Charleston

LABORATORY HATCHING AND REARING OF PACIFIC COAST CLAMS AND OYSTERS

ANNUAL REPORT
July 1, 1967-June 30, 1968

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U. S. Department of Interior
Fish and Wildlife Service
Bureau of Commercial Fisheries
Commercial Fisheries Research and Development Act
Subproject No. 1-27-R-1
Contract No. 14-17-0007-833

November 1968

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INTRODUCTION

The Pacific Coast oyster industry is dependent upon imported oyster seed from Japan. Inconsistent quantity and quality of the imported seed is limiting growth and expansion of the oyster industry while the demand for marketable oysters is increasing. The development of oyster hatcheries on the Pacific Coast could provide the oyster industry with a continuous supply of seed needed for increased production. Controlled hatchery conditions would also provide better quality oyster seed production through selective breeding.

The main objectives of the first year were to develop spawning and setting techniques for Pacific Coast molluscs. The following molluscs were successfully spawned and reared to metamorphosis: razor clams (Siliqua patula), butter clams (Saxidomus giganteus), gaper clams (Tresus capax), cockle clams (Clinocardium nuttalli), native oysters (Ostrea lurida), European flat oysters (O. edulis), and Pacific and Kumamoto strains of the Japanese oyster (Crassostrea gigas).

MATERIALS AND METHODS

Spawning techniques were developed and optimum conditions for larval growth were determined for the previously mentioned molluscs. In addition, preliminary work in determining suitable cultch materials for setting oysters and in monitoring growth of juvenile oysters in the field was started.

Adult molluscs were conditioned on trays of 18 to 20 C sea water for 2 to 3 weeks before spawning to permit gonadal maturation. Water was renewed daily.

Most of the molluscs used in this work were placed in a plexiglass trough after conditioning so spawning stimulants could be applied (Figure 1). A pump provided continuous circulation of water through the chamber. Spawning was induced by thermal and organic or inorganic chemical stimulation depending on the species involved (Table 1). Species not placed in the trough were the native and European oysters and the cockle.

Native and European oysters were given no additional stimulation since the conditioning procedure induced spawning. Pacific and Kumamoto oysters required a raise in water temperature to 28 C for the former and 30 C for the latter and the addition of sex products "stripped" from sacrificed oysters to trigger spawning. Cockles were given alternate 6 and 18 hour treatments in 20 C and 15 C water, respectively. Spawning in the gaper clam was induced by adding sex products and reducing the water temperature to 12-15 C. A chemical method of stimulation was used on razor and butter clams, viz., the addition of potassium chloride at a concentration of 2 grams per liter of water with exposure for a period of 1 to 1-1/2 hours.

Procedures for handling the molluscs after spawning commenced varied. The larviparous native and European oysters which retain the gametes in the mantle cavity for fertilization and early development of the egg were left in the conditioning trays. The hermaphroditic cockles were removed from the stimulation troughs and placed in spawning containers with several other spawning cockles. The unisexual clams and the Pacific and Kumamoto oysters were put in individual containers so the gametes could be collected and united.

