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# THE SURVIVAL AND GROWTH OF SOUTH CAROLINA SEED OYSTERS IN VIRGINIA WATERS[1]

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## Introduction

Most of the seed oysters planted on private grounds along the Atlantic Coast of the United States are obtained from public seed beds. The supply depends largely upon a wild crop over which there is little control. It is to be expected, perhaps, that the quantity of seed available at various localities along the coast is in proportion to the duration of the warm season. It follows that oystermen are usually searching southward for their supply of seed and the ramifications of this hunt are complex and ever changing.

Between 1825 and 1880 millions of bushels of Virginia oysters were shipped north to oyster-growing areas from Delaware to New Hampshire (Goode 1887). In 1879, for example, two million bushels were exported from Maryland waters alone at a price of seven cents per bushel. Some 200 sail-powered "run boats" were engaged in the transfer of oysters from Chesapeake Bay to northern waters. The cost at the point of delivery was 25 to 35 cents a bushel. Most of these Chesapeake oysters were marketed immediately, but some were planted for use the following summer and fall. Evidently most were of marketable size when shipped north; the primary purpose of relaying was to hold them for sale in the succeeding summer and early fall when native oysters were spawning and poor in quality.

By 1880 northern dealers had established shucking plants in Norfolk and Baltimore, and thereafter shipments of oysters in the shell to northern ports declined. The search for southern oysters has never ceased, but now small seed oysters may be held in northern waters for several years before marketing, and few are taken north of New Jersey. Growing southern oysters for several years in northern waters is a far different task than holding large oysters through one summer season before marketing, for survival and growth become important as well as the ability to fatten.

As production of market oysters on private grounds increased in Virginia, the home market absorbed most of the supply of seed, and as recently as ten years ago less than 10 per cent of James River seed was sold out of State. Today the sale of seed oysters from public grounds of the James River for direct transport out of State is forbidden, and northern growers have turned to private grounds and the seaside of Eastern Shore for their supply.

[1] Contributions from the Virginia Fisheries Laboratory No. 73.

These limitations on the export of seed were necessary under the present organization of the industry in Virginia, for the amount of ground under lease has been increasing, the demand within the State has been great, and in the last few years the price has steadily increased. Despite the ban on direct shipments out of State, the annual catch of seed oysters from the James River has increased. Potential seed areas on public grounds in other rivers have not been utilized and seed production on private grounds has been slow to develop. Prior to 1947 considerable quantities of Pamlico Sound seed oysters were used in Chesapeake Bay and particularly on the seaside of Eastern Shore. This practice ceased when the state of North Carolina placed on oysters an export tax of 50 cents per bushel (Chestnut 1949). Until recently shipment of seed from South Carolina has been virtually barred by various laws of that state, but now that regulations have been revised and South Carolina is ready to encourage production of seed for northern planters (Wallace 1956).

In South Carolina most oysters are grown in the intertidal zone and the beds are characterized by heavy sets. Planters are intrigued by the high count per bushel but they recognize that consequent crowding may produce inferior shucking stock. It is not clear, moreover, whether oysters from the high-salinity waters of South Carolina can be transplanted successfully to the much less saline waters of upper Chesapeake Bay. In addition to these problems, scientists have been concerned about the growth and survival characteristics of southern oysters. Little attention was paid to quality and fitness of stock in the early days of extensive transplantation along the coast, and control of pests and diseases was given no consideration. It might be surmised that whatever damage could be done by mixing stocks and transplanting pests has already occurred, but recent troubles with the fungus Dermocystidium in Delaware Bay, and the possibility that the fungus may have been introduced in Chesapeake Bay some years earlier, suggest that unrestricted transplanting may yet be unwise.

The Chesapeake Biological Laboratory at Solomons, Maryland, began studying the characteristics of out-of-state seed grown in Chesapeake Bay a number of years ago (Beaven 1949); in 1951, in cooperation with the Bears Bluff Laboratory and the Maryland laboratory, studies of South Carolina seed oysters were begun in Virginia. Small numbers of these oysters have been held in trays for growth and mortality observations and upon these experiments is based a preliminary estimate of the usefulness of South Carolina seed in Chesapeake Bay.

We have attempted to compare the growth, survival, and fattening qualities of native and South Carolina oysters. We have assumed that the intensity and duration of setting in South Carolina waters will necessitate the removal of seed oysters at an early age--probably less than nine months. To hold stock longer in South Carolina produces a very dense cluster of oysters which can scarcely be separated a year later. In our experiments South Carolina and native spat of the same age were placed in trays when one to three months old and grown side by side. Data were obtained on oysters of three different year-classes from the two sources. The history of each group is given in Table 1.

