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VIRGINIA FISHERIES LABORATORY OF THE COLLEGE OF WILLIAM AND MARY
AND COMMISSION OF FISHERIES OF VIRGINIA

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YORKTOWN

INTRODUCTION

THE Seaside oyster producing grounds of Tidewater lie between the string of off-shore islands and the mainland. The area is made up of a series of wide shallow bays and marsh islands cut by channels through which the tide ebbs and flows. Streams emptying into these bays from the mainland side are short and, excepting in extremely unusual wet weather, have little effect on the salinity of the bay waters which varies from 28 to 30 parts per thousand. The tidal range is nearly 5 feet, and at high spring tides cover the highest points of the marsh islands. At low tide the bays are largely mud flats, or else are covered with only shallow water. The natural oyster rocks rise above these mud flats, built of accumulations of shell, and the individual rocks ordinarily are narrow ridges varying from perhaps 50 feet to a mile in length. Small oyster producing areas extend intermittently along the margins of the creek estuaries and the tidal drains of the marsh islands.

Although small stunted clumps of oysters grow high up on the marsh islands, the commercial production and optimum conditions are found in the lower half of the intertidal zone. All the "rocks" correspond approximately in the level of the lower margin, which is about at mean low tide. The elevation of the tops of the rocks above mean low tide varies with the individual rock. The height of any individual rock is a reflection of the intensity of fishing and the stage of its development.

Strike on the Seaside is heavy and consistent. Oysters grow rapidly, probably exceeding the average rate for any other area of Tidewater Virginia. Marketing methods and cultural methods differ materially from those of the remainder of Tidewater, and the problems are correspondingly peculiar. All the Seaside public grounds are seed grounds since the 3 inch cull law does not pertain, but mar-

* Contribution No. 25 from the Virginia Fisheries Laboratory of the College of William and Mary and Commission of Fisheries of Virginia.

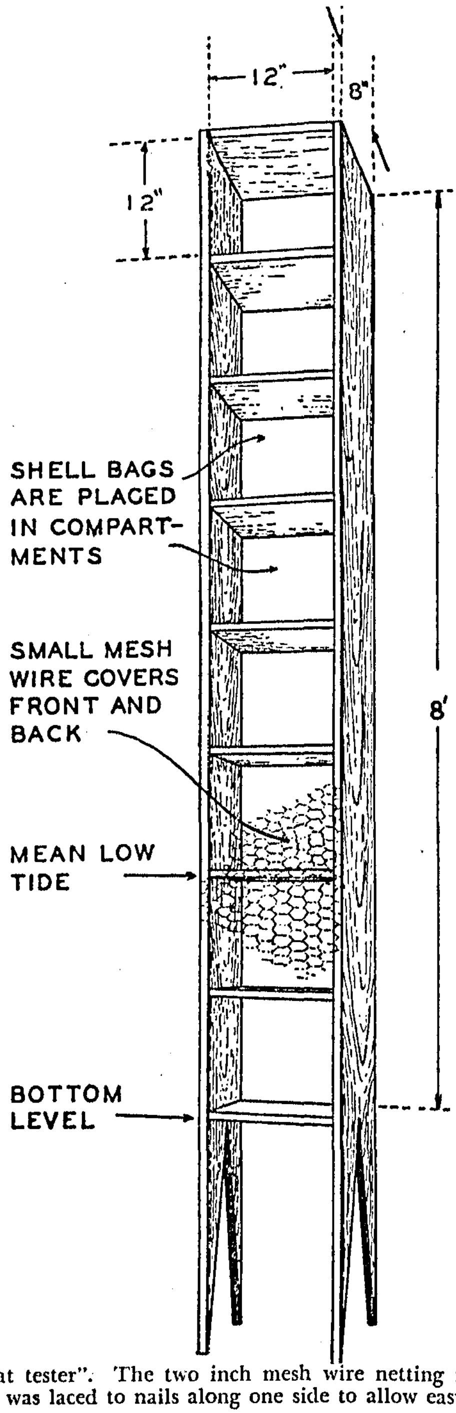

Fig. 1. A "spat tester". The two inch mesh wire netting indicated as covering front and back was laced to nails along one side to allow easy opening.

ket oyster production is the important phase of the industry on private leased grounds, and probably on the Public rocks as well.

The studies described in this paper were largely undertaken to check certain findings of Victor E. Loosanoff* who conducted extensive experimentation in collection of spat and distribution of spat in relation to tidal leevl, and to add such data as could be found pertaining to time of strike, growth of spat and destruction of spat by drills.

