Molluscan Mariculture in South Carolina

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ABSTRACT

Culture activities in South Carolina range from simply developing spawning techniques for local and exotic species to complete growout from seed to market size. At the present time, greatest emphasis is being placed on the hard clam, Mercenaria mercenaria, and the eastern oyster, Crassostrea virginica. The hard clam culture protocol is described.

INTRODUCTION

South Carolina has a long history of molluscan mariculture endeavors. Oysters, Crassostrea virginica, were transplanted into ponds to improve meat quality as early as 1830 (Keith and Gracy, 1972). Lunz (1955) revived shellfish culture experiments in ponds in the 1950's after a hiatus of some 100 years. Development of hard clam (Mercenaria mercenaria) mariculture as an industry has been stressed in recent years. Molluscan mariculture efforts have received new emphasis with the establishment of the James M. Waddell, Jr. Mariculture Research and Development Center in Beaufort County, South Carolina. Many species, both indigenous and exotic, are routinely conditioned and spawned in hatchery facilities at the Center (Table 1). Bay scallops (Argopecten spp.), surf clams (Spisula solidissima), and hard clams (M. mercenaria) are grown to various stages as dictated by research regimes and climatic conditions. For instance, bay scallop (A. irradians) seed are imported from the northeastern United States and reared in shrimp ponds in winter. This activity may result in more efficient use during the non-growing period for shrimp ponds. Surf clams have been grown in cages to 50 mm size in the period November to March. Taste tests of these clams steamed have indicated that they may compete favorably with soft clams (Mya arenaria) and blue mussels (Mytilus edulis) in the restaurant trade. A long term program to revitalize the oyster industry in South Carolina by development and introduction of innovative culture methods to improve quality is underway. This has involved production of seed, intensive on bottom tray and suspended string culture (Burrell, 1983; 1985).

Greatest progress has been realized in development of a hard clam mariculture industry in South Carolina (Manzi et al., 1981). The South Carolina Marine Resources Research Institute, Sea Grant and a private company in 1980 entered into a cooperative agreement to develop technology and establish

TABLE 1. CULTURE STATUS OF MOLLUSCAN SPECIES IN SOUTH CAROLINA.

SPECIES	CONDITIONED & SPAWNED	GROWN FROM IMPORTED SEED	GROWN FROM NATIVE SEED
CROSSBARRED VENUS, CHIONE CANCELLATA	X		
SAWTOOTHED PENSHELL, ATRINA SERRATA	X		
PAPER MUSSEL, AMYGDALUM PAPRIUM	X		
BLUE MUSSEL, MYTILIS EDULIS	X		
ANGEL WING, CYTOPLEURA COSTATA	X		
GIANT ATLANTIC COCKLE, DINOCARDIUM ROBUSTUM	X		
NORTHERN BAY SCALLOP, ARGOPECTEN I IRRADIENS	X	X	
SOUTHERN BAY SCALLOP, ARGOPECTEN I APLICOSTATIS			
SURF CLAM, SPISULA SOLIDISSIMA		X	
NORTHERN QUAHOG, MERCENARIA MERCENARIA	X	X	X
SOUTHERN QUAHOG, M. CAMPECHIENSIS	X		
GULF QUAHOG, M. M. TEXANA	X		
EASTERN OYSTER, CRASSOSTREA VIRGINICA	X	X	X

TABLE 2. COMPARISONS BETWEEN DENSITY, FLOW RATE, AVAILABLE CHLOROPHYLL (C-a), CLEARANCE RATE AND MONTHLY GROWTH IN DIFFERENT SEASONS IN UPFLOW NURSERY SYSTEMS UTILIZING WATER PUMPED FROM THE FOLLY RIVER, SOUTH CAROLINA.

