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SURVIVAL AND GROWTH OF *VENUS MERCENARIA*, *VENUS CAMPECHIENSIS*, AND THEIR HYBRIDS IN SUSPENDED TRAYS AND ON NATURAL BOTTOMS[1]

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Introduction

In the course of laboratory experiments on spawning of mollusks and propagation of larvae and young, Loosanoff and Davis (1950) of the Milford Laboratory of the U. S. Fish and Wildlife Service crossed the southern hard-shell clam, *Venus campechiensis* Gmelin, with the northern species *Venus mercenaria* Linné (Loosanoff, personal communication). To determine the ecological adaptations of the hybrids, groups of the parent species and their reciprocal hybrids were sent for testing to six laboratories from Maine to Florida. The northern quahog or hard-shell clam inhabits the shores of the Western Atlantic from the Gulf of St. Lawrence to Florida and the Gulf of Mexico; the southern quahog has been recorded from Chesapeake Bay to Florida (Abbott 1954) although it is doubtful that it occurs naturally in Chesapeake Bay for we have not encountered it. Since the two species cross easily in the laboratory, questions arise about the validity of the species and the amount of natural hybridization which occurs in areas south of Chesapeake Bay where the ranges overlap. The characters used by conchologists to distinguish *Venus campechiensis* are obesity, great width of lunule, thickness of shell, persistence of growth ridges, and absence of purple color internally.

The first series of clams, received in Virginia in May 1954, was planted in screen-covered boxes dug into the bottom at Gloucester Point near the Virginia Fisheries Laboratory. This experiment was a joint project with James B. Engle of the U. S. Fish and Wildlife Service. Although all four groups of clams were of the same age, the hybrids were distinctly larger when received from Milford. In the fall of 1954 when the boxes were first examined, mortality had been high, particularly in the groups containing the smaller clams; some predation was evident. Later in the fall hurricane Hazel dislodged some of the boxes and seriously curtailed the experiment.

After this experience, we conceived the idea of growing clams in boxes in trays suspended in the water; by this method oysters have been carried successfully through several hurricanes at Gloucester Point. Later it was discovered that Belding (1912) had used a similar method some 50 years earlier. The primary purpose of the tests was to compare

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growth and mortality of the two species and their hybrids under identical environmental conditions. With all four groups in one tray, the habitat was essentially similar, and predation, type of substratum (Pratt 1953), and accessibility were easily controlled.

Methods and Procedure

In November 1954, Dr. Loosanoff shipped a second series of clams selected arbitrarily for uniformity of size from lots of the same age. The clams were grown in wooden boxes filled with sandy mud, suspended about one foot off the bottom in "Sea-Rac" trays. The wooden boxes, 37 x 16 x 4 inches and subdivided into four 9 x 16 inch compartments, were covered with a lid of one-fourth inch mesh hardware cloth. With lids on, the boxes were submerged in water and refilled; this removed mud snails, coarse shells, and rocks from the muddy-sand bottom. The substratum in the boxes was seldom eroded, but a layer of soft mud one-quarter to one inch thick accumulated between examinations. Examinations were made once a month during the growing season, but less frequently during the winter. The clams were washed from the boxes over a screen. Individual clams were measured but weights and volumes were obtained by groups. Length is defined as the greatest dimension of clams from the anterior to the posterior margin.

Mortality of Clams

Upon arrival in Virginia, each group of clams, containing from 125 to 145 individuals, was placed in one of the four compartments. In November 1954, therefore, the density was about 125 clams per square foot, and the mean length was approximately 11 mm in each group. In July 1955 the clams were rearranged in two boxes, which increased the space available and decreased the density by half. In late October 1955, the clams had reached such a size that crowding was again suspected and differential mortality had changed the density in the various compartments. At this time numbers were marked on all clams; 25 of each group were placed in boxes and the rest planted on natural bottom. The density of clams in the boxes was reduced to about 10 per square foot, and average lengths of the groups were from 25 to 33 mm.