In order to assure accuracy of data on the relation of tidal level to the amount of strike, four "spat testers" were built (figure 1.). The figure is self-explanatory. Five or six small bags of shells were placed in each one of the compartments in accordance with the plan indicated in figure 2.

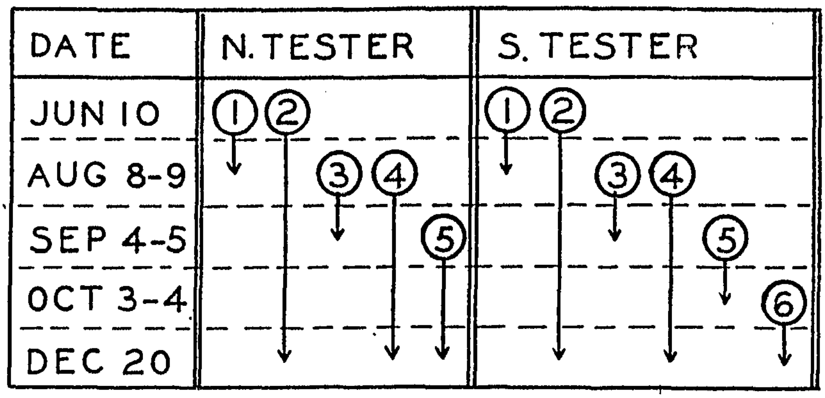

Fig. 2. Diagram to illustrate the methods of staggering periods during which shell bags were kept in the testers. Circles represent shell bags. The figure is for one compartment of the Burton's Bay testers. The arrangement was duplicated in each compartment. The same diagram serves for the Finney Creek testers by substituting date of June 25 for June 10.

Two of the testers were placed in Finney Creek near the Virginia Fisheries Laboratory Field Station at Wachapreague and two near the Eastern side of Burton's Bay, also near Wachapreague. The depth of water was selected in such manner that, with the lowest (number 1) compartment on the bottom, mean low tide level was approximately at the division, between compartments 2 and 3, numbering from the bottom. Thus, the levels tested were at one foot intervals and the vertical coverage was from 2 feet below mean low tide to 6 feet above.

* Loosanoff, V. D., 1932. Observation on Propagation of Oysters in James and Corrotoman Rivers and the Seaside of Virginia. Virginia Commission of Fisheries Report.

