WATER MANAGEMENT IN A COMMERCIAL SHELLFISH HATCHERY

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Abstract. International Shellfish Enterprises, Inc., operates a commercial hatchery for the production and sale of marine clams and oysters. The development of three distinct water supply systems is described. The problems in dealing with material compatibilities, physicochemical vagaries, and disease control in the open sea water system are discussed.

INTRODUCTION

Oysters have historically been the major invertebrate species produced by aquaculture. Today, oysters are grown in maritime countries throughout the world, their culture involving techniques that vary widely in method, level of sophistication, and degree of success.

The oyster has many of the characteristics preferred for aquaculture candidates. Being sedentary obviates the problems of management associated with fugitive species. It is herbivorous, satisfying its nutritional requirements more readily and at greater efficiency than those of a carnivore. It is highly fecund, with a life history adaptable to captive conditions. It has a rapid rate of growth from egg to marketable size. Finally, and of considerable importance with respect to economic considerations, natural oyster stocks have been depleted in most parts of the world so that planting and cultivation are necessary to ensure their survival and development.

The use of hatcheries to produce seed oysters is increasing in the United States. The supply of seed oysters to growers from natural production is decreasing in many places because of environmental degradation, and the cost of imported seed is increasing. Under these conditions oyster hatcheries are becoming economical. In 1976, there were 21 oyster hatcheries in the United States of which 12 were in commercial effort production. Several of these hatcheries produce seed oysters attached to oyster shell "cultch" for use in traditional culture systems although most produce unattached or "cultchless" seed which must be reared in trays until large enough to be planted in culture areas. Production efforts have concentrated on the

American oyster, Crassostrea virginica, the Pacific oyster, Crassostrea gigas, and the European Flat oyster Ostrea edulis. "Cultchless" seed has the advantage of light weight which permits economical air shipment, but has the disadvantage of requiring specialized and intensive culture in order to grow the seed to an appropriate planting size.

International Shellfish Enterprises was established in 1970 and began commercial operations in 1975. Hatchery production of "cultchless" seed of the European Flat oyster, the Pacific oyster, and the Manila clam, Tapes semidecussata constitute the major products of the company, with an emphasis on the development and sale of large, plantable sized seed, previously unavailable to the oyster grower. This paper describes some of the major obstacles and solutions developed in reaching commercial production capability.

THE HATCHERY PROCESS

The hatchery is located in Moss Landing, at the inland extension of Monterey Bay. The site was chosen due to the relatively unpolluted water available in the area, the proximity of a grow-out area in Elkhorn Slough, a tidal embayment with good tidal flushing, the availability of warm circulating water from the Pacific Gas and Electric fossil fueled plant at Moss Landing, and a proximity to product shipping facilities.

The hatchery building has 6,000 square feet of culture area housing a laboratory, food culture, brood stock conditioning, larval culture, and spat culture facilities.

The hatchery process begins with the conditioning of brood stock for spawning. A large population of the European oyster must be held in running sea water at 20°C due to its larviporous spawning behavior. The female of this oyster retains the fertilized eggs for 10 days and releases 160u long swimming larvae, which are collected in overflow screens daily and transferred to larval culture tanks. The Pacific oyster is spawned by thermal shock at 28 to 32°C, eggs and sperm collected, and fertilization conducted in 10 liter containers. After assurance of fertilization is determined, the eggs are transferred to larval culture containers for subsequent larval development.

Larval culture is conducted in 1,000 liter fiberglass tanks, at densities of 1 larva/ml, the culture room being maintained at 22°C. Larvae are fed daily and the water is replaced every second day.

At an age of 12 days, the larvae reach 325-350u in length, develop a ciliated foot, and begin exploratory behavior in preparation to setting. At this stage, ground and sized shell fragments are provided in the tank, with larvae setting within 24 hours.

These spat are then transferred to growing trays where they grow to 2-3 mm in 2 weeks.

Integral to the hatchery process is the food culture area where monospecific axenic cultures of flagellates and diatoms are batch cultured from 1 liter containers through 1,200 liter tanks for harvest and feeding.

At the 2 mm size, the spat are transferred to growing trays in rafts located in Elkhorn Slough where subsequent growth to sale sizes of 6-10, 10-20, and 20-25 mm takes place.

Buyers receive air shipments of carefully cleaned and packed seed shipped in styrofoam cartons. When carefully packed and cooled, the oyster seed survive shipments up to 7 days without harm.

SEA WATER SYSTEMS

Three sources of sea water contribute to the hatchery operation, a sea water well, an offshore sub-sand intake system, and warm sea water discharged from the local power plant. Adjacent to the beach, the sea water well delivers 70 g.p.m. of filtered sea water. The installation consists of 20 feet of 6" PVC casing terminated by 10 feet of 2" diameter, 1 mm slot opening, Johnson well screen, capable of drawing 7.5 g.p.m. per foot. This water is used for those critical areas of culture such as algal and larval culture where water with an absence of predators and competitors is essential. Filtration and sterilization of this water is unnecessary.

