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Winter mortalities of oysters on the Eastern Shore of Virginia, 1959-1961

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WINTER MORTALITIES OF OYSTERS ON THE EASTERN SHORE OF VIRGINIA, 1959-61

INTRODUCTION

During the winter of 1960-61 exceptional mortalities occurred among certain oysters on the Virginia Seaside. These mortalities were greatest among James River oysters held intertidally and South Carolina imports placed below low tide level. Intertidal native oysters suffered small mortalities but among subtidal native or James River oysters only the very oldest, with extensive disease histories, showed any winter mortality.

Previous workers have associated Hexamita with mortalities in low temperatures (near 6°C). However, the precise relationship between Hexamite and oyster mortalities has not yet been established. Temperatures were present in Eastern Shore waters for nearly three months during the winter of 1960-61, but were rare during the relatively warmer winter of 1959-60.

These studies are part of an overall study of oyster mortality of the area. Dr. J. D. Andrews provided suggestions and assisted with tray studies.

TEMPERATURE

During the two complete years that mortality studies have been conducted on the Eastern Shore of Virginia (September 1959-September 1961) the winters were very difficult. The winter of 1959-60 was relatively mild and that of 1960-61 was one of the coldest local residents could recall (Table 1). In 1959-60 water temperatures were always over 5°C, except during two weeks in March when they temporarily dropped to near freezing. In sharp contrast, water temperatures in 1960-61 were below 5°C from the first week in December through February 14. From January 26 to February 7, 1961, temperatures were below 1°C, much of this time between 0° and -1.8°C Intertidal oysters were consistently exposed to temperatures below freezing, and on at least three occasions were exposed at low tide. During this cold period sea ice occurred sporadically in Seaside bays, and the other trays at Wachapreague had to be kept clear by breaking the ice. All Bayside creeks were covered for several days with three or more inches of ice during this and other cold spells. Although no oxygen measurements were read, there was no evidence of oxygen depletion (such as blackening of shells or death of epizoites).

MORTALITY

Intertidal Oysters

Winter mortalities in Virginia have apparently been negligible in subtidal oysters (Hewatt and Andrews, 1954) except for from South Carolina (Andrews and McHugh 1957). This was generally true in 1959-60 when mortalities in all stocks of oysters were rare (Table 2), except that in March there was a mortality of 20 percent in a single tray of South Carolina oysters held in Hungars Creek.

During the winter of 1960-61 mortality was not evident until the extremely cold weather of January 1961. James River oysters, held

[1] Winter is used here to include what are usually the coldest five months (November through March), when temperatures of 10°C or colder can be expected.

intertidally at Wachapreague on the Virginia Seaside, had the most severe mortality, up to 99 percent by mid February (Table 2). These James River oysters were in three lots transplanted on February 19, 1960; at Machipongo (Table 2), June 1959; and November 1960. The first group went through the cold weather of February and March of 1960 with negligible mortality. Small mortality of James River oysters has been evident, however, during other periods of the year. The group brought in June 1959 was held subtidally in Swash Bay through the first winter, but was brought to Wachapreague the first week of January 1961 and held intertidally. The other groups were held intertidally at all times.

In contrast, mortality of native oysters held intertidally was almost non-existent in 1959-60 and small in 1960-61. Three groups of oysters brought to Wachapreague from Swash Bay the first week of January 1961 showed 6 to 7 percent mortality by February 15. Native oysters growing intertidally on pilings nearby showed a similar light mortality during January 1961. Other trays of native oysters that were discontinued before the winter of 1960-61 showed less than 2 percent mortality during the winter of 1959-60.

Another group of oysters moved from the James River to Outlet Bay on May 15, 1959 was moved to the intertidal zone at Hungars Creek on November 28, 1960. By February 2, 1961, 94 percent were dead; the remaining live oysters were preserved. There was no evident mortality of native intertidal oysters on nearby pilings on February 2.