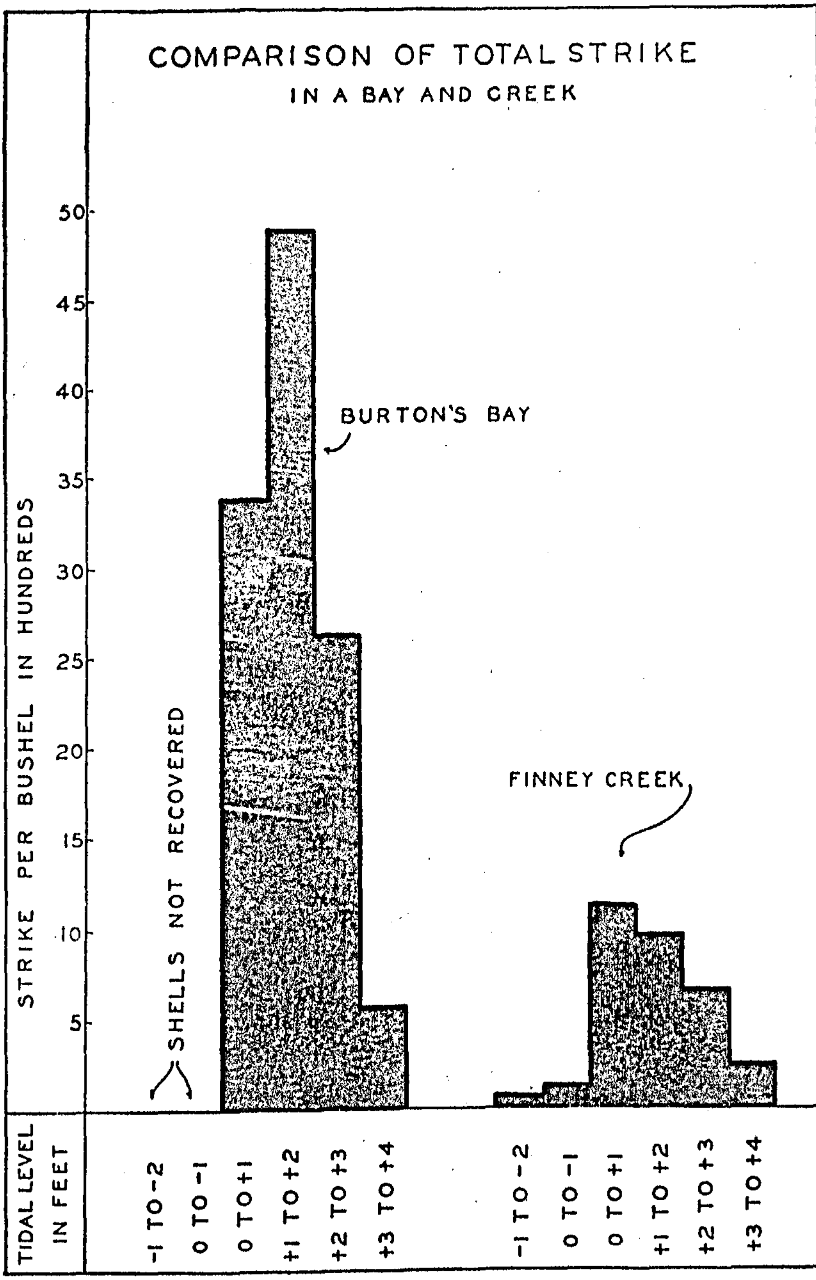

Fig. 3. Histogram showing amount of strike accumulating during entire strike season of 1945 in Burton's Bay and Finney Creek testers. Number of spat is estimated per bushel.

The two highest compartments (7 and 8) received no strike and will not be further mentioned.

The dates on which the bags of shells were placed in the testers are shown in figure 2. The first bags were placed in the testers in Burton's Bay on June 10 when two bags were placed in each compartment. On June 25 the same procedure was followed for the two Finney Creek testers. Notice that the two testers of both stations are distinguished by designating them North (N) and South (S) although they are within a few feet of each other. All spat counts referred to in later sections of this paper are average for the two testers of a station. Note the difference in the time number 5 bag remained in the North and South testers. This variance in procedure being the result of insufficient space in the compartments. Also, attention is called to the fact that strike after October 3 was checked only in the south testers.

A study of figure 2 shows that the placement of the bags in the testers is designed (1) to show the amount of strike in different months (approximately) of the season, and (2) to duplicate this information at different tidal levels by duplicating the arrangement in each compartment of each tester.

In addition to information on the amount and distribution of strike in relation to time and tidal level, considerable data on growth were derived from measurements of the spat. All spat found were measured, using length as indication of growth.

Drills invaded the testers and destroyed many spats. A record of all drilled spat found was kept and used to compute the relative amounts of destruction taking place at different tidal levels. Since the drilled top valves were in many cases lost, the percentages of destruction indicate minimum amounts.

Loosanoff found that the greatest concentration of strike occurred between 1.5 feet and 3.0 feet above "low water mark" (mean low tide) with the greatest concentration 2.5 feet above low tide. Our tests show most strike slightly below this level, but as a whole the basic correspondence of the two checks is more remarkable than the variation. Reference will be made in the following sections to other specific comparisons with Loosanoff's results.

STRIKE

Total strike for the season, as shown by examination of the bags placed in the testers in June and removed in December is shown in figure 3. First, it should be noted that the strike in Finney Creek is