TIME	DENSITY (KG/M2)	FLOW RATE (L/MIN/KG)	C-a (UG/L)	C-a X FLOW (UG/MIN/KG)	CLEARANCE (UG/MIN/KG)	(%)	GROWTH (G/100G)
SPRING 1982	10	26.4	14.79	390.52	44.09	11.27	119.5
	20	13.8	14.79	204.14	21.80	10.70	112.7
	30	9.1	14.79	124.61	27.94	20.75	77.8
SUMMER	5	55.3	6.39	353.37	60.28	17.06	91.7
	10	27.6	6.39	176.36	62.10	35.21	80.7
	20	13.9	6.39	88.82	39.75	44.75	51.0
	30	9.1	6.39	58.15	30.58	52.59	33.1
FALL	5	58.0	16.05	930.90	156.02	16.76	256.5
	10	29.1	16.05	467.06	151.32	32.40	213.1
	20	14.5	16.05	232.73	108.89	46.79	125.6
WINTER 1983	5	59.4	8.56	508.46	28.93	5.69	11.6
	10	28.5	8.56	243.96	19.78	8.11	9.0
	20	14.4	8.56	123.26	17.56	14.25	5.9
SPRING	5	58.1	4.96	288.18	24.63	8.55	125.9
	10	29.7	4.96	147.31	25.63	17.40	126.1
	20	14.5	4.96	71.92	24.36	33.87	98.5

protocols that would result in a commercially successful clam farm.

A system has been developed that involves the following phases:

Nursery phase. Seed (~1 mm in size) are imported from commercial hatcheries and placed in an upflow nursery system. Here they are grown to 7-8 mm in length. We use two types of nursery systems, both upflow types (Figure 1). Active or forced upflow systems, consist of a PVC cylinder, closed at the bottom which has a small mesh nylon screen attached approximately one third of the height of the pipe from the bottom. Estuarine water is pumped into the bottom of the cylinder up through the clam mass supported on the nylon screen. The water flows out an overflow pipe at the top of the cylinder. Seed clams are grown to 3 mm size in an active upflow system. The 3 mm seed are then placed in a passive upflow system which consists of a large diameter PVC cylinder with a small mesh nylon screen to hold seed clams placed across the bottom, suspended in a larger diameter reservoir. Water from an adjacent estuary is pumped into the reservoir and flows up through the nylon mesh on the bottom of the cylinder, through the seed clams supported on the mesh, and out an overflow pipe located near the top of the inner cylinder. Clams appear to grow as well in upflow systems as in raceways. The advantages of the upflow system are that they are easy and economical to construct, take up less room, are easier to maintain and clean and the flow is more uniform through the clam mass (Manzi et al., in press).

The time to grow 1 mm seed to 7-8 mm seed in the nursery phase, depends on season, salinity, density, flow rate, and available chlorophyll clearance rate (the actual amount of chlorophyll removed by the clams). Growth is best in spring and fall (Manzi et al., in press). Under conditions of unrestricted growth, planting size seed are produced in as little as 60 days (Table 2).

Growout Phase. Planting size clams (7-8 mm) are small enough to be vulnerable to high predation by several species of crabs, drills and some bottom feeding fish. Therefore, protective pens are used for growout to harvest size (45-50 mm in longest dimension). The pens, 2 x 10 x 1 m in size, are constructed of vinyl clad 1.25 x 1.25 mm (17 gauge wire) mesh. Pens are held in place by 3.2 mm diameter PVC pipe corner supports extended into the bottom approximately 1 m (Figure 1). The pens are deployed in the intertidal zone and a layer of sediment is allowed to accumulate to a depth of 8-10 cm. Clams are then broadcast (1100-2200 seed/m^2) on top of this sediment in which they rapidly bury themselves. Time to reach market size ranges from 20-36 months. Preliminary analysis of data indicate a relationship of clam growth to density (Table 3). Also, season in which clams are planted also appears to influence growth and survival with fall appearing to be the most favorable planting time. Stocks from different parental lines have shown different growth and survival patterns. Seed obtained from Aquaculture