## Patterns of Mortality

The pattern of mortality of native Chesapeake Bay oysters has been described by Hewatt and Andrews (1954). The death rate is high during warm periods (June to October) and extremely low during the winter and spring. Sporadic departures from this usual pattern, caused by mortalities from unknown causes, occur in some areas (Beaven 1946). In Figure 1 the pattern for native oysters is depicted over a period of three years (Trays 11 & 12). Figure 1 and Table 2 reveal also that in the warm period the mortality of South Carolina oysters (Trays 4 & 38) often is little more than half as great as that of natives. Andrews and Hewatt (1957) have shown that South Carolina oysters are more resistant to the fungus, <u>Dermocystidium marinum</u>, which is the cause of most summer deaths in trays. During winter and spring, however, the death rate in South Carolina oysters is appreciably higher than that of natives. In the warm winters of 1952-53 and 1953-54, these losses were relatively inconspicuous, but when winters were cold, as in 1954-55 and 1955-56, deaths were frequent in February and March and again in May and June (Fig. 1). The causes of these deaths in later winter and again in late spring are unknown. When organisms are transplanted to colder climates, minimal temperatures are often limiting, but oysters grown intertidally in South Carolina usually are exposed to lower temperatures and greater extremes than those held subtidally in trays at Gloucester Point. It appears that susceptibility to winter mortalities involves other factors in addition to low temperatures--perhaps diseases, favored by cold waters, to which South Carolina oysters are more susceptible than natives. The winter survival of South Carolina oysters in their native waters is unknown.

For convenience in computing biomass, it is best to express mortality in terms of survivors, as in Figure 2. Mortality and growth records were not collected in the first year because weights and counts of spat were difficult to obtain. For convenience, also, survivorship was computed on the basis of an original stock of 1000 oysters in each lot. Death rates for each period between observations were applied to the number of survivors at the beginning of the period. From Figure 2 the number or percentage of survivors at any age in months can be determined.

South Carolina oysters (closed circles) had less seasonal variation in death rate, hence the survivorship curve declines rather steadily, but the curves for native oysters (open circles) show steep declines in summer and almost no drop in winter. These curves include the unusual year of 1954 when over half the native oysters, but only one-fourth of the South Carolina oysters died. The South Carolina oysters had a distinct advantage in survival during this warm year.

Table 1. History of Virginia and South Carolina oysters grown in trays at Gloucester Point

| Year of birth | Tray number | Origin | Date transplanted |
|---|---|---|---|
| 1951 | 4 | South Carolina | July 1951 |
| | 11 | James River | Nov. 1951 |
| | 12 | Corrotoman River | Nov. 1951 |
| 1952 | 28 | South Carolina | Nov. 1952 |
| | 27 | York River | Aug. 1952 |
| 1953 | 38 | South Carolina | Nov. 1953 |
| | 39 | Chincoteague | Nov. 1953 |
| | 40 | York River | Aug. 1953 |