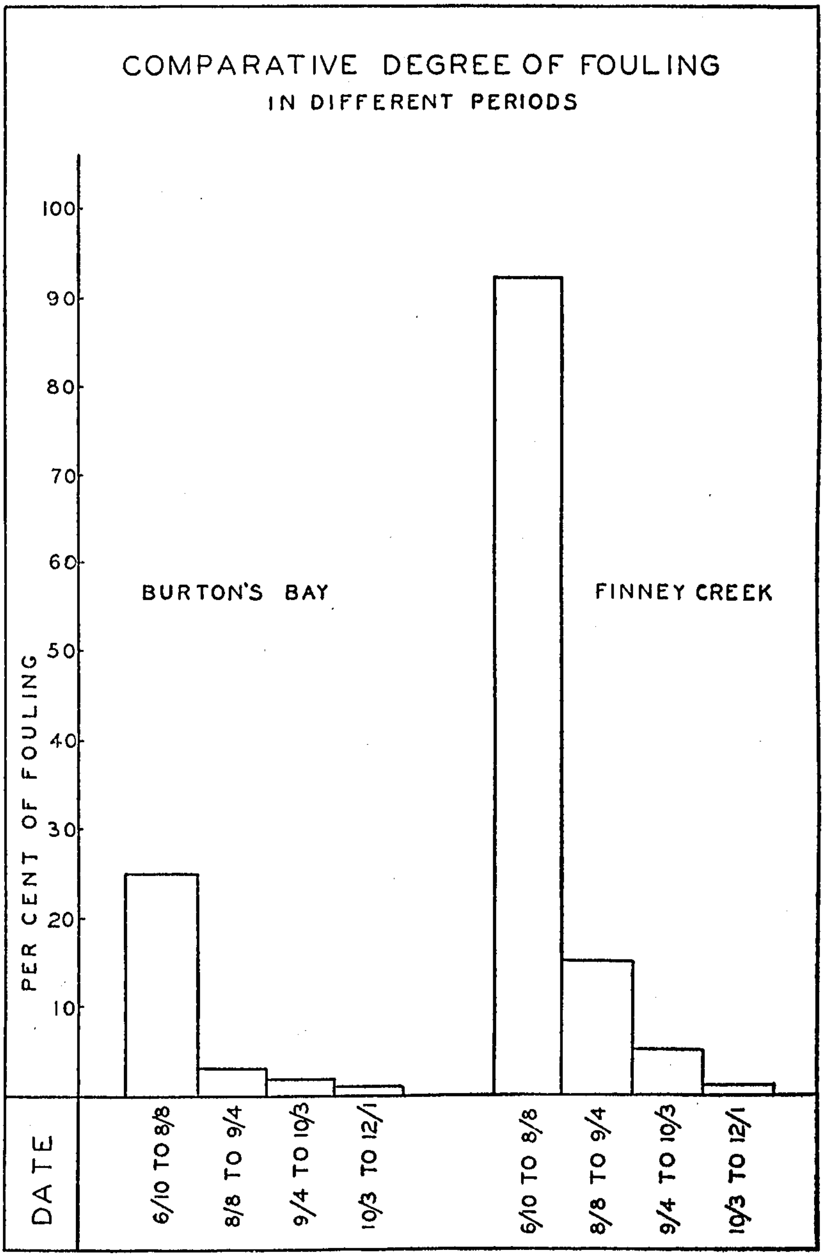

Fig. 5. Comparison of amount of fouling in different periods of the strike season in Burton's Bay and Finney Creek. Percent of fouling is based on the estimated fouled surface area of the shells.

period as was found by Loosanoff in 1931 when the setting occurred on July 19 and 20. However, the average dates coincide remarkably well.

As shown by the figure, the amount of strike in August was so small as to be for all practical purposes non-existent. The size distribution of the spat shows that what strike did occur was scattered in time although most of it certainly took place in the latter part of the month.

Strike of moderate proportions did occur in the period between September 4 and October 3. In the Burton's Bay testers the level between one and two feet above mean low tide received nearly 550 spat per bushel which, in areas not as fortunate as the Seaside, would be considered a satisfactory total for the entire season. It remains to be seen whether this is a regular annual occurrence. Loosanoff recorded that a small strike occurred during the third week in October but he made no per bushel computations. Shells placed in the South testers on October 3 and examined in December showed that no strike occurred after that date.

FOULING

Comparative estimates were made of the amount and type of fouling on shells placed at different levels. These data are briefly summarized here. Fouling, below tide level, was by sponges, hydroids, tubeworms, etc., but was mostly by an algal growth. Since no appreciable strike occurred at these levels, it makes little difference what type and amount did occur. Shells in the heavy strike compartments from low tide to 3 feet above were covered by a layer of gummy organic mud, and by barnacle strike. This sticky deposit was laid down at about the time of the earliest and heaviest strike, in July, and in Finney Creek it was estimated to be more than 90% effective in covering the shells. The deposit disappeared almost completely in August and shells previously covered were clean by the end of September. No fouling of consequence occurred in the high compartments at any time, which fact is again of no practical value, since strike and spat growth rates are also inconsequential. The data suggest that the heavy rains of July were responsible for the extraordinary mud fouling, and in any event it failed to prevent a satisfactory set of oysters. A monthly estimate of the amount of fouling in the Burton's Bay and Finney Creek testers expressed as percent of total shell surface covered is shown in figure 5. The level is between one and two feet above mean low tide.