Subtidal Oysters

There was very little mortality in subtidal oysters except for South Carolina imports, which apparently are very susceptible to winter mortality in Virginia (Andrews and McHugh 1957). One tray of imports brought from South Carolina in February 1960 has slightly less than 20 percent mortality by the end of March. However, most of the remainder perished in a very short time in 1960-61. Mortalities of native and James River oysters were low both winters, but were significantly higher during the winter of 1960-61 in the older lots of oysters which had histories of heavy mortality during the preceding warmer months. The mortalities were also slightly higher in James River oysters on the Bayside than in Seaside oysters on the Seaside, but the difference is small and may not be significant. Most of the highest mortalities in 1960-61 (B-3, 4, 5) in subtidal oysters were roughly comparable to the lowest mortalities of native oysters (W-5, 6, 7) held intertidally (Table 2). Medcof (1961) has presented similar data comparing mortalities of introduced Ostrea edulis during mild and severe winters.

Incidence of Hexamita

Oysters were examined for Hexamita only during the colder periods from January 28 through February 24, 1961 (Table 3). Thirty-six live oysters were examined, including native oysters from natural bottoms and trays, and James River and South Carolina oysters from trays. Smears were made from heart and gill tissue. All revealed concentrations of Hexamita.

It was obvious that Hexamita was associated with leucocytes in the blood of the oyster. In some cases the trophozoites were almost obscured, but thrashing movements of flagella would move the clump of surrounding leucocytes. A few trophozoites were always observed swimming actively, indicating that Hexamita was not slowed by higher temperature in the laboratory but by the action of leucocytes.

DISCUSSION

It is obvious that certain stocks of oysters are less resistant to winter mortalities than others. The fact that James River oysters showed similar catastrophic mortalities regardless of acclimation time in the intertidal zone indicates a possible genetic basis for susceptibility to winter kill. However, acclimation was valuable because James River oysters held for a winter died later than those recently transported. High winter death rates for James River stock is not surprising since they are native to subtidal regions while Seaside oysters are native intertidally. Genetic resistance to cold weather has probably been acquired by selection over a long period. Small mortalities during the winter of 1960-61 are evidence that this process is still going on. Conversely, James River oysters have been subjected to freezing and sub-freezing temperatures and therefore, are less resistant. This would be true whether the cause of death was from cold *per se* or from reduced resistance at low temperature to certain pathogens.

Even though the distribution of *Hexamita* in gapers was such that it could be suspected as a pathogen, the number of oysters examined was small and in some dead and dying oysters few trophozoites were seen. This was especially true in intertidal James River oysters which showed the smallest percentages of *Hexamita* in both gapers and live oysters. However, the concentration of *Hexamita* in some gapers and an occasional live oyster was large, sometimes tremendous, similar to those concentrations pictured by Mackin *et al*. (1952:274) and Stein *et al*. (1959:67-81).

The mortalities were not most severe after temperatures first reached minimum levels near $0^{o}C$ but occurred mostly during and following an extremely cold spell in February.

Both Tripp (1957) and Stauber (1950) concluded that phagocytosis is a significant means of defense for the oyster. Since authors have concluded that leucocytes could not remove foreign bodies in the blood as well below temperatures of 5°C, it seems reasonable to conclude that phagocytosis of Hexamita was observed. Lack of phagocytosis in temperatures below 5°C might result in the oyster's inability to cope with invading trophozoites. Hence the mortality, which was associated with low temperatures.

It is interesting to note that a gaping scallop, *Aequipecten irradians* Lamarck, dredged with oysters from Hog Island Bay on February 10, 1961, showed concentrations of *Hexamita*, many of which were obscured by clumped leucocytes, as described previously in oysters. A few traphozoites were free-swimming, but most were not. Medcof (1961) found a dead scallop, *Placopecten magellanicus*, heavily infected with *Hexamita*.

