Since it is understood that the demand for seed oysters in the Chesapeake Bay area and in other northern waters is almost unlimited, and since South-Carolina has available 300,000 bushels of shell yearly, it is theoretically possible to ship over 500,000 seed bags from South Carolina each year. A bag of seed oysters of the size used in these experiments will sell for about fifty cents. In a large scale venture the cost of shell bags could be reduced somewhat. Taxes can certainly be reduced. Lower costs can be had in re-use of the wire baskets. If transportation can be had reasonably enough, a new phase of the oyster industry may be possible in South Carolina provided the South Carolina seed grow and survive sufficiently to satisfy the demands of oystermen in the Chesapeake Bay area. Mr. Beaven has been working on this phase of our problem and he will now discuss with you the survival and growth of South Carolina seed in northern waters.

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: The seed problem in Maryland and some observations on the survival and growth of South Carolina spat when transplanted experimentally to different type areas in the Maryland-Virginia region.

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One of the greatest problems of oyster production in the Maryland area, as in many states further north, is that of securing a sufficient supply of seed oysters. Natural setting over many bars in this region usually is too light to replace the market oysters harvested by conventional methods. This lack of spat favors the growth of well shaped, fat single oysters but makes it necessary that either the rate of harvesting be greatly restricted or that the bars be reseeded periodically in order to maintain their production. Where such conditions prevail private planters have found that the greatest profits can be realized through harvesting by the most efficient means possible and then reseeding the bottom for each succeeding crop. An essential factor in the success of such a system, however, is the ability to obtain an ample and dependable source of seed oysters. This has become increasingly difficult in recent years. A similar problem is faced by the State in its management of the publicly worked natural rocks.

Extensive supplies of small or seed oysters once were found on the natural beds in the upper part of Chesapeake Bay and in the upper Potomac River. These have been destroyed almost completely by recurring freshets during recent years. Even if oysters again bcome reestablished on these upstream beds the supply there still would remain undependable. The famed James River seed beds in Virginia long have been a major source of seed for Maryland planters. For the past few years, however, the sale of seed from these beds has been banned periodically to out-of-state buyers. Pamlico Sound once also was an important source of seed planted in Maryland but the supply became badly depleted and the sale of seed was restricted a number of years ago. Present seed sources include Delaware Bay, private plantings in Virginia, limited sales of seed by the State from public areas, and low priced market oysters from natural rocks. Planters in Chincoteague Bay at times buy large-sized seed from Long Island growers. Occasional plantings of cluster oysters from South Carolina reefs have been tried but have failed to do well. Additional seed sources are being sought and are urgently needed.

The use of newly-set spat as seed oysters has become an accepted practice in Maryland only during recent years. Planters formerly demanded a fairly large seed oyster, typically two to three inches in length. These were planted in early spring and left to grow for only one or two seasons before they were harvested. Yields seldom were better than one for one. On the type of bottom commonly available to Maryland planters small single seed oysters tend to settle and become smothered so that they may yield even less than plantings of larger sized seed.

About ten years ago the State first began to concentrate a considerable portion of its shell plantings in certain limited high setting areas for the express purpose of producing seed oysters to be replanted on other bars. These shells with quantities of young spat attached are taken up and scattered on good growing bottoms during the following fall or spring months. Such seed are known as "shell plants." The excellent yields provided by this type of seed soon interested private growers in its use. A shell encrusted with spat will stand up on bottoms where small single oysters will sink. Since the count of spat per bushel may run quite high, such seed, when planted thinly, may yield several bushels of oysters for each bushel of seed. Unfortunately, only limited areas have been found in Maryland where sets are consistantly high enough to produce good quality shell plants and these areas are not available for leasing to private planters.

The ability of South Carolina to produce seed oysters of the shell plant type, in quantity and at compartively low costs, offers the possibility of a trade profitable to both the producer and planter provided that such seed would thrive under the conditions found in the Chesapeake area. Preliminary observations of experimental plantings of southern seed oysters in Maryland waters had indicated that fairly good survival and growth is possible in certain cases although no seed of this particular type has been tried. It was felt that transplanting as spat might enable the oysters to become more easily adjusted to new conditions and that natural selection after transplanting would result in the survival of those best suited to the new environment.