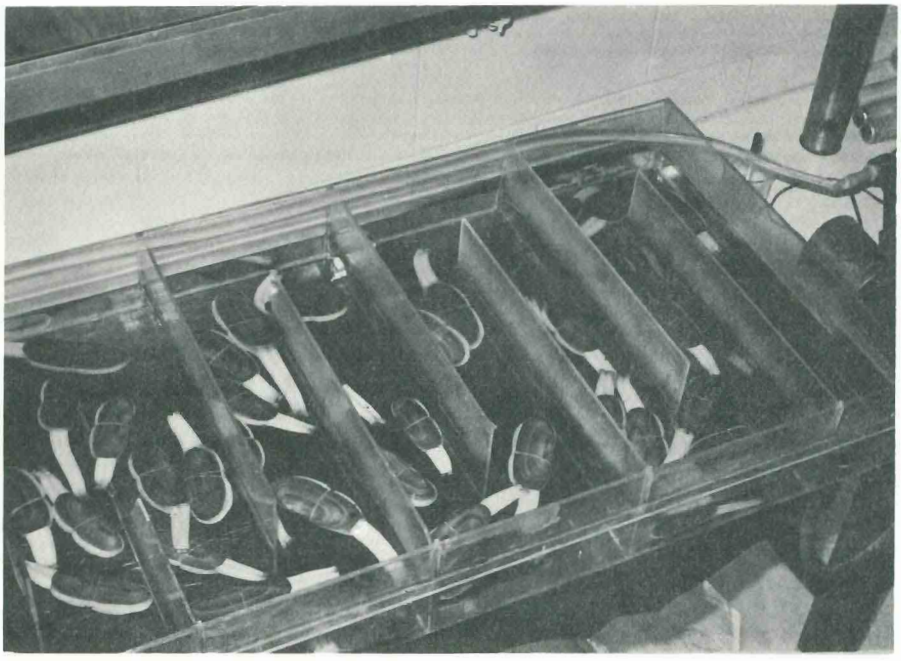

Figure 1. Spawning razor clams in a plexiglass spawning chamber

Table 1. Methods used to induce spawning in adult molluscs

Species	Water salinity	Method of stimulation
Crassostrea gigas (Pacific)	25.0°/oo	Heated water to 28 C. Added sex products.
Crassostrea gigas (Kumamoto)	25.0°/oo	Heated water to 30 C. Added sex products.
Clinocardium nuttalli	Uncontrolled	Heated water (20 C) 6 hours, cooled (15 C) 18 hours.
Ostrea lurida, edulis	Uncontrolled	Held at room temperatures (18 to 20 C) 2 to 4 weeks, changed water daily.
Siliqua patula	Uncontrolled	1. 2.0 gm KCL/liter, 1 to 1.5 hours, returned to fresh sea water. 2. "Stripped."
Tresus capax	Uncontrolled	1. Held in flowing sea water at 12-15 C. 2. "Stripped."
Saxidomus giganteus	Uncontrolled	2.0 gm KCL/liter for 1 to 1.5 hours, returned to fresh sea water.

The fertilized eggs of clams and oysters (excepting the two larviparous species) were placed in 5 gallon jars until the D-shaped velliger larvae stage was reached. At this point they, like the released larvae of the native and European oyster, were transferred for rearing to 46 x 46 x 24-inch plastic lined tanks containing 680 liters of water (Figure 2). Most plankton and particulate material was effectively eliminated from the water by use of a Microfloc filter and ultraviolet light.

Figure 2. Larval rearing tank with polyvinyl pipe being tested as cultch material

Temperatures and salinities during larval rearing were maintained within the desirable limits of each species studied (Table 2). Thermostatically controlled heaters regulated the water temperature.

Larvae were fed and sampled for growth three times a week. Algal diets of Monochrysis lutheri and Isochrysis galbana were used at densities of 20,000 to 40,000 cells per milliliter of rearing water. Unialgal cultures were maintained in 250 and 2,000 ml culture flasks containing autoclaved, nutrient-enriched sea water. Cultures were grown under fluorescent lighting and agitated by orbital shakers (Figure 3). The nutrient media used in the algal culture was suggested by Matthiessen and Toner (1966). The 2,000 ml algal cultures were used to inoculate 100 and 500 liter mass culture tanks (Figure 4).

Filtered and ultraviolet treated sea water was chlorinated with 0.5 ml/l of household bleach to eliminate undesirable blue-green algae. Chlorine was removed by an activated charcoal filter.

Algae in mass culture tanks reached densities of 1 million cells/ml within 4 to 7 days. Algal densities were determined electronically by a Coulter Counter.

Cultch material was added to the oyster rearing tanks prior to larval metamorphosis. Old oyster shell, fiberglass, and polyvinyl chloride materials were used as cultch. After setting, the young oysters were moved to areas in Netarts and Yaquina bays where bottom and suspended culture techniques are being studied.