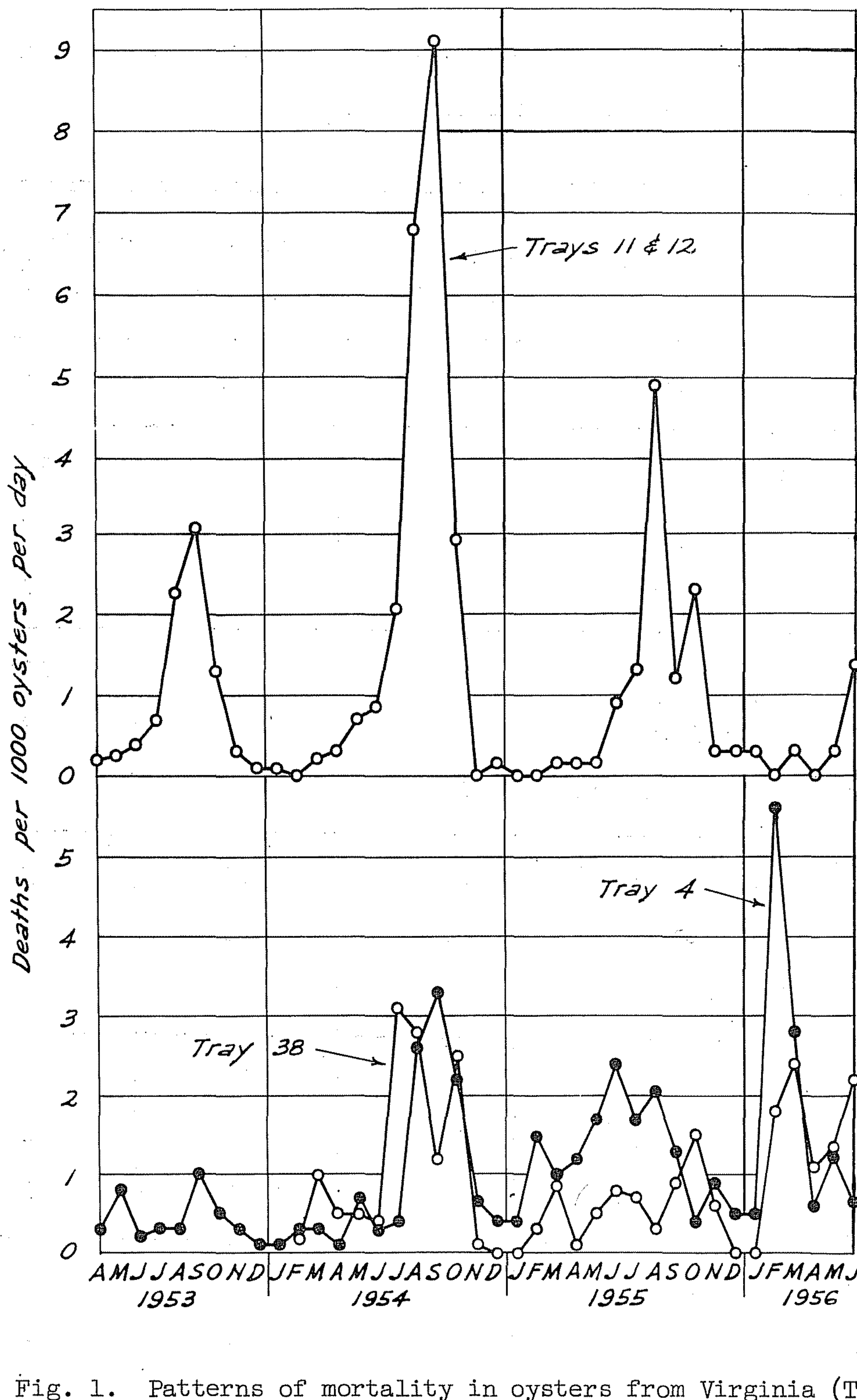


Fig. 1. Patterns of mortality in oysters from Virginia (Trays 11 and 12) and South Carolina (Trays 4 and 38). Mortality for each month is expressed as the average number of deaths per 1000 oysters per day.

Table 2. Mortalities of oysters in trays in the warm and cold seasons at Gloucester Point, Virginia

| Year | Tray number | Source | Mortality in per cent | | |
|---|---|---|---|---|---|
| | | | Warm months (June to Oct.) | Cold months (Nov. to May) | Annual (June to May) |
| 1951 | 4 | South Carolina | 9 | 16 | 24 |
| 1952 | 4 | South Carolina | 7 | 6 | 13 |
| | 11 | James River | 4 | 4 | 8 |
| | 12 | Corrotoman River | 3 | 0 | 3 |
| 1953 | 4 | South Carolina | 10 | 6 | 15 |
| | 11 | James River | 24 | 5 | 28 |
| | 12 | Corrotoman River | 17 | 6 | 22 |
| 1954 | 4 | South Carolina | 24 | 19 | 39 |
| | 11 | James River | 57 | 1 | 57 |
| | 12 | Corrotoman River | 51 | 4 | 53 |
| 1955 | 4 | South Carolina | 22 | 31 | 46 |
| | 11 | James River | 26 | 8 | 32 |
| | 12 | Corrotoman River | 30 | 2 | 32 |
| 1956 | 4 | South Carolina | 25 | .. | .. |
| | 11 | James River | 16 | .. | .. |
| | 12 | Corrotoman River | 25 | .. | .. |

In years in which average winter and summer temperatures are nearly normal, it appears that losses in South Carolina and native oysters may be about equal. Although summer losses are less in South Carolina oysters, winter deaths are more serious than in natives. The designation of "warm" and "cold" winters is difficult, but after 1948 Virginia had six consecutive warm winters during which the three winter months rarely had average temperatures below normal. In each of the past two winters (1954-55 & 1955-56), two of the three winter months had average temperatures well below normal and these were by far the coldest winters since 1948. During this experiment (1952 to 1956), two quite warm and two rather cold winters were experienced. It appears that warm winters and warm summers (1952-53 & 1953-54) favor the survival of South Carolina oysters, but cold winters (1954-55 & 1955-56) and cool summers (1956 permit greater survival of natives (Table 2).

