.128 g/day, which is close to the growth rates reported from the Sonora coast.

The survival rate of 53% was low, and most mortality was observed during the winter coinciding with the period during which growth was also slowest.

CONCLUSION

In conclusion, it appears that in this case, culture of C. corteziensis would not have been economically feasible due to the slow growth and low survival. Given that conditions during this particular year may have been more adverse than usual given the low temperatures, low chlorophyll a levels and generally low productivity of the bay, repetition of these trials may be merited at a future date, rather than entirely discarding the idea of culturing C. corteziensis in the northern areas. Additionally, beginning nursery culture earlier in the year when temperatures are higher may increase growth rates.

Despite the disappointing results, some benefit did accrue to local oyster farmers as they received technical assistance in oyster farming that will benefit them in their work with C. gigas, and potentially with C. corteziensis in the future.

ANTICIPATED BENEFITS

The results of this work have spurred efforts to establish a bivalve hatchery at the School of Marine Sciences (FACIMAR) at the Autonomous University of Sinaloa. Even if future spat collection efforts are more productive than this trial, there is a chronic shortage of eye-larvae and spat for nearly all species, but particularly for native species. Even *C. gigas* larvae are increasingly difficult to obtain given the problems with production encountered by the large U.S. oyster hatcheries which have previously supplied stock to the Mexico oyster farmers.

Additionally, this work involved a considerable amount of training in both nursery and grow-out methods for oysters which benefited two oyster growing cooperatives, "Marine Culture of Colorado Beach" and "Fishers of La Reforma". These cooperatives have a total of 23 members (4 women and 19 men). One CRSP student, Saul Lopez Sanchez, used this work as his research topic for his undergraduate thesis. Mr. Lopez Sanchez is originally from Santa Maria Bay and plans to return to work there after graduation.

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