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CONTAMINANT PROBLEMS AND MANAGEMENT OF LIVING
CHESAPEAKE BAY RESOURCES

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MOLLUSK CULTURE FOR THE CHESAPEAKE BAY

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INTRODUCTION

The water quality of the Chesapeake Bay has suffered a decline over the last 5 decades due to anthropomorphophobic activities. Insidious additions of industrial and farm pollutants to the Bay have created a situation where in many areas there are periodic sublethal levels of chemicals. Although the juveniles and adults seem to survive these levels, they are obviously interfering with some early life stages of the living organisms that make up the bay fauna. Species whose early life history take place out of the Bay (i.e. Callinectes sapidus) are less affected by this problem than those species whose eggs, embryos and larvae are found in the Bay.

Over 70,000 chemicals are being manufactured in the United States today. Of these approximately 50,000 are being produced in excess of 1.3 billion pounds annually. 6

Population shifts and expansion are pushing more people toward this nation's coastlines. By 1990, it has been estimated that 75% of the population will live within 50 miles of the oceans. 10 This population shift is bound to exacerbate the already frightening statistics on land-based pollution of the coastal zone; i.e., there is no toxicity data for 90% of the common chemicals in use which ultimately find their way to the estuaries or oceans. There is no similar data on 65% of the pesticide formulas in common use. 6 To further compound the problem, the fresh water input into the Bay has declined due to increased water demands on the major drainages of the Bay. 20

These effects can be compared by observing the fouling organisms found on pilings and bulkheads along the coast. In badly fouled areas such as busy harbors, common fouling organisms are absent.

Unfortunately, the environmental quality of the Bay has not been judged
by subtle changes in fauna. Instead, in past history, it is judged by the annual fishery production of key species for which the Bay is noted. This has severe drawbacks. Most commercial species are harvested as adults, which means in most cases a time lag of several years. Most harvestable species have regulations and laws governing them which sometimes cloud the picture. Most important, if a decline in a fishery is used as a measure of degradation, then only an increased yield per unit effort would indicate an improvement in the environment. Unfortunately, this is sometimes not effected in a reasonable length of time, and in some cases not in a lifetime.

MOLLUSK FISHERY

The mollusk fisheries of the Bay, especially oysters, were at one time the most important fisheries in Virginia. Virginia until the late 1950's was the leading shellfish producer in the U.S.1 This fishery has declined sharply, probably due to the decline of the environmental quality of the Bay due to anthropomorphic additions. These additions can both directly and indirectly affect certain life history stages of mollusks. The other two commercial mollusk species in the Bay are hard clams and soft clams. These too have shown a decline. Other species occur in the Bay such as Rangia cuneata which are commercially harvested in other areas. Since there is no commercial fishery for this species, I have not included them as a commercial mollusk.

REMEDIAL ACTION

The mollusk harvest has shown a continued decline despite efforts to clean up the Bay and to manage the resource11.

Unless the water quality of the Bay is improved, it is doubtful that management or replenishment programs will solve or even have much impact on the problem. History of the fisheries has indicated the commercial mollusk fishery has continued to decline despite regulatory changes or infusions of money for replenishment of stocks or improvement of substrate12.

A possible method of increasing production is aquaculture.

At the present time there are a number of commercial firms using intensive aquaculture methods to produce seed oysters and clams. These seed, after being grown through hatchery and nursery phases, are then planted in protected beds or predator exclusion devices such as trays. Although these methods have proven profitable for private firms, it does not mean that the same methods would be successful for repletion programs. However, the yield from this type of culture could certainly supplement the acute seed shortage the entire industry is facing. Further, the harvest of private firms will contribute to the yield of mollusks.
In the Bay the hatchery rearing and remote setting of *Crassostrea virginica* is presently being explored. This is being carried out in the following manner. Adult oysters are brought into the hatchery prior to spawning. One or two can be opened and the condition or ripeness of the gonads ascertained. If the gonads do not appear to be ripe, they can be brought to a ripe condition by holding them in warm flowing seawater (22 to 24°C) with ample unicellular algae for food for one or two weeks. If they are collected from nature in a ripe condition, this step can be eliminated. Once they are ripe, the adult spawners can be held in cooled seawater between 16 and 19°C to prevent spawning and to maintain the gonadal ripeness until needed. Rations of unicellular algae should be fed daily to maintain the stock and prevent reabsorption of the gonads. This technique can be used to hold oysters for several months.

The ripe spawners can then be induced to spawn either individually or as pooled or mass spawn. Mass spawning is usually used in commercial operations. Approximately 25 to 200 spawners are placed in a trough or tank with filtered (10 µ) seawater at about 22°C. Then by raising (28°C) and lowering (24°C) the water temperature in about 45-minute cycles, the animals can be induced to spawn.

Other stimuli are used besides temperature shock or temperature cycling. The addition of gonadal products to the water is usually the best stimulus to trigger spawning. The addition of food or the injection of serotonin can also be used as a spawning stimulus. When the bivalves spawn, they simply eject the eggs and sperm into the water where fertilization and development take place. Within about 24 hours the fertilized eggs will have developed through the embryo stages into larvae. The larval stages have a relatively short duration but are important to the life cycle. They contribute to the recruitment, distribution and genetic exchange of adult populations. The larvae, called veligers, are then grown in a hatchery for the next 8 to 30 days (depending on the species, water temperature and amount of food in the culture tanks). The water is changed 3 or 4 times a week by siphoning the water through an appropriately sized fine mesh nylon sieve to collect the veliger larvae. The larvae are then placed into a clean container of filtered water with the appropriate unicellular algal food to continue their growth. The larvae grow from about 50 µm to approximately 230 µm. They are then ready to metamorphose. At this point the oyster larvae develop a red spot that can be seen through the shell. The oyster larvae usually metamorphose within 72 hours of its appearance. Early investigators believed this to be a light receptor and identified it as an eyespot. Shortly after the appearance of the eyespot, the larvae develop a foot. At this stage, called pediveliger, the larvae spend part of the time swimming and increasing periods of crawling as if seeking a suitable substrate to attach and cement shell to and start the sessile phase of its existence.