Two years of observations revealed that the death rate of the native species, V. mercenaria, was low during all seasons (Table 1). At these early ages and small sizes, neither disease nor environmental factors caused much death among clams of the northern species, although they were bred artificially from brood stock obtained in Long Island Sound. During the warm seasons, all groups had low mortalities, and it may be surmised that in Virginia summer conditions are probably not limiting to the species or the hybrids. In winter, however, the southern species had heavy losses and the two hybrids had important losses (Table 1).

After 25 of each group had been placed in trays, the remainder of the numbered clams was placed on natural bottom. In June 1956 about two-thirds of these clams were recovered by diving. In all groups, boxes (empty shells) and dying clams comprised less than three per cent of the total recovered---except in V. campechiensis which had a death rate of 74 per cent. As the warm season progressed, all groups of clams were rapidly decimated. Shell fragments began to appear in June, increased in abundance in July, and a large quantity was recovered in August. Positive identification of predators was impossible, but the size and nature of shell fragments, higher losses in the groups of smaller clams, and the long period of predation cause us to suspect the blue crab (Callinectes sapidus).

Growth

Growth of clams began in April or early May and ceased in November each year. V. campechiensis and the two hybrids had very similar growth rates (Fig. 1). In trays these groups increased in weight from 0.5 to nearly 11 gm in the 1955 growing season and from 11 to 29 gm in the 1956 season. However, none of the clams of the southern species survived the second winter. The northern quahogs grew little more than half as fast as the others; they reached a length of 26 mm and a weight of six gm the first season and 38 mm and 17 gm at the end of the second season.

During the growing season of 1956, clams retained in the suspended trays outgrew their counterparts in natural bottom (Table 2) although relatively few of this last group survived. This supports our belief that boxes of muddy sand suspended off the bottom in trays provide a suitable habitat for growth and survival of clams.

Yield

The potentiality of these clams as seed for Virginia waters depends ultimately upon the yield to the clammer. The amount of crop obtained and rapidity of harvest after seeding or setting depend upon rates of growth and survival of clams before a marketable size is reached. All the southern clams died before reaching a marketable size. During the two years of the experiment, the hybrid clams usually have had a greater biomass or yield than the northern clams (Fig. 2). Relative yield or biomass has been discussed by Andrews and McHugh (1957). None of the clams has reached marketable size yet, however, and the slow growth of the northern clams is almost compensated by the high rate of survival.

Discussion

The causes of clam mortalities in Virginia waters are unknown, yet it is significant that when predation was prevented losses were very

Table 1. Mortality of clams in trays at Gloucester Point, Virginia

Group	Number (Nov. 1954)	Percentage dead		Number (Nov. 1955)	Percentage dead	
		Nov. 1954 to Mar. 1955	Apr. to Oct. 1955		Nov. 1955 to Mar. 1956	Apr. to Oct. 1956
Species						
V. mercenaria	145	4.8	8.4	25	0.0	0.0
V. campechiensis	130	66.9	6.0	25	96.0	- -
Hybrids						
V. mercenaria ♀ x V. campechiensis ♂	125	24.8	6.8	25	12.0	0.0
V. campechiensis ♀ x V. mercenaria ♂	130	5.4	5.7	25	24.0	0.0