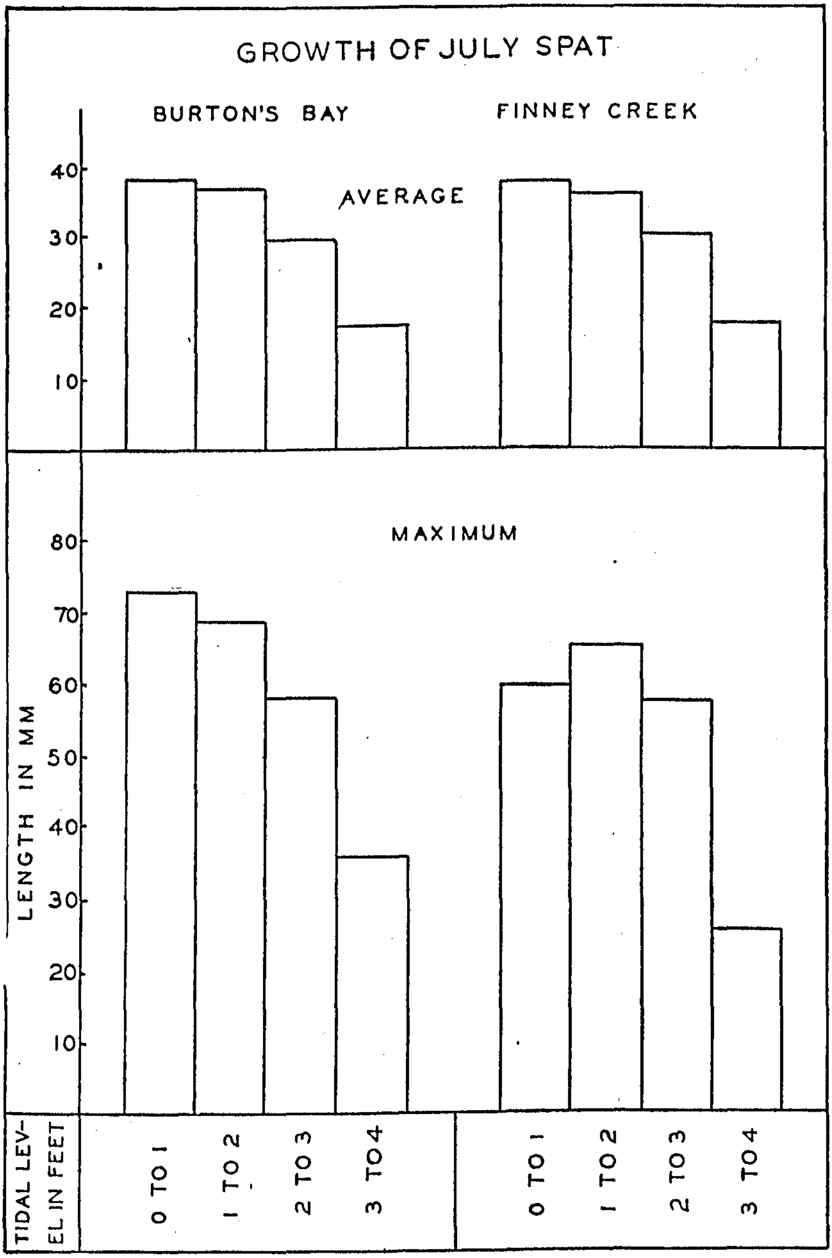

Fig. 6. Histograms showing average and maximal growth of July spat.

GROWTH OF SPAT

It is of primary importance to know whether the high strike levels also produce satisfactory growth conditions for Seaside oysters. It is of course obvious that tidal level affects rate of growth and that in general high inter-tidal levels are unsatisfactory due to daily feeding period being shortened. By measuring the length of all the spat, a satisfactory comparative evaluation of growth at different levels has been possible. The problem was unexpectedly complicated because the set was distributed over a considerable period. Strike in August and September, and some mortality of July strike have served as modifying factors, thus making it difficult to compute the amount of growth of the heavy early strike.

The amount of strike below low tide level was too little to afford sufficient data for satisfactory evaluation of growth rate. Mortality from drill predation also contributed to reduce the data, so that no estimates for these levels are given.

For those levels above low tide, the following procedure was followed: the average growth for oysters striking after July was studied and maximum sizes and modal classes were obtained. This enabled an approximate elimination of late strike from the computation of average growth for the July strike. While some error undoubtedly accrued, its magnitude is probably less than 5 per cent.