Apparently South Carolina oysters are not immune to winter mortalities at any age, whereas all oysters reach two years of age before summer losses from Dermocystidium become heavy. In low-salinity waters, where no deaths occur from the fungus at any age, South Carolina oysters may suffer high winter losses (Beaven 1953). In the lower bay, therefore, South Carolina oysters appear to have no advantage over natives in ability to survive and in the upper bay they may be quite inferior.

## Growth

The growth of oysters, expressed as weight in the shell after cleaning, shows small differences between Virginia and South Carolina oysters of the same year-class but large variations among year-classes (Fig. 3). In other words, environmental differences apparently caused greater variation in growth than genetic differences between native and South Carolina oysters. The oysters of the 1951 year-class (Trays 4, 11, & 12) grew faster than those of the two succeeding year-classes. At the end of 24, 36, and 48 months of age they were 40 to 45 per cent heavier than the 1952 year class at the same age (Trays 27 & 28). In two of the three year-classes, South Carolina oysters were heavier than natives at the beginning of the experiment, but soon the natives exceeded them in weight. There is some indication that South Carolina oysters may never reach a size as large as natives. Marketable oysters of three to three and one-half inches weigh from 60 to 90 grams.

## Yields

In these experiments the yield of oysters is the resultant of losses from deaths and gains from growth. In the computation, average weight is multiplied by number of survivors; this is less complex than the method used by McHugh and Andrews (1955). To facilitate comparison of groups, the biomass or total weight has been converted to relative biomass or yield based upon an initial weight of 19 grams per oyster.