Oyster growing conditions in most of the Chesapeake area are quite different from those on the intertidal reefs of South Carolina. In Maryland oyster bottoms are of various textures and usually continuously submerged. Tidal amplitudes generally are less than two feet, ranging from a few inches to a little over three feet. Strong winds cause the greatest tidal variations and may result in shallow flats at times being exposed for several days during winter storms. Waterways typically are broad and margined by sandy beaches where pounding waves prevent the establishment of oysters in the immediate vicinity of the shore line. For these reasons few oysters are found growing intertidally. Depth of water over the oyster bars may range from a few inches in sheltered coves to over a hundred feet in one instance. Maximum depths of oyster bars, however, seldom exceeds forty feet.

Most of the Maryland half of Chesapeake Bay and the greater part of its tributaries have prevailing salinities of less than half that of open sea water. Oysters are found where salinities at times reach zero and seldom rise above ten parts per thousand, or a little less than one third that of sea water. In the upper Bay salinities are consistantly low rather than fluctuating from near zero, to rather high values as is characteristic of many of the southern coastal estuaries subject to periodic flooding. On the deeper rocks of Tangier Sound and in the Virginia portion of the Bay salinities range above half that of sea water and oyster drills there become a serious problem. In the shallow waters of Chincoteague Bay along the Maryland-Virginia coast salinities usually approach that of sea water and may become even higher during hot dry spells. Water temperatures range from near freezing in mid winter to the low thirties (on the Centigrade scale) in mid-summer.

The first South Carolina spat on planted shell transplanted to Maryland waters at Solomons consisted of only two shells brought up by Mr. G. Robert Lunz of the Bears Bluff Laboratories on a business trip in July of 1950. These were planted on a tray in shallow water. The spat on them showed such rapid growth and good survival during the remainder of the summer and fall months that enthusiasm became high over their possible use as seed.

During November of 1950 a number of bags of late summer South Carolina set were transported to Solomons by truck and then distributed to several locations typical of the oyster growing areas in the Maryland portion of the Chesapeake. All of these seed oysters were planted on trays and in most cases left undisturbed until late winter or the following spring. The seed were out of water for two days during transportation. At Solomons one tray was held out for three additional days and a second for seven additional days in order to observe the losses which might be caused by delays in transportation.

Most of the trays were left undisturbed until the following spring although those at Solomons were examined at more frequent intervals. A number of the trays were lost but those remaining presented a very disappointing picture of survival under the conditions of the experiment. A summary of the pertinent results is shown in Table 1.

TABLE 1

Survival of S. C. We Creek 1950 Transplants

Planting location	Survival January 1951	Survival May 1951
Solomons, 2 shells July	99%	6%
7 areas above Solomons, Nov. 3		0
Solomons, Nov. 3	over 90%	1%
Solomons, Nov. 6	over 90%	2%
Solomons, Nov. 10	approx. 1%	0 + (1 oyster)
Crisfield, Nov. 4		12% approx.

All of the seed plantings above Solomons, which is about median in salinity conditions for the Maryland area of the Chesapeake, showed no surviving oysters. At Solomons too few survived to be of significance as seed except on the two shells in July which still had a few living oysters on each shell. At Crisfield survival was slightly better but still unsatisfactory. There the salinity was higher and the tray had been accidentally placed where it was partially exposed at low water. Holding the seed out of water for five days prior to planting at Solomons caused no significant loss but oysters left out for nine days were nearly all dead at the time of the first examination.

In spite of the poor results of this first experiment it seemed possible that better survival might be obtained if seed were moved in mid-summer or if they were planted in waters of higher salinity. There also was the possibility that intertidal exposure might be a factor in the survival of seed of this type. For these reasons a second experiment was tried in which part of the seed were planted during mid-summer and in areas having higher salinities. A group of plantings was made in late fall in which comparisons were possible between South Carolina intertidal seed, South Carolina seed produced on submerged bottom, local Chesapeake seed and seed from the intertidal flats at Chincoteague Island.