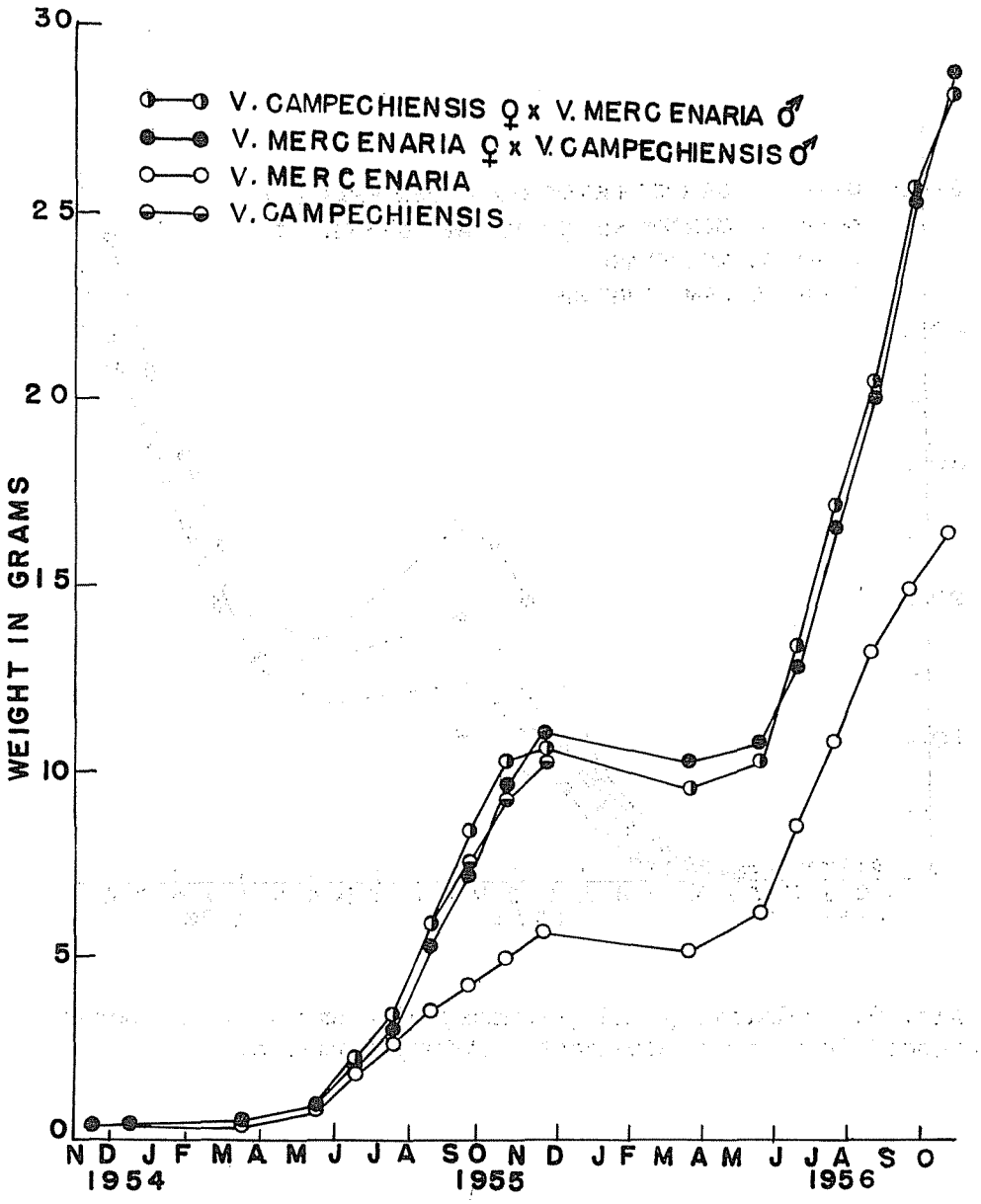

Fig. 1. Mean weight, including shell, of clams grown in boxes suspended in trays at Gloucester Point, Virginia.