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Table 1. Water temperatures (^{o}C) in winter at Wachapreague 1959-61

	1959-1960		1960-1961	
	Range	Average	Range	Average
November	6.0 - 17.0	9.7	9.5 - 14.8	12.4
December	6.5 - 9.0	7.2	-1.0 - 7.5	3.8
January	2.6 - 6.5	5.1	-1.8 - 5.0	1.0
February	4.0 - 8.0	5.6	-1.8 - 13.0	5.1
March	-1.8 - 14.8	7.4	7.0 - 14.5	11.4

Table 2.--Winter Mortality of Oysters, Eastern Shore of Virginia, 1959-1961

Location	Tray No.	Date Started	Source	Tidal Level	1959-1960 No. Oysters	1959-1960 Percent Dead	1959-1960 Period	1960-1961 No. Oysters	1960-1961 Percent Dead	1960-1961 Period
W	W-1	2/19/60	JR	I	150	5	2/19/60-3/28/60	78	99	12/29/60-3/8/61
W	W-2	12/23/59	SB	I	285	1.7	2/23/59-3/14/60	----	----	--------------
W	W-3	12/23/59	SB	I	114	1.7	3/2/60 -3/14/60	----	----	--------------
W	W-4	11/--/60	JR	I	---	---	--------------	180	99	11/--/60-1/31/61
W	W-5	1/-3/61	SB	I	---	---	--------------	125	6	1/23/61-3/-6/61
W	W-6	1/-3/61	SB	I	---	---	--------------	125	7	1/31/61-2/16/61
W	W-7	1/-3/61	SB	I	---	---	--------------	95	6	1/31/61-2/16/61
W	W-8	1/-3/61	SB	I	---	---	--------------	72	96	1/-3/61-2/-6/61
M	S-11	6/15/59	JR	I	457	0.2	--------------	325	98	1/-3/61-2/24/61[2]
M	S-14	6/15/59	M	I	295	0.0	--------------	205	64	1/-3/61-2/24/61[2]
C	B-1,2	3/31/59	C	S	459	2	2/-2/60-4/-5/60	172	16	12/28/60-4/-4/61
G	B-3	2/25/59	JR	S	447	1	2/17/60-3/31/60	305	4	12/-1/60-3/15/61
G	B-4,5	2/25/59	G	S	335	1	2/17/60-3/31/60	183	5	11/18/60-4/-4/61

W--Wachapreague
M--Machipongo River
C --Cherrystone Creek
G --Gulf
H --Hungars Creek
SC--South Carolina

JR--James River
SB--Swash Bay
I----Intertidal
S----Subtidal
BB--Bradfords Bay

Table 2. (continued)

					1959-1960			1960-1961		
Location	Tray No.	Date Started	Source	Tidal Level	No. Oysters	Percent Dead	Period	No. Oysters	Percent Dead	Period
G	B-13	2/--/60	G	S	---	---	-----------------	406	2	2/12/61-4/-4/61
G	B-18	11/--/60	JR	S	---	---	-----------------	398	0.5	--------------
G	B-19	11/--/60	G	S	---	---	-----------------	298	0.0	--------------
SB	B-9, 10	3/5/59	SB	S	556	2	1/26/60 - 3/28/60	289	3	12/-6/60-4/-5/61
SB	S-13	6/16/59	JR	S	455	1	1/26/60 - 3/28/60	---	---	--------------
SB	S-22	12/-2/60	SB	S	---	---	-----------------	239	2	3/16/61-4/-5/61
H	B-14	3/2/60	SC		316	20	3/2/60 - 4/-1/60	---	---	--------------
BB	B-14	11/28/60	H [3]		---	---	-----------------	215	94	11/28/60-2/-2/61

1. Acclimated James River oysters (not in text)

2. Tray closed at this date

3. South Carolina oysters moved from Hungars to Bradfords Bay

Table 3. Incidence of *Hexamita* in oysters, Jan. 28 - Feb 24, 1961

Source	Number examined	Hexamita present	Heavy infection
	Live oysters		
Native (subtidal and intertidal)	21	10(47.6%)	1(4.8%)
James River (intertidal)	5	5(100%)	3(60.0%)
South Carolina (subtidal)	10	8(80%)	3(30.0%)
	Gapers		
Native (mostly intertidal)	11	9(81.8%)	5(45.4%)
James River (intertidal)	36	25(69.5%)	15(41.7%)
South Carolina (subtidal)	10	10(100%)	8(80.0%)