Figure 6 shows the average amount of growth of the July strike in Burton's Bay and Finney Creek, comparing four levels above mean low tide mark. The results were approximately as expected, and the salient points are summarized here: Greatest growth took place at the lowest level, between low tide and 1 foot above, where the spat reached about an average of 38.5 mm (about 1½ inches) in Burton's Bay and 38.0 mm in Finney Creek. Growth in the level one foot to two feet above low tide was only slightly less (37.0 mm and 35.5 mm respectively). In the level two to three feet above mean low tide, the retarding effect of a shortened feeding period could be plainly seen while those in higher levels attained less than 50 per cent of the size attained by oysters in the low levels.

Maximal growth as indicated by the size of the largest individual spat is also shown in figure 6. These data are not satisfactory as reflectors of general growth conditions but are of interest in estimating the effect of optimum conditions. Spat set so thickly at the high strike levels that by the end of the season they were badly crowded and the majority undoubtedly were somewhat stunted as a result. The largest individuals were those which by circumstance of favorable condition were free to grow unimpeded. Also, there is the unmeasurable factor of individual genetic makeup which influenced the size, and the unknown factor of exact time of strike.

The largest individuals of the high levels (above 3 feet above mean low tide) did not attain the *average* size of individuals grown between low water and 2 feet above. These latter levels showed remarkable growth in the largest spat. If optimum conditions could be provided for the majority of spat rather than for only a few individuals, the saving in time would be very valuable indeed to the oyster grower.

The fact that the amount of growth in certain levels is satisfactory during the first season does not necessarily mean that growth in subsequent seasons will likewise be good. However, there is reason to believe that it *probably* would be proportional. Further studies on second and third year oysters as regards growth at different levels is desirable.

TIDAL LEVEL AND DRILL ACTIVITY

Drills early invaded the spat testers at both stations, and a number of clumps of egg capsules were found in the lower compartments. No attempt was made to eliminate the drills and a record of the number of spat drilled was kept. While conditions in the testers could not be considered as exactly paralleling those on the natural rocks, the data on zonation of drill activity so parallels the data from observation of drill predation under natural conditions that it seems worth while to outline briefly the findings.

The most complete data were obtained in the Finney Creek testers. When shell bags were examined which had been in the compartments from June to December, a considerable number of spat were found to have been drilled. Spat scars were few in number, so that the data seem to be fairly accurate as to relative percentages of drilled to live spat. The data are summarized in figure 7.

As expected, the amount of damage was controlled by the tidal level. In the lowest compartment (1 to 2 feet below mean low tide in Finney Creek) 83% of the spat were drilled and in the compartments 0 to 1 foot below low-tide the percent was 75. As indicated previously, the actual total number of spat striking below the low tide level was small, so that the amount of error is probably rather high. However, observations in the field corroborate the basic conclusion that few oysters of any size survive long in these levels.