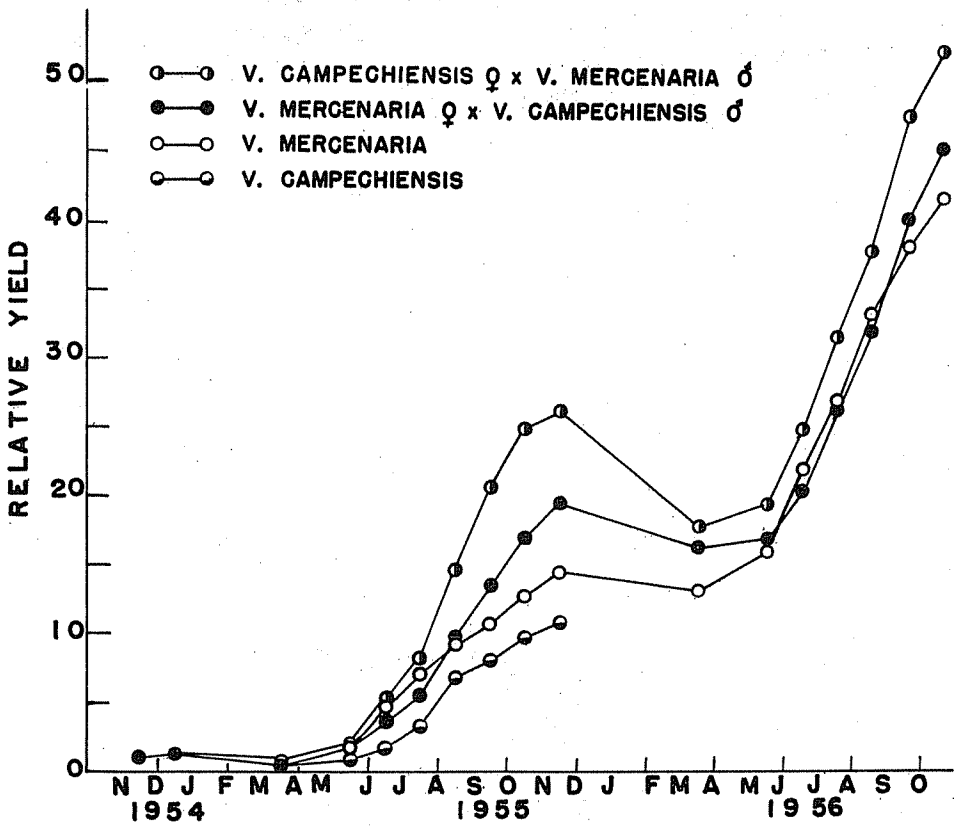

Fig. 2. Relative yield (biomass) of clams grown in boxes suspended in trays at Gloucester Point, Virginia.

Table 2. Mean Lengths and weights of clams in trays and in natural bottom, September 14, 1956[1]

Group	Length (mm)		Weight (gm)	
	Tray	Natural bottom	Tray	Natural bottom
V. mercenaria	37	33	15	13
V. mercenaria x *V. campechiensis*	44	40	26	19
V. campechiensis x *V. mercenaria*	43	39	26	22

[1] All clams were grown in trays until October 1955 when part of each group was planted on natural bottom. Subsequently, there were heavy losses in the bottom-living clams from predation.

low in the northern species at all seasons. Methods for reducing winter mortalities of northern quahogs in Maine have been discussed by Dow and Wallace (1951). The deaths of the southern clams and some hybrids in late winter suggest inability to withstand low temperatures. The experiments imply that V. campechiensis may be unable to persist in Chesapeake Bay long enough to breed and establish a population. The test in trays was fairly rigorous in respect to temperatures, for the water was shallow, and the winters of 1954-55 and 1955-56 were the coldest in a decade. The southern clams living in natural bottom also died at a high rate in the winter of 1955-56.

Growth of the hybrids was clearly superior to that of the northern clams. It appears that this desirable characteristic may be traced as much to inheritance from the southern quahog as to hybrid vigor, for V. campechiensis equalled the hybrids in growth in Virginia waters. It must be remembered that the progeny of V. mercenaria were obtained from brood stock native to the cold waters of Long Island Sound. Clams native to Chesapeake Bay may grow faster.

The relative yield of the hybrids and the northern clams at marketable size is undetermined. If growth becomes slower with age, and winter losses continue, then the hybrids may yet be exceeded in yield by the northern quahog.

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