The offshore system extends 150 feet onto the beach, drawing water through an 8", .5 mm slot PVC well screen, 4 feet below the beach level. Adequate levels of phytoplankton come in with this water to be used for supplemental feeding in brood stock holding and spat culture. Extensive storm damage to this system has necessitated planned replacement with an 8" steel, epoxy-lined intake system.

The power plant effluent source water is drawn through access manholes via 4 inch PVC pipes. Use of this water has been temporarily discontinued while an economical technique is developed to reduce the pH and ammonia levels in the water. The power plant draws process water from the harbor, which receives agricultural and sewage plant runoff. Harbor water surface samples have yielded ammonia levels ranging from 13 to 55 ugm-at/liter at pH's of 8.2 to 8.5. These high levels of toxic ammonia gas in the water have proven toxic to oyster larvae and have affected spat by increasing disease susceptibility. Tests at reducing the ammonia levels and stabilizing pH in the power plant effluent have included biological filtration which reduced the toxic fraction of un-ionized ammonia by 25%, and foam-fractionation of the water with large volumes of air which reduces and stabilizes the pH at 7.6 to 7.8. These techniques offer an expedient and economical method of stabilizing the water quality and reapplication of the water to the culture program is anticipated soon.

MATERIAL COMPATIBILITIES

A great deal of caution and evaluation has been given to assembling the components of the culture system of non-toxic materials. All new materials to be used are evaluated initially with a 48 hour oyster embryo bioassay.

All main pumps used are constructed of cast-iron, with 316 stainless steel shafts and seals. These pumps have proven non-toxic to the system and are economical to purchase and maintain. Sub-system delivery pumps are constructed of PVC or CPVC.

All culture vessels are constructed of fiberglass reinforced plastic or high density polypropylene. Any new tank is flushed for 10 days at 3°C above the anticipated operating temperature to leach any volatile plasticizer remaining in the plastic.

Most of the materials and equipment used in the operation have been borrowed or adapted from other applications. A few examples are the use of swimming pool high rate sand filters for sea water filtration, fiberglass lined hot water heaters for heating small quantities of sea water, and the use of sprinkler system plastic solenoid valves controlled by time clocks, pressure switches, or immersion thermostats.

DISEASE CONTROL

The use of large volumes of sea water to operate the hatchery has necessidated the use of an open sea water system. The problem of dealing with varying source water conditions are small compared to the problems of development of a closed system technology.

Disease introduction is a constant problem with an open water system. Although at a low level of occurrence, potential pathogens are always possible. Economic large scale sea water sterilization is not available. Ultraviolet radiation units are adequate to reduce bacterial numbers, but allow the passage of some microbes. Water treatment facilities at the hatchery are limited to sub-micron filtration and low-flow rate U.V. sterilization in such critical and pathogen susceptible areas as algal and larval culture.

Bacterial pathogens can kill oyster larvae within 24 hours of introduction. The larvae reduce their motility, internal granular necrosis is evident, and internal structures are destroyed. With the lack of agreement on marine bacterial taxonomy, identification is limited to characterization of carbohydrate utilization, motility, and nitrate reaction. Generally, isolated pathogens are gram-negative, fermentative, and either motile or non-motile. They are generally in the Vibrio-Aeromonas group.

The major effort at controlling disease introduction and spread is through a rigorous sanitation program. Possible sources for introduction of pathogens are incoming sea water, brood stock, tools, and personnel. Propagation can occur anywhere that the basic needs of the microorganism are found. Chlorine foot baths, utensil baths, and floor wash down is routinely used. The use of isolated culture systems is integral to pathogen control. Each culture tank is isolated from adjacent tanks by plastic screens, while each culture segment is conducted in separate rooms. The use of all aerosol producing practices has been eliminated, since aerosol droplets can contribute to pathogen spread.

A major effort is the continual monitoring for pathogen presence.

A staff microbiologist is employed to detect, isolate, and develop treatments for pathogenic organisms. Daily screening for pathogens on BTB and blood agar plates is done on algal and larval cultures. When contaminated food is discovered, it is sterilized with chlorine and discarded. When disease does occur in larval cultures, that tank is isolated, treated with antibiotics, and the disease can often be arrested. Isolated pathogens are subjected to antibiotic sensitivity tests, with Sulmet, Tetracycline, Neomycin, and several sulfa drugs being used for tank treatments.

CONCLUSIONS

The state of the technology of marine shellfish hatcheries is still somewhat primitive, production depending on the availability of suitable water and the continual monitoring and treatment of disease outbreaks. Hatchery productivity and reliability can be increased substantially through establishment of rigorous sanitation procedures. With consistency of production, and the disappearance of traditional wild sources of seed, shellfish hatcheries are becoming economical and are able to supply an increasing demand for their product.