RESULTS

Spawning of adult Pacific and Kumamoto oysters from Yaquina Bay was induced throughout the year. The Kumamoto oyster requires temperatures above 25 C to spawn, hence spawning does not occur in Yaquina Bay. Although Pacific oysters spawn naturally in shallow

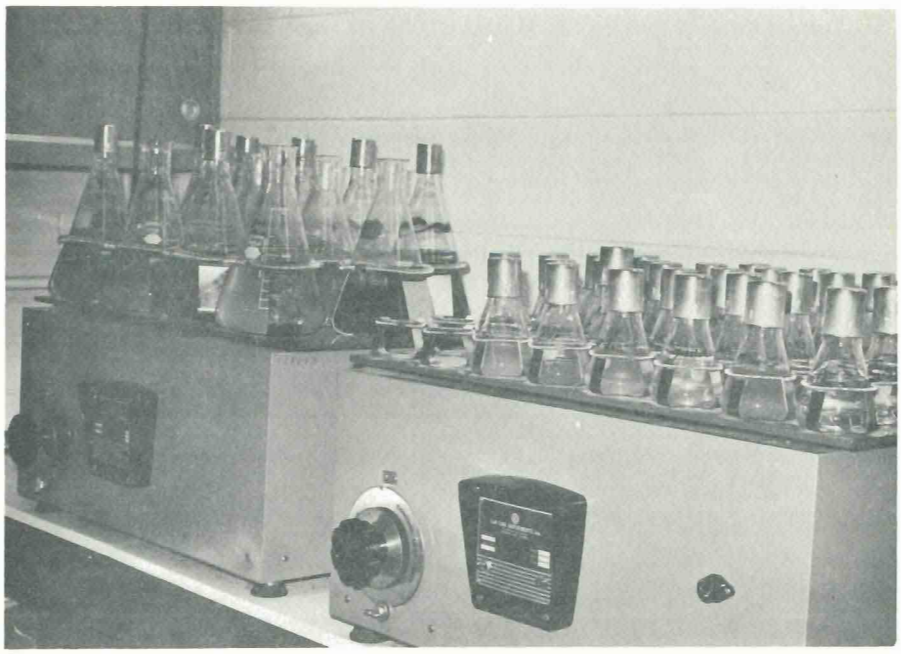

Figure 3. Unialgal cultures maintained in flasks on orbital shakers

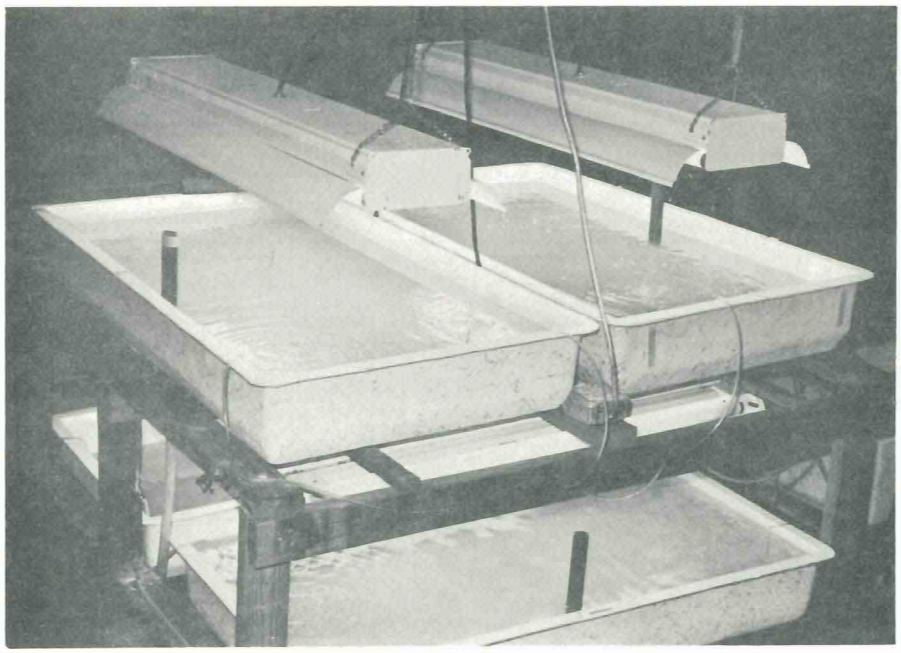

Figure 4. Fiberglass tanks for mass culture of algae

Table 2. Temperature and salinity ranges of larval rearing tanks

Species	Salinity (ppt)	Temperature (C)
Crassostrea gigas (Pacific)	25.0	24-27
C. gigas (Kumamoto)	25.0	26-29
Ostrea edulis	28.0-33.0	16-20
O. lurida	28.0-33.0	16-20
Tresus capax	28.0-33.0	14-18
Saxidomus giganteus	28.0-33.0	17-18
Clinocardium nuttalli	30.0-33.0	18-19
Siliqua patula	30.0-33.5	14-16

areas of Yaquina Bay, unspawned oysters can be obtained from deep, colder areas of the bay throughout the year. Native oysters were conditioned and spawned from November through July. Summer spawning leaves the oysters in poor gonadal condition during the fall months.