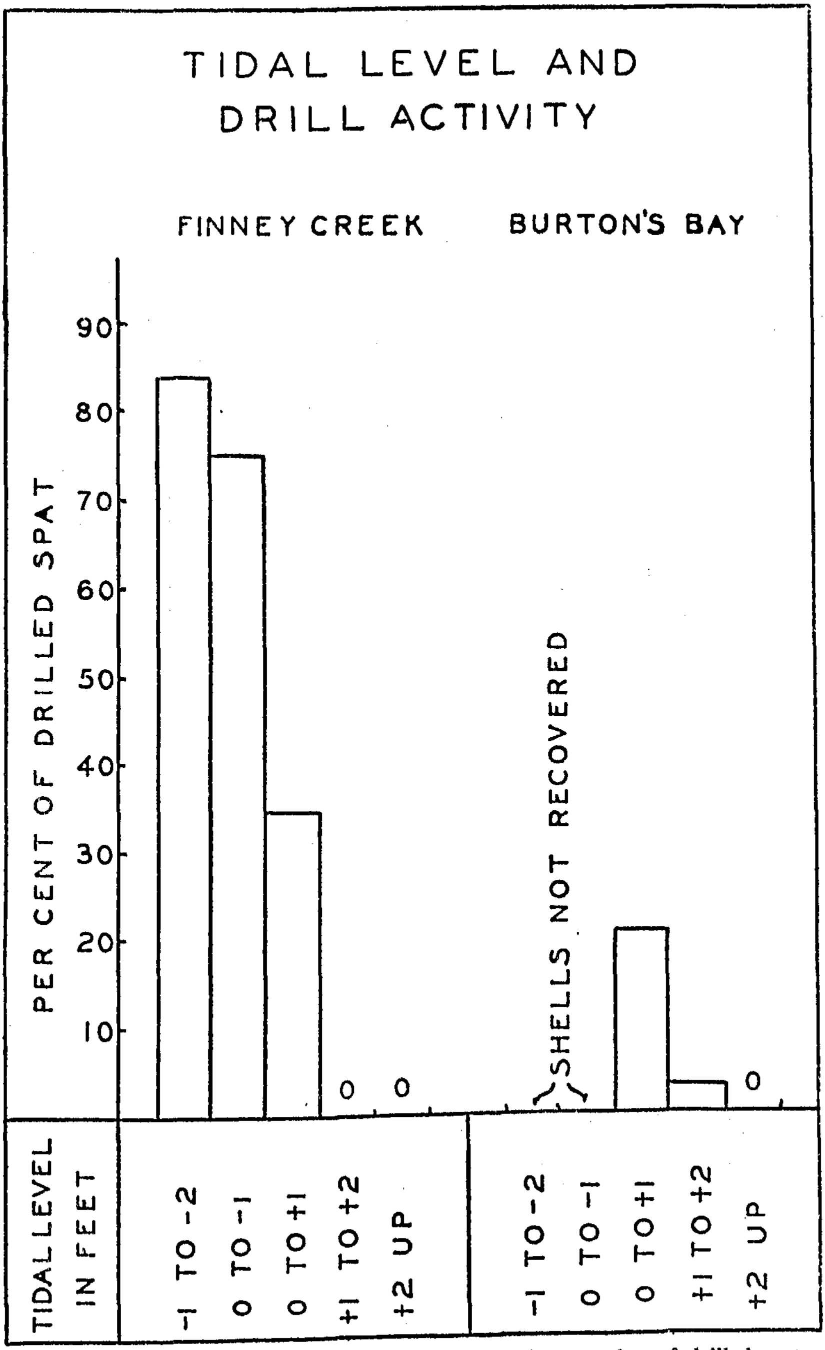

Fig. 7. Histogram showing relation of tidal level to number of drilled spat.

In the compartments 0 to 1 foot above low tide mark the percent of destruction dropped sharply. In the Finney Creek testers 35 percent were drilled and in the Burton's Bay testers 17 percent. Even these percentages are high when the certainty of added destruction in subsequent years is taken into account. An added observation on a commercial shell planting made on a mud flat by Mr. Reese Harrison of Wachapreague is also pertinent. The planting was made in a row of piles, which, after wave action had somewhat leveled them, were in the zone from about 3 or 4 inches below mean low tide to 4 or 5 inches above. The shells were planted on June 9th, 1945. On August 8th they were sampled for spat, the shells being taken from the highest part of the piles, i. e., from a level a few inches above mean low tide. The sample showed an estimated 566 spat per bushel,

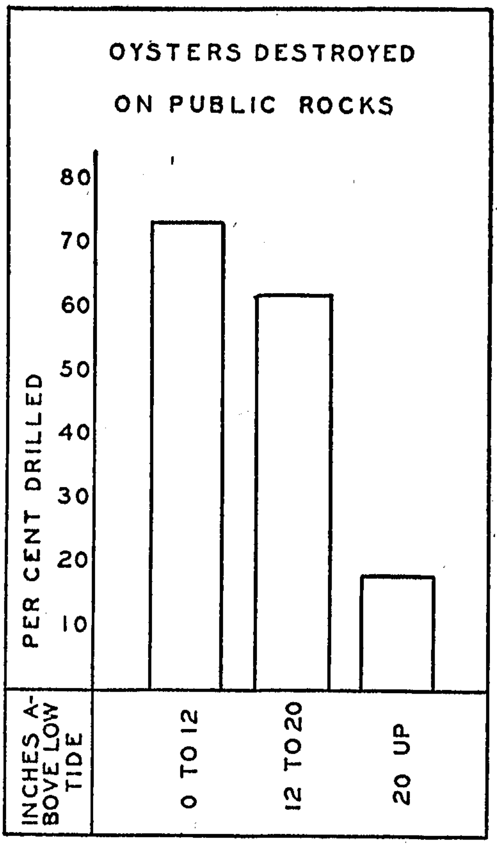

Fig. 8. Histograms showing comparative percentages of drilled oysters of all sizes at three different tidal levels. Average of 38 random samples of oysters on public rocks of Burton's Bay, Brandford Bay and Finney Creek.

and none drilled. Examination showed no drills in the shells. Nearby rocks were heavily infested. On September 5, another sample showed numerous drills in the planted shells and 55 percent of drilled spat. The total number of live spat remaining was estimated to be 126 per bushel. On October 4, the number of live spat had dropped to 4 per bushel and the drilled spat found comprised 98.6 perent of the total.