TABLE 2

SURVIVAL OF JULY 1951 WE CREEK SEED

Location	Mid Winter	March	May	Oct.	Length
Solomons, Md.	est. + 90%	67%	43%	good	59.4 mm.
Upper Patuxent	est. + 90%	66%		fair	59.4 mm.
Gl. Pt. Va. open*	0% all drilled				
Gl. Pt. Va. prot.*	87% (51 mm.)	80%	74%	69%	68.4 mm.
Chinc. Is. submerged	nearly all drilled			0	
Chinc. Is. intertidal	nearly 100%	nearly 100%		all top mat of 3" + coon oysters	

* Oysters singled

Table 2 summarizes essential results from the July transplanting of 1951. Survival and growth in late summer and fall were excellent at Solomons and at all of the other locations except where drill damage was high. The Virginia Fisheries Laboratory at Gloucester Point singled up two groups of the oysters and kept very careful records of growth and mortality at frequent intervals. At this location it was found that the mortality rate among South Carolina seed compared with James River seed, when protected from drills, was significantly greater during the winter months but less during the summer months. Oysters in the tray open or unprotected from drills at Gloucester Pt. proved very attractive as drill bait as did the submerged tray at Chincoteague Island. Average lengths measured in October 1952 are given in the last column. Measurements of the clusters of seed at Solomons were taken from the oysters on the upper surfaces of the shells. Exceptionally good growth occured at Gloucester Pt., especially during the first summer and fall. At Chincoteague Island the intertidal tray, though thinly planted, required an additional thinning to just a few shells in the spring of 1952. In spite of this, such excellent survival and growth occured that the oysters became too matted together to separate and measure in October. Survival among the different groups was poorest in low salinity areas and best at the higher salinities.

Engagements in other work caused postponement of the 1951 fall planting of seed until the first of December. A summary of the survival of South Carolina intertidal seed of this planting is shown in Table 3.

TABLE 3

Survival of We Creek Seed Transplanted Dec. 1

Location	Mid Winter	March	May	Oct.	Length
Solomons, Md.	94%	35%	1%	....	
Upper Patuxent		4%		....	
Chincoteague Is.,* submerged		53%	16%	all drilled	
Chincoteague Is.,* intertidal		67%	54%	good	58.0 mm.
Ocean City,* submerged			9%	lost	
Ocean City,* intertidal			11% (some buried)	lost	
Mid Chincoteague* Bay submerged	88%		85%	excel'nt	63.7 mm.

* Nearly all loss caused by drills.

At Solomons and up-river from Solomons an almost complete mortality occured during late winter and early spring. Poor survival at the Ocean City Inlet is attributed to wind occasioned low tides which left the trays exposed for several days in freezing weather. These trays later were tampered with and lost. Drills again destroyed the submerged seed at Chincoteague Island and appeared to be the chief cause for losses in the other Chincoteague area plantings. At the plantings mid way up Chincoteague Bay survival was best and growth excellent.

TABLE 4

Survival of Different Seed at Solomons, Md.

Source of Seed	Mid Winter	March	May	Oct.	Length
We Creek—July	est. + 90%	67%	43% (35mm.)	good	59.4 mm.
We Creek—Dec. 1	94%	35%	1%	....	
Ashepoo—Dec. 1	86%	32%	10%	....	
Chinc.—Dec. 1	92%	70%	66%	fair	mixed age
St. Marys—Dec. 1	95%	lost	lost		
St. Marys—early spring				good	49.3 mm.
In Upper Patuxent River					
We Creek—July	est. + 90%	66%		fair	59.4 mm.
We Creek—Dec. 1		4%		....	
Ashepoo—Dec. 1		3%		....	
Chinc.—Dec. 1		11%		very poor	47.0 mm.
St. Marys—Dec. 1		87%		excellent	55.5 mm.

Table 4 compares seed from different sources which were planted at Solomons and up-river from Solomons. The Ashepoo seed was produced in submerged South Carolina waters of lower salinity than the intertidal area at We Creek. Spat on these shells were small and scattered. The upper Patuxent typically produces a better growth of local seed than at Solomons. This was not the case with the South Carolina seed although at both locations it somewhat exceeded the size of the native St. Marys River seed. The Chincoteague intertidal seed showed a much better survival at Solomons than that from We

Creek but proved quite poor at the upper station. St. Marys River seed survived and grew better at the upper station than at Solomons, and showed the least mortality at both locations.