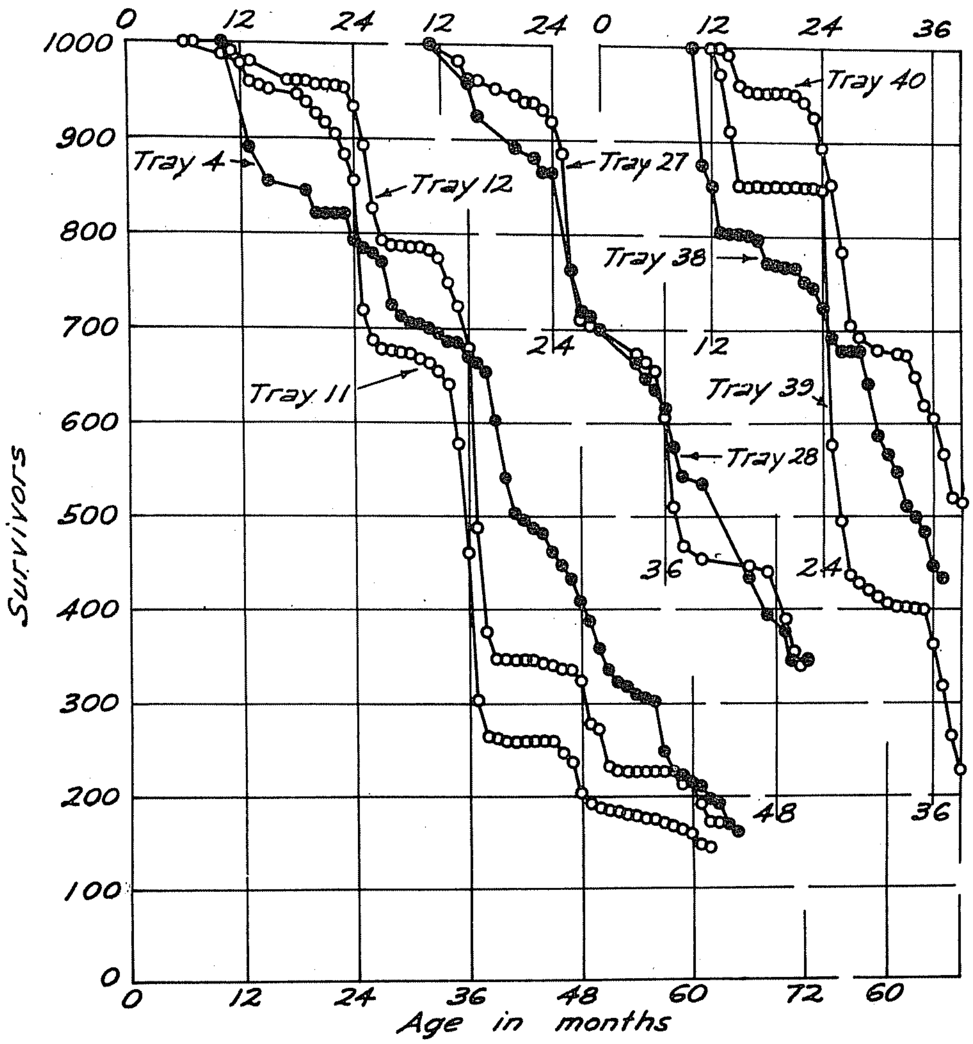


Fig. 2. Numbers of survivors from initial lots of 1000 oysters; calculations were based upon the death rates of oysters suspended in trays from the Virginia Fisheries Laboratory pier. The 1951 year-class is represented by Trays 11 and 12 from Virginia and Tray 4 from South Carolina; the 1952 year-class by Trays 27 (Virginia) and 28 (South Carolina). Tray 39 contained oysters from the seaside of the Eastern Shore of Virginia. Native oysters are represented by open circles and South Carolina by closed circles.