Successful spawning of clams was limited to periods before and during normal spawning time.

Growth of larval molluscs to metamorphosis was affected by temperature, larval density and food. Using similar algal diets, Pacific oyster larvae reached 250 microns (the generally accepted size at metamorphosis) in 21 and 13 days when reared at 25 and 28 C, respectively (Figure 5). Metamorphosis was first observed at 22 and 14 days. Similarly, gaper clam larvae reared at 14 to 15 C and 17 to 18 C reached 230 microns in 23 and 15 days, respectively (Figure 6). Metamorphosed clams were first observed at 26 and 16 days.

Native oyster larval growth was affected by larval density when food and temperature were constant. At larval densities of 0.3 million (0.5 larvae/ml) and 1.5 million (2.5 larvae/ml) per tank, the larvae reached 250 microns in 13 and 21 days, respectively (Figure 7). Based on six larval rearing studies, optimum larval density lies between

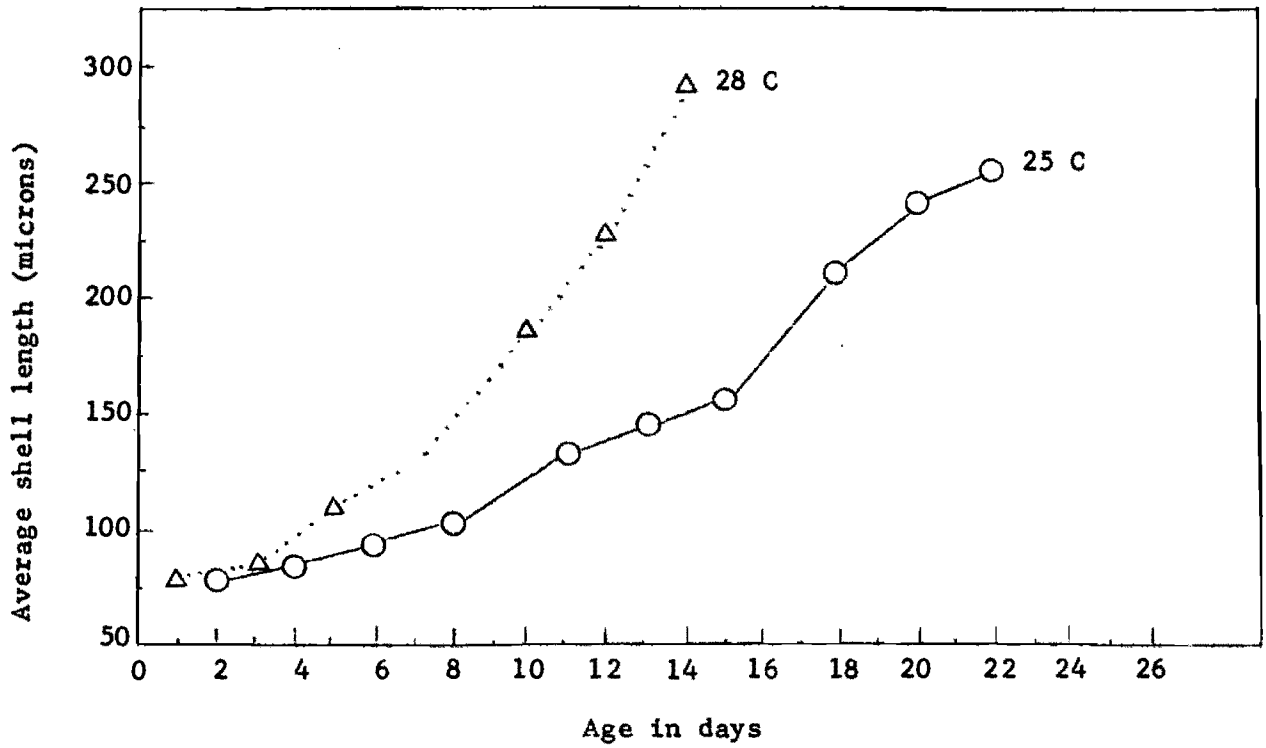

Figure 5. Larval growth of Pacific oysters at different temperatures

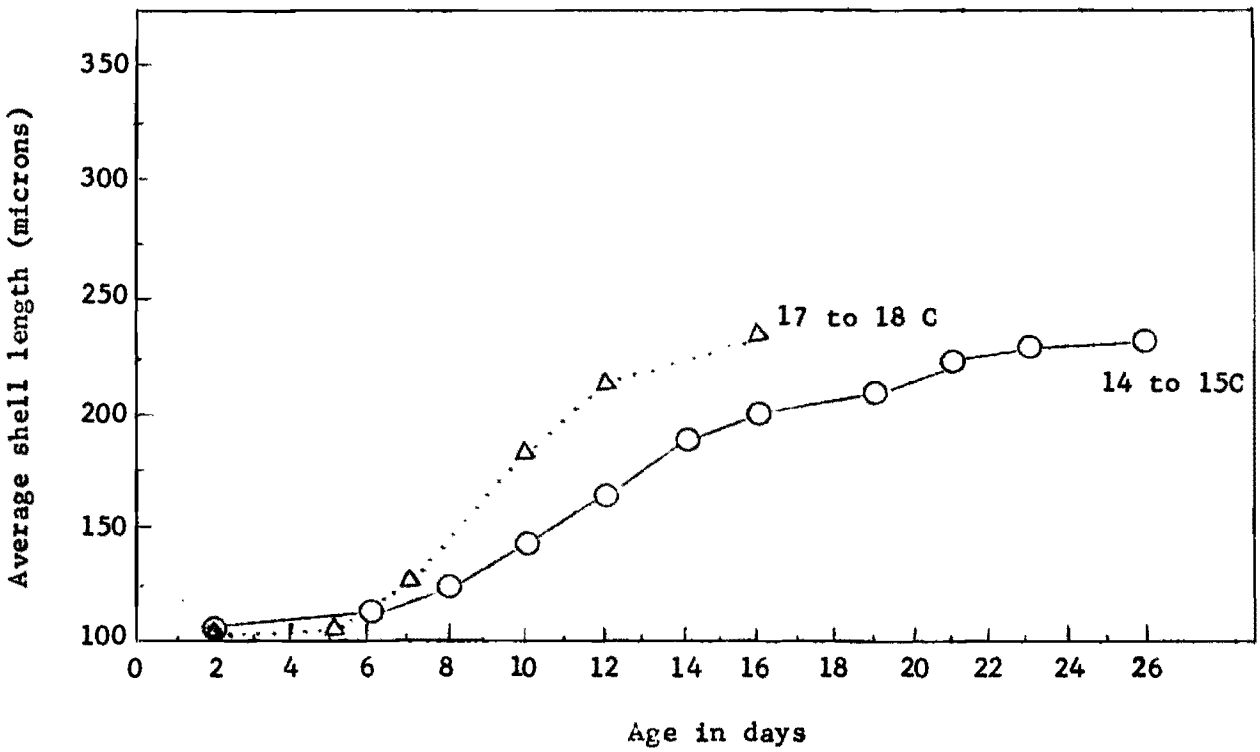

Figure 6. Larval growth of the gaper clam at different temperatures

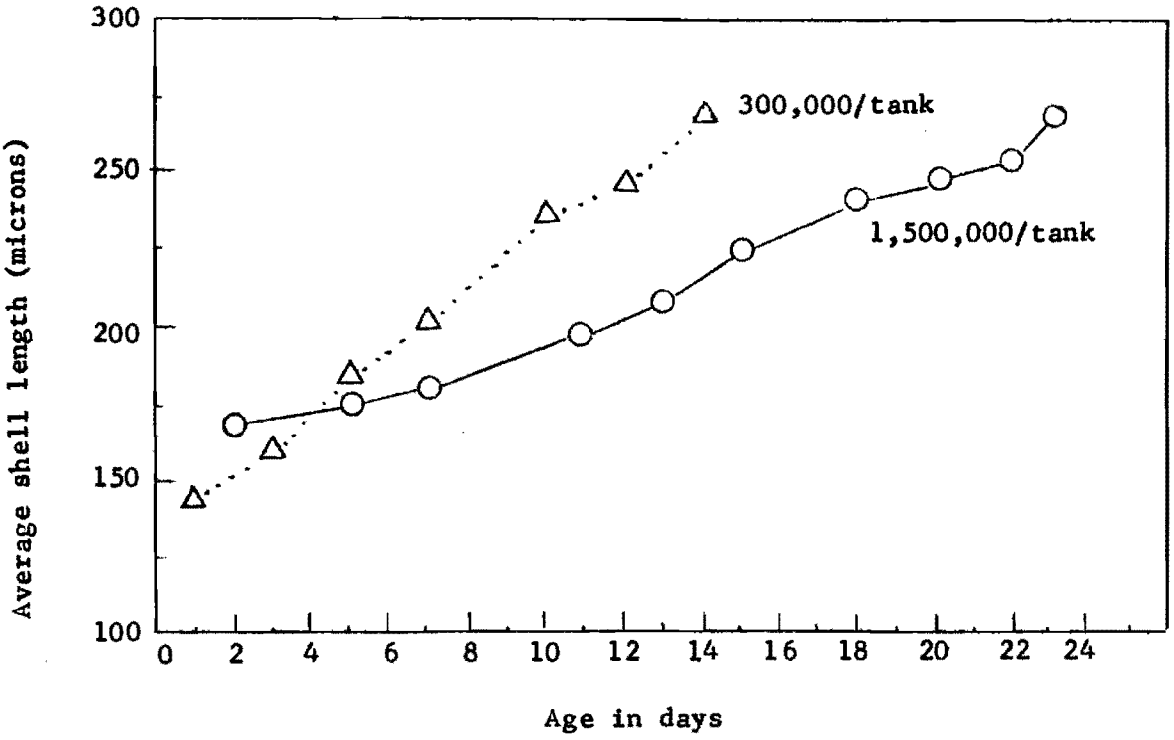

Figure 7. Larval growth of the native oyster at different larval densities