Similar results were obtained by sampling a series of natural (public) rocks in Burton's and Brandford's Bays in the Wachapreague area. Thirty-eight samplings were made, of which approximately one-third were taken from each of the following levels: (1) mean low tide to 12 inches above, (2) 12 to 20 inches above, and (3) above 20 inches. Random collections of oysters were made in each case and the number of drilled and live oysters counted and the percentages of each computed. In order to include only oysters drilled recently, only those with intact right valve, clean internal surface and obvious drill hole were counted as drilled. The data are summarized in figure 8.

While the levels do not exactly coincide with those of the compartments of the spat testers, the general agreement of the data is obvious. The levels from 10 inches to 20 inches are put in a less favorable light, but the general thesis that drill activity is curtailed rather abruptly at a certain distance above mean low tide is sustained.

SUMMARY AND DISCUSSION

The important general characteristics of the biology of the Seaside oyster may be summarized as follows: (1) Strike is abundant at levels from low tide to 3 feet above with a maximal level somewhere around 1½ to 2½ feet; (2) strike may be depended upon to be consistent and sufficient even with abnormal fouling conditions; (3) growth of spat is rapid; (4) degree of predation by drills is controlled by tidal level, and destruction of oysters is not too prohibitive at the best strike level.

Two major problems of the Seaside industry are (1) drill control, and (2) elimination of growth distortion and stunting caused by overcrowding. Actually these are problems which could be solved by employment of sufficient labor to handpick the drills and break up the oyster clumps. The problems relate then to the prohibitive cost of enough labor to control the drill population. The actual problem therefore, is to find an economical solution.

It has been demonstrated by experiments of the U. S. Fish and

Wildlife Service*, ** and others that commercial quantities of seed oysters may be readily collected on partitions or other culch. These methods are readily applicable on the Seaside. The difficulty seems to lie in being able to demonstrate on a practical basis how to separate the spat before crowding becomes an adverse factor in growth. Secondarily, the problem on the Seaside is to prevent accumulation of spat during the second and third years, which may so envelope an originally free oyster as to prevent any semblence of normal growth.

While the problem of freeing spat from artificial collectors has been partially solved by Needler *** in Malpeque Bay, Prince Edward Island, in which region it is used on a small commercial scale, it is significant that these devices have never been extensively tried in Virginia. Whether this is because of natural aversity of local oyster-growers to innovations or whether there are technical difficulties involved is not known to the writer. In any event, the partition collectors represent a distinct advance and with refinements it should be possible to use them. Past experimental work suggests that further studies with a view to development of practical methods of following up the knowledge already gained should be undertaken. This effort should be directed toward the development of improved methods for separating spat without involving excessive labor costs, and for assuring a profitable survival and use of resulting seed for growing high quality shucking stock.

Studies to date indicate that the solution of the drill problems on the Seaside will depend in large measure on the substitution of more refined artificial cultural methods than those now employed. Data on zonation, meagre as they are, support the conclusion that a wise choice of planting level is about the only promising method now in sight. It is recognized that only the planters whose ground are high enough can expect consistent success. Such grounds are now so scarce that successful oyster farming in the future will seemingly be dependent on an artificial production of correct levels. Since the cost of constructing such high level grounds on a large scale would be prohibitive, small areas must be made many times as productive as even good natural grounds in order for such a plan to succeed.

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* Galtsoff, P. S., Prytherch, H. F., and McMillin, H. D., 1930. An Experimental Study in Production and Collection of Seed Oysters. U. S. Dept. of Commerce. Fisheries Doc. No. 1088.

** Prytherch, H. F., 1930. Improved Methods for Collection of Seed Oysters. U. S. Dept. of Commerce, Fisheries Doc. No. 1076.

*** Needler, A. W. H., 1940. A Machine for Separating Spat from Cardboard Collectors. Fisheries Res. Board of Canada. Oyster Farming Circular No. 12.