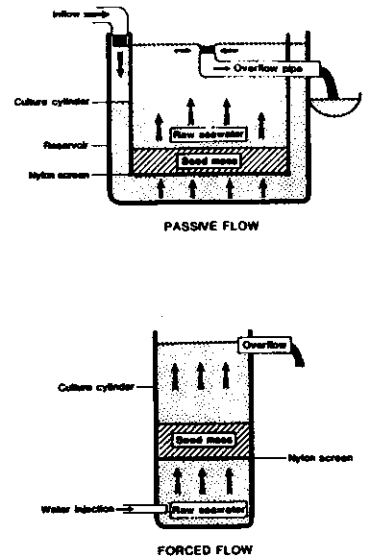

Figure 1. Generalized diagrams of upflow systems presently in use in South Carolina clam culture operations (after Manzy, 1985).

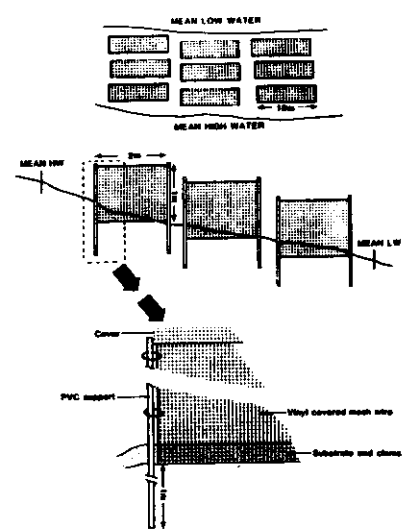

Figure 2. Vinyl wire pens utilized for intertidal growout of hard clams in the intertidal zone of South Carolina. Top: Bird's eye view of intertidal bank planted with rows of pens. Middle: End view of pens in place. Bottom: Cose-up showing construction details.

TABLE 3. GROWTH OF HARD CLAMS IN PROTECTIVE TRAYS DEPLOYED IN THE INTERTIDAL ZONE IN SOUTH CAROLINA.

INITIAL DENSITY (SEED/M^2)	TIME (MOS)	SIZE (MM)	RECOVERY SURVIVAL (%)	MEAN GROWTH RATE (MM/MO)
2200	21	39.0	60	1.5
8800	15	26.0	52	1.2
12000	16	28.4	46	1.2
13200	10	17.6	38	0.8

TABLE 4. GROWTH OF THREE STOCKS OF HARD CLAMS IN SOUTH CAROLINA INTERTIDAL PENS.

STOCK*	TIME (MOS)	RECOVERY SIZE (MM)	RECOVERY SURVIVAL (%)	GROWTH RATE MM/MO
SC	21	32	41	1.1
ARC	23	41	60	1.5
ARC X SC	23	38	54	1.4

*ALL STOCKS PLANTED AT THE SAME TIME AT THE SAME DENSITY AND INITIAL SIZE
SC = SOUTH CAROLINA WILDSTOCK
ARC = GROWTH SELECTED STOCK FROM AQUACULTURE RESEARCH CORPORATION (DENNIS, MA.)
ARC X SC = CROSS BETWEEN SC AND ARC STOCKS

Research Corporation (ARC) and crosses between ARC and South Carolina native stock grew faster and had higher survival than did seed from South Carolina native stock (Table 4).

Harvest Phase. When at least 50% of samples of clams reach harvest size (45-50 mm, longest dimension) all clams are harvested using a venturi suction device. The clams less than harvest size are returned to another pen for further growth.

SUMMARY

1. Small seed (1 mm) are grown to planting size (7-8 mm) in an upwelling nursery.

2. Large intertidal pens, approximately 10 m x 2 m x 1 m in size, constructed of 1.25 cm x 1.25 cm vinyl coated wire mesh are economically efficient units for field growout.

3. A single stage growout strategy is fully acceptable if initial stockings of seed clams are no smaller than 7-8 mm and stocking density ranges from 1100-2200 seed/m^2 (100-200/ft^2).

4. Seed stocked between August and December have exhibited higher initial survival than seed stocked at other times of the year.

5. Latest results with growout from 7-8 mm selected seed stocks showed an average time to minimum market size of 22 months and mean survival of 60% to first harvest.

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