TABLE 5

SURVIVAL OF DIFFERENT SEED AT CHINCOTEAGUE IS. PLANTED DEC. 1 OR A LITTLE LATER

Source	Type Planting	March	May	October	Length
We Creek	intertidal	65%		53%	58.0 mm.
We Creek	submerged	53%	16%	rep. all drilled	lost
Ashepoo	intertidal	67%	54%	41%	47.5 mm.
Ashepoo	submerged	21%	2%	rep. all drilled	lost
Chincoteague	intertidal	92%	92%	excellent	mixed year classes
Chincoteague	submerged	16%	1%	rep. all drilled	lost
St. Marys	intertidal	100%	99%	99%	(older seed)
St. Marys	submerged	98%	14%	rep. all drilled	lost

Table 5 compares the same types of seed as Table 4, when planted at Chincoteague Island intertidally and submerged. Some of the seed in this case was first placed temporarily on submerged trays in the central Chincoteague Bay and shortly afterward moved to permanent locations at Chincoteague Island. Here again all submerged seed was reported to have been drilled prior to the October examination. The South Carolina intertidal seed appears to have survived and grown quite well in the intertidal zone. Unfortunately, exact comparisons with local seed could not be made since seed of the same year class was not obtained in this case.

TABLE 6

SURVIVAL OF DIFFERENT SEED IN MID CHINCOTEAGUE BAY AREA—SUBMERGED

Source	March	May	October	Length
We Creek	88%	85%	good	63.7 mm.
Ashepoo	75%	70%	fair	51.1 mm.
Chincoteague	89%	82%	good	mixed age
St. Marys	94%	88%	good	larger seed

Table 6 shows that the South Carolina intertidal seed survived quite well and made exceptionally good growth when submerged in the mid Chincoteague Bay area. Drills apparently caused most of the losses here but were not nearly so destructive as at Chincoteague Island.

The data gathered thus far are not nearly as complete as desired but do seem to indicate some tentative conclusions. Survival of South Carolina seed under the conditions of the experiments has been decidedly poor in the upper portions of the Chesapeake oyster producing areas, good in the lower Chesapeake and excellent in the Chincoteague area, exclusive of drill damage. There is evidence that this difference in survival rate is more dependent upon salinity conditions than upon other factors.

The accompanying graph (Figure 1) shows the average and extreme conditions of temperature and salinity which were recorded at Solomons during the time of the experiments. During both 1951 and 1952 winter and spring salinities were lower than usual while temperature conditions showed little variation from normal. Daily records of conditions at Gloucester Point are not at hand but data published by the Chesapeake Bay Institute for the same period indicate that salinities at Gloucester Point will run about seven parts per thousand higher than at Solomons, during the season of lowest values. Differences in water temperatures at the two locations are too slight to appear significant. Weekly records from the Chincoteague area show salinities ranging from about 23 to 32 parts per thousand during the time of the experiments. Typically they remain at high levels most of the time with quick recovery after the occasional drops caused by heavy local rainfall.