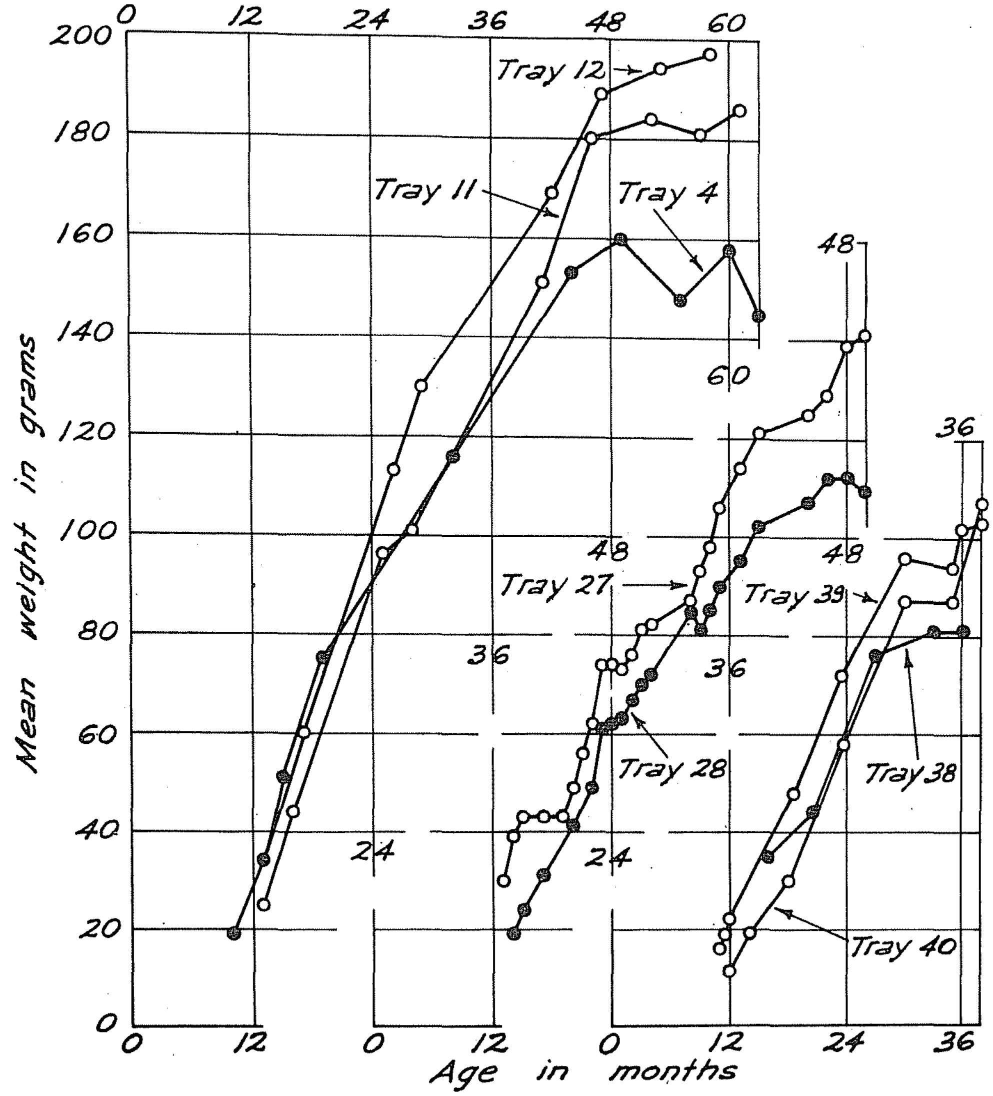


Fig. 3. Mean growth rate in total weight, including shell, of oysters from Virginia and South Carolina. The 1951 year-class is represented by Trays 11 and 12 from Virginia and Tray 4 from South Carolina; the 1952 year-class by Trays 27 (Virginia) and 28 (South Carolina); and the 1953 year-class by Trays 40 (Virginia) and 38 (South Carolina). Tray 39 contained oysters from the seaside of the Eastern Shore of Virginia. Open and closed circles represent native and South Carolina oysters respectively.