When oyster larvae develop an eyespot, they are referred to as eyed larvae. At this point the larvae can be concentrated by draining the culture through
an appropriate-sized mesh sieve. The concentrated larvae can then be rinsed through a stack of sieves stacked in descending order to sort the larvae by size. The larger eyed larvae can then be stored in a moist cold condition. The smaller larvae are put back into culture to continue to grow.

The eyed larvae can be rinsed onto a small piece of nylon mesh cloth. This is folded around the mass of larvae and then wrapped in seawater-soaked paper towels. This packet can then be stored in a cold styrofoam ice chest (with refrigerant packs) for about 5 days. Two and a half million larvae will pack to about the size of a ping pong ball. During this storage period more eyed larvae can be collected, packed and stored, or the eyed larvae can be transported in this condition.¹³

The ability of larvae to successfully withstand this treatment allows the remote setting technique to work. An oyster grower can arrange to receive a given number of eyed larvae transported in this condition for use in a remote setting operation.

The oyster grower will establish a tank or a portable swimming pool near the bay or estuary. He can then fill this container with clean ready to use cultch. Most planters use an extruded plastic mesh about 70 cm long and 30 cm in diameter with a 2 cm stretch mesh made into bags that are then filled with oyster or clam shells. Other material can be used for cultch such as plastic tubing or pieces of rubber tires, but there are limited choices which are as cost effective as shells.

The tank is equipped with an aeration system usually made of ½" PVC pipe fitted together along the bottom edge of the tank. A series of ½" holes is drilled in the pipe for air escape. Cross pipes are used in larger tanks. This aeration pipe is attached to a regenerative blower or other air source to produce adequate air to vigorously bubble the water. This ensures the distribution of the larvae in the water.

Before the larvae arrive, the cultch or bags of clean shells are stacked in the tank like cord wood. The tank is filled with filtered seawater. The water can be filtered using a sand filter or a convenient 25 µl bag filter (GAF®). The shells are soaked in the aerated water for 24 to 48 hours to ensure that a bacterial film has coated the shell surfaces. The tank is drained and refilled just before the arrival of the eyed larvae. If necessary, the water in the tank can be heated to about 24-28°C with immersion heaters. The packets of eyed larvae are unpacked and rinsed into the tank of filtered water containing cultch and aerated for about 72 hours. At the end of that period most of the eyed larvae will have metamorphosed and set to become oyster spat. An excellent description of this method has been written by Bruce and Gordon Jones.¹³

After setting has taken place, the bags of cultch are usually moved to a nursery or a pier or float where they are suspended off the bottom, or they are placed on an intertidal area to grow to a larger, heavier shell size that can survive better. They can then be transferred to a growing ground. The bags are cut open and the cultch with seed are spread onto the bottom to grow.
The above describes remote setting in a simple form. If eyed larvae production is adequate to support a larger operation, larger tanks can be used and the cultch handling can be containerized and the entire system mechanized to make it less labor intensive.

In 1986 a west coast oyster company produced 18 billion eyed larvae from their hatchery. If they had a setting success of 20% (well within their average rate), they would produce over 3 and one half billion spat or the equivalent of over 3 and one half million bushels of seed (in Virginia a heavily set bushel of shell cultch will have from 1 to 3 thousand spat per bushel).

As the industry converts to cultured spat, the traditional oyster growing methods will undoubtably change. For instance, since the spat are in containers of some type for setting and nursery growth, it would probably be advantageous both biologically and economically to continue off-bottom culture through the first one or two growing seasons of the oyster. This would greatly increase survival and ultimately the yield at harvest.

Aquaculture of clams is carried out in much the same manner as with oysters. Clams are spawned in the same manner and the larvae are grown using almost identical methods. Since clams require no cultch to attach to when they metamorphose, they are normally allowed to set in a hatchery. After setting, the seed is grown in a nursery in either flowing water troughs or in an upweller system. Upwellers are screen bottom cylinders or square containers in which clams are placed. Flowing water enters the bottom, passing through the clams creating a semi-fluidized bed and then out an opening near the top of the container.

When the seed clams attain a length of 8 to 10 mm, they are planted in protected beds or trays, placed in the bay or estuary and grown to market size. This culture method has been used primarily for the hard clam, *Mercenaria mercenaria*. The soft clam, *Mya arenaria*, has not been commercially cultured due to its relatively poor market value and its success as a wild fishery.

The cost of culturing bivalves is high when compared to the cost of wild natural seed. However, its dependability makes this method attractive to the commercial industry. This method has been studied as a repletion method for public fishing areas. However, only small token plantings have been made with questionable results. Commercial use of these methods will increase the yield of these valuable mollusks and may relieve some fishing pressures from the natural seed areas.

Since the quality of the Bay has been measured by the yield of its fisheries, this method, by increasing the harvestable yield, may be interpreted as an improvement. This is not necessarily true, but it may mitigate the damage to the mollusk fishery by the degradation of the water quality in the Bay.
LITERATURE CITED