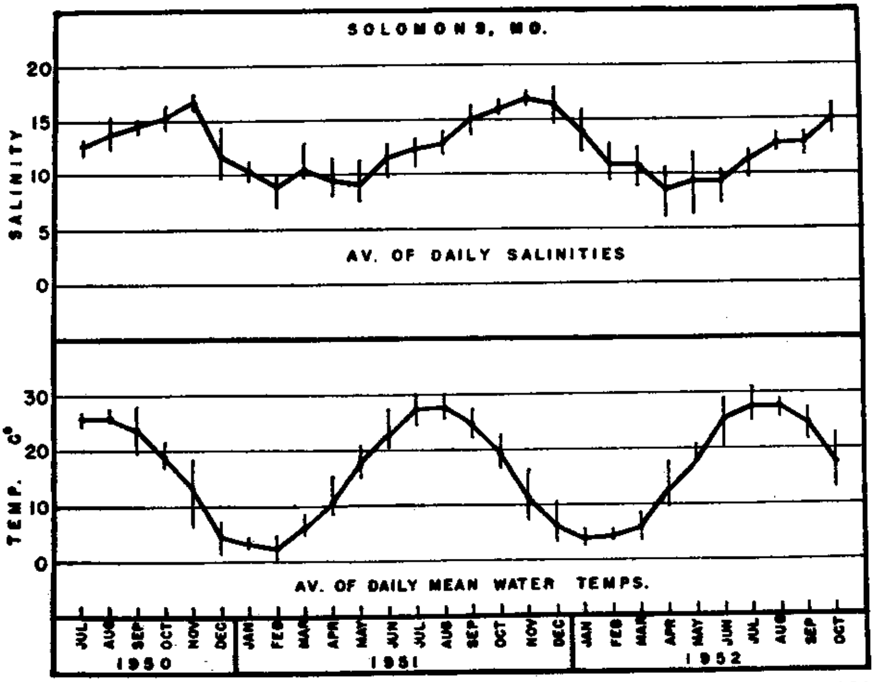

FIGURE 1. Averages of daily salinities and daily mean water temperatures, Solomons, Md., 1950, 1951 and 1952.

Temperatures of the shallow Chincoteague water fluctuated more abruptly than in the Chesapeake and during the winter at times were near freezing with some ice formation. The average temperatures, however, appear to be little different from those of the Chesapeake area.

South Carolina intertidal seed in its native habitat is subjected to considerable temperature variations, especially when exposed at low tide, but is not subjected to long periods of low salinity. At Solomons the South Carolina seed was exposed to a long period of much lower salinities and of lower water temperatures than normally occur in its native habitat. The fact that low temperatures and depressed salinity were both experienced at the same time probably made survival more difficult. The lower salinities at Solomons and at further up-stream locations appear to be the principal cause of poor survival of South Carolina seed in those areas as compared with Gloucester Point and Chincoteague Bay.

Further observations of the continued survival and growth of South Carolina seed planted in the Chesapeake area are needed in order to evaluate its potentialities for commercial use. Indications drawn from the present data may be summarized as follows:

(1) South Carolina intertidal seed transplanted during the summer months survives better in the less favorable of the habitats tried than does similar seed transplanted in late fall.

(2) Such seed has shown better survival and growth in the lower Chesapeake area than at Solomons or above, and has survived still better in the Chincoteague area.

(3) Destruction of small seed of this type by drills in infested areas is a serious problem and may limit its usefulness.

(4) Survival and growth appear to be as good in submerged plantings as in intertidal plantings except where drill infestation is heavy.

(5) The South Carolina seed produced on submerged shells in the Ashepoo River had fewer spat per shell, survived no better, and showed less rapid growth than the intertidal seed.

(6) Growth in length of the South Carolina intertidal seed generally has been more rapid than that of the other seed with which it was compared.

(7) Crowding of oysters on the South Carolina shells necessitates very thin planting and may result in poorly shaped oysters. Thinning at about one year of age would materially improve the resulting market oysters.

The observations here reported upon have been made possible through the cooperation and assistance of the following: Mr. G. Robert Lunz, Director of the Bears Bluff Laboratories, and his staff; Dr. Jay D. Andrews, oyster biologist of the Virginia Fisheries Laboratory; Dr. J. L. McHugh, Director of the Virginia Fisheries Laboratory; Inspector Steelman and his son at Chincoteague, Va.; Mr. Fred W. Sieling, biologist in charge of Chincoteague Bay Investigations; Mr. Joseph H. Manning, oyster biologist at Solomons; and Mr. Harvey Mister of the laboratory staff at Solomons.

Quantitative Measurement of Effect on Oysters of Disease Caused by "Dermocystidium marinum"[1]

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ABSTRACT

Measurement of effect of the *Dermocystidium* mycosis in terms of weight of oyster meats has been accomplished by analysis of measurements of meat weights and shell capacity of 508 oysters over a period extending from April, 1952, to August, 1952. The 508 oysters included 198 heavily infected with *D. marinum*, 83 moderately infected, and 227 either lightly infected or

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