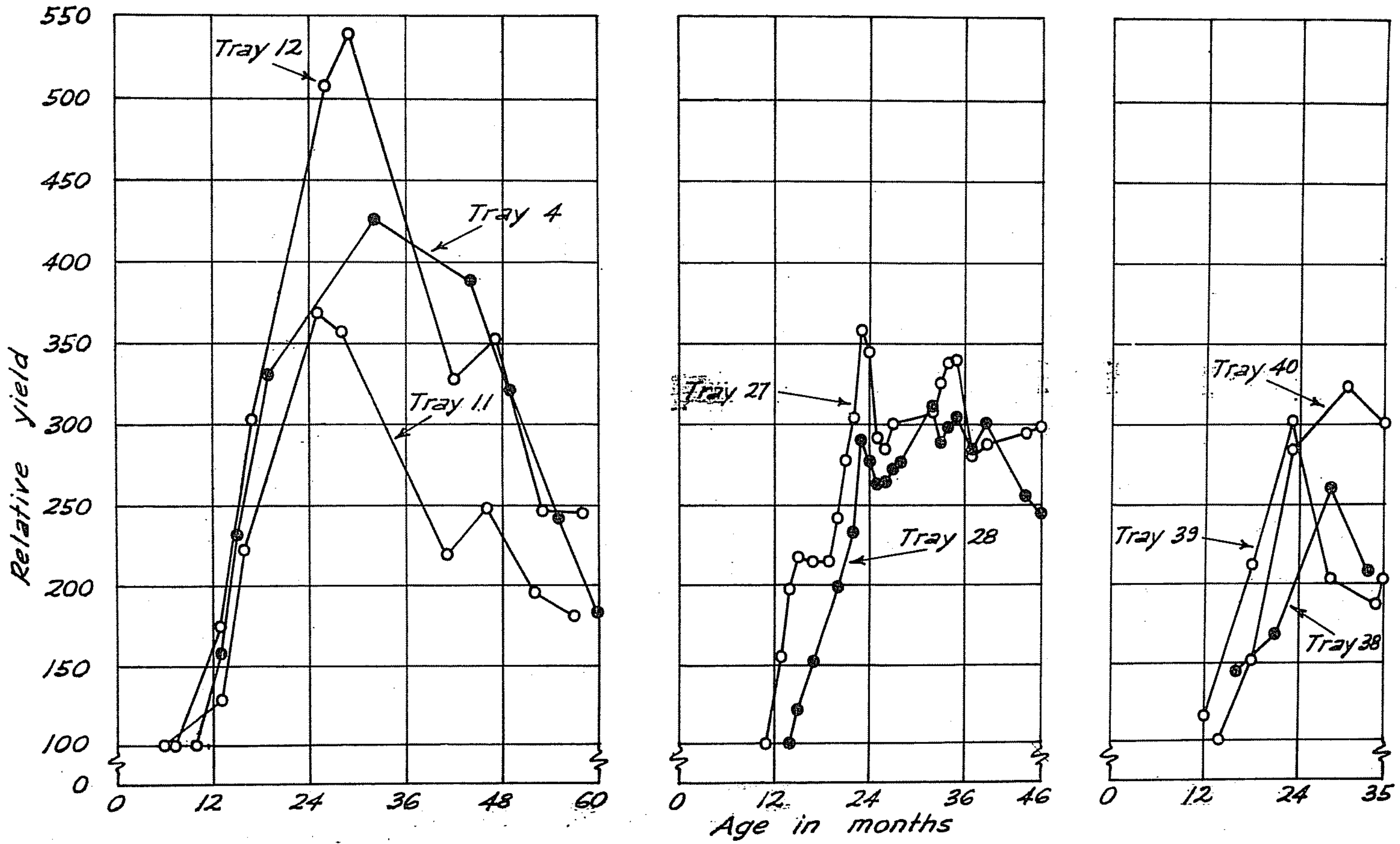


Fig. 4. Relative yield (biomass) of oysters from Virginia and South Carolina. The 1951 year-class is represented by Trays 11 and 12 from Virginia and Tray 4 from South Carolina; the 1952 year-class by Trays 27 (Virginia) and 28 (South Carolina); the 1953 year-class by Trays 40 (Virginia) and 38 (South Carolina). Tray 39 contained oysters from the seaside of the Eastern Shore of Virginia. Native oysters are represented by open circles and South Carolina by closed circles.

This was the approximate size at which each group of spat was separated from the cultch and weighed. Although actual weights varied, the month when each group reached an average weight of 19 grams was determined from the known weight-length relationship (McHugh and Andrews 1955). All points in Figure 2, however, are based on actual weights. A value of 100 was assigned to the initial biomass of 19,000 grams (1,000 oysters at 19 grams each). Yields are expressed as a percentage of the initial biomass, and at any age they can be read from the graph in any unit of weight or volume desired.

In all groups relative biomass increased rapidly during the first two years when growth was rapid and death rates low, and maximum yield was obtained in 24 to 30 months after setting (Fig. 4). In Trays 11 and 12 biomass declined rapidly thereafter for this was the period of excessive death rate in the summer and fall of 1954. Although there were rather wide differences in relative biomass of the two groups of native oysters of the 1951 year-class, the pattern was very similar. The decline in biomass was precipitous in the late summer and fall but tended to rise in spring when few deaths were occurring. If there had been a measurement at 34 months (late spring of 1954), biomass would undoubtedly have increased as it did in the spring of 1955 (41 to 46 months). In the spring of 1956 (53 to 58 months), these oysters were nearly five years old and growth had declined. The curve for South Carolina oysters (Tray 4) exhibited a distinctive pattern in which the inflections were less abrupt because the rate of survival was less variable. The sharpest declines in these oysters came in winter and spring when growth was slow and mortalities fairly high.

In Trays 27 and 28 (Fig. 4) the patterns were similar to those in the 1951 year-class but biomass was maintained near maximum levels longer because survival in 1955 was comparatively high. These groups never attained the maximum biomass of the 1951 groups because excessive mortalities in 1954 depleted the ranks early. It will be noted again that seasonal fluctuations in biomass are not as drastic in South Carolina oysters (Tray 28) as in natives (Tray 27).

Again, in oysters of the 1953 year-class (Trays 38, 39, and 40) biomass did not reach the level achieved by the 1951 groups (Fig. 4). In this latest year-class native oysters (Tray 40) had a distinct advantage over imported oysters; susceptibility to the fungus D. marinum caused high losses (48 per cent) in Chincoteague oysters (Tray 39) in the summer and fall of 1955 and many deaths occurred in the South Carolina oysters (Tray 38) in the winter and spring of 1956. Figure 4 clearly illustrates that these losses altered the biomass curve in Trays 38 and 39, and these oysters produced much lower yields at marketable sizes.

Yields of three, four, or five to one may not seem realistic to oystermen. It must be remembered that oysters grown in trays are protected from injury, smothering, drill predation, and other agents of attrition which operate on natural grounds; these are factors which

Table 3. The condition index in South Carolina and native oysters held in trays at Gloucester Point, Virginia[1]

| Date | Source | Tray number | Mean length mm | Condition index |
|---|---|---|---|---|
| 1 June 1955 | York River | 27 | 91 | 11.0 |
| | South Carolina | 28 | 84 | 12.5 |
| 10 Sept. 1955 | James River | 11 | 100 | 9.0 |
| | South Carolina | 4 | 106 | 7.1 |
| 4 May 1956 | York River | 27 | 93 | 7.8 |
| | South Carolina | 28 | 81 | 6.5 |
| 25 June 1956 | York River | 27 | 97 | 11.7 |
| | South Carolina | 28 | 96 | 9.2 |

[1] These determinations were made by Dexter S. Haven.

cause early losses in planted oysters when tray losses are negligible. The yield on natural grounds, consequently, never attains the level found in tray oysters; to achieve high yields, gains from growth must greatly exceed losses from deaths.