0.5 million to 1.0 million larvae per tank or 0.8 to 1.3 larvae/ml of rearing water. Six and seven larval rearing studies with Pacific and Kumamoto oysters, respectively, indicated the optimum rearing densities were similar (0.5 to 1.0 million per tank).

Attempts were made to find a synthetic cultch material for setting oyster spat in the laboratory tanks. Old oyster shell, commonly used by growers, is expensive to clean and larvae do not set the shell uniformly. In addition to oyster shell, resin coated wood posts, fiberglass sheets, and polyvinyl sheeting and pipe were tested (Figure 2). Polyvinyl pipe was selected for further testing.

Larvae of gaper and butter clams were raised through metamorphosis. Juveniles will be planted in the field in the near future to evaluate growth and survival.

Although larvae of cockle and razor clams were raised successfully, high mortality resulted to the newly metamorphosed juveniles. Mortality might be attributed to lack of a suitable setting substrate. Further investigation will be done in the near future.

FUTURE STUDIES

Future studies will include: (1) evaluation of growth of mollusc larvae raised on various unialgal and mixed algal cultures; (2) evaluation of growth of oysters set on various cultch materials; (3) comparison of growth of hatchery and imported oyster seed; (4) studies of bottom and suspended oyster culture; and (5) evaluation of growth and survival of juvenile clams in the field.

SUMMARY

Pacific and Kumamoto oysters were induced to spawn throughout the year, native oysters were spawned from November through July.

Clams could not be induced to spawn at times other than their normal spawning period.

Optimum temperatures and larval densities were determined for clam and oyster larval rearing. Pacific and Kumamoto oyster larvae grow best at water temperatures of 28 C. Optimum temperatures for native oysters, cockle and butter clam larvae lie between 16 and 19 C. Gaper larvae required a rearing temperature of 17 to 18 C. Razor clam larvae were grown at 14 to 15 C.

A synthetic cultch material, polyvinyl pipe, was used successfully for setting oyster larvae and was selected for further study.

Larvae of gaper, cockle, razor, and butter clams were raised through metamorphosis. Juvenile butter and gaper clams will be placed in the field to study growth and survival.

LITERATURE CITED

Matthiessen, G. C. and R. C. Toner. 1966. Possible methods of improving the shellfish industry of Martha's Vineyard, Duke's County, Massachusetts. A publication by the Marine Research Foundation, Inc., 138 p.