In yields, as in growth and mortality, South Carolina oysters appear to be at a disadvantage when compared with natives, although they may retain their peak biomass for a slightly longer time. In years of low temperatures South Carolina oysters do not attain the biomass of natives.

## Condition

A preliminary attempt has been made to compare the condition index (Higgins 1937) or "fatness" of South Carolina and native oysters. In three of four samples natives had higher indices of condition than South Carolina oysters (Table 3). Samples have not been taken in the fall and winter when most oysters are marketed. Seasonal and annual fluctuations in condition factor have been so great from river to river that data must be collected for several years before any firm conclusions on condition index can be reached.

## Discussion of Other Factors

The importance of several other characteristics of South Carolina oysters, when grown in Chesapeake Bay, has not been determined. These oysters are relatively more elongate than natives and the shell appears to be thinner. We have encountered more difficulty with breakage of shells in shucking South Carolina oysters, although it is not clear whether this is caused by a heavier infection of boring sponge or by thinner shells. The cupped valves have a deeper cavity in South Carolina oysters than in natives, and they are usually cucullated, that is, the cavity extends under the hinge. A few measurements indicate that the capacity of the shell cavity is greater than in natives for a given weight or size of oyster. The upper valve in South Carolina oysters lies on the cupped valve like a flat lid whereas in natives it contributes to the shell cavity.

## Summary

Most oystermen and biologists recognize that native oysters are the most satisfactory seed for planting in a given area. Although the demand for seed in Virginia presently exceeds the supply, there is no reason why this situation should continue to exist, for the proper utilization of suitable public grounds such as the Corrotoman and Piankatank Rivers, and greater attention to the production of seed oysters on private grounds, should be adequate to supply all planters within the state.

If these obvious sources of local seed are not exploited, however, planters will continue to look elsewhere for a supply. The recent relaxation of laws in South Carolina already has aroused interest among Chesapeake planters. In comparison with native Chesapeake Bay oysters, South Carolina seed is definitely superior in resistance to the fungus, almost equal in growth, but usually inferior in rate of survival during the cold season. Planters who desire to experiment further with these seed oysters should consider the interaction of the various biological factors with the economic and fiscal problems associated with their import from South Carolina.

## Literature Cited


Andrews, J. D. and W. G. Hewatt. 1957. Oyster mortality studies in Virginia. II. The fungus disease caused by Dermocystidium marinum in oysters in Chesapeake Bay. Ecol. Monogr. 27: 1-25.

Beaven, G. F. 1946. Effect of Susquehanna River stream flow on Chesapeake Bay salinities and history of past oyster mortalities on upper Bay bars. Conv. Addresses Natl. Shellfish. Assoc. 1946: 38-41.

Beaven, G. F. 1949. Growth observations of oysters held on trays at Solomons Island, Maryland. Conv. Addresses Natl. Shellfish. Assoc. 1949: 43-49.

Beaven, G. F. 1953. A preliminary report on some experiments in the production and transplanting of South Carolina seed oysters to certain waters of the Chesapeake area. Part 2. Proc. Gulf and Carib. Fish. Inst., 5th Ann. Sess: 115-122.

Chestnut, A. F. 1949. The oyster industry of North Carolina and some of its problems. Conv. Addresses Natl. Shellfish. Assoc. 1949: 39-42.

Goode, G. B. 1887. The fisheries and fishery industries of the United States, Washington, D. C.: 5 sections.

Hewatt, W. G. and J. D. Andrews. 1954. Oyster mortality studies in Virginia. I. Mortalities of oysters in trays at Gloucester Point, York River. Texas Jour. Sci. 6: 121-133.

Higgins, E. 1937. Progress in biological inquiries. Bur. Fish. Admin. Rep. No. 30: 50.

Lunz, G. R. 1953. A preliminary report on some experiments in the production and transplanting of South Carolina seed oysters to certain waters of the Chesapeake area. Part 1. Proc. Gulf and Carib. Fish. Inst., 5th Ann. Sess: 115-122.

McHugh, J. L. and J. D. Andrews. 1955. Computation of oyster yields in Virginia. Proc. Natl. Shellfish. Assoc. 45 (1954): 217-239. Also, in Southern Fisherman 15(8), August 1955: 21-39.

Wallace, D. H. 1956. South Carolina legislature passes seed export law. Bull. Oyster Inst. N. A., 11(9) April 2, 1956: 1.