Oyster (Crassostrea virginica) Mortality Studies along the Texas Coast

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ABSTRACT

Mortality rates among oysters (Crassostrea virginica) of different sizes and from different bay areas were compared in three separate studies in Galveston, Matagorda and Aransas Bays. A general pattern of spring and late summer mortality cycles was observed in Galveston and Aransas Bays with higher mortalities occurring in late summer. An unusual fall (November) mortality period was observed in Matagorda Bay.

Dermocystidium appeared to be the major cause of mortality among oyster stocks in Galveston Bay but was not responsible for the extreme mortalities in Matagorda and Aransas Bays. The presence of Aransas Bay Organisms (ABO) in these areas was suspected but not confirmed.

INTRODUCTION

Studies of mortality among tray-held oysters (Crassostrea virginica) were initiated in Aransas Bay in 1962 and in Galveston Bay in 1963 in cooperation with Dr. J. G. Mackin of Texas A & M University. The studies in Aransas Bay led to the detection of "Aransas Bay Disease" by Dr. Mackin. This disease, caused by an intracellular organism (referred to here as ABO for Aransas Bay Organism), was responsible for sudden, and high, mortalities among all sizes of oysters and caused complete loss of market oyster stocks in Aransas Bay. ABO was not found in Galveston Bay, but tray studies indicated Dermocystidium marinum as a major cause of late summer mortality.

Mortality studies were continued in 1965. In Aransas Bay, oyster stocks from several bays were compared to determine whether any stock was resistant to ABO and therefore suitable for restocking purposes. In Galveston Bay, losses among seed stock during recent years, as shown by reef sampling, prompted a comparison of mortality rates among oysters of different sizes. Recent mortalities in Matagorda Bay, which were suggestive of infections from both Dermocystidium and ABO, led to a small scale study comparing mortality among oysters from Tres Palacios Bay and Galveston Bay. The results of the three studies are presented and discussed here.

STATION LOCATIONS

Location of the mortality stations in Aransas, Matagorda and Galveston Bays are shown in Figure 1. Within recent years the presence of ABO had been detected in Aransas and Matagorda Bays and suspected in San Antonio Bay. Infections of Dermocystidium were prevalent throughout Galveston Bay and in portions of Matagorda Bay.

Aransas Bay stations included Pintail and Halfmoon Platforms (Stations 1 and 2) which had been in use since 1962. Both were located on oyster reefs in areas of acute ABO infection. The Matagorda Bay station (Station 3) consisted of a temporary platform supporting four trays near the mouth of Tres Palacios Bay in an area subject to high Dermocystidium infection but with a recent history (1964) of extensive oyster mortality suggestive of ABO infection. Galveston Bay stations included Switchover and Hanna Platforms (Stations 4 and 5) in use since 1963. Switchover station was located in an area of consistent oyster production for the past several years while Hanna station was located in an area of declining production.

METHODS

Oysters at all stations were held in vinyl-coated metal trays measuring 32 inches long, 18 inches wide and 4 inches deep, covered with hardware cloth (1/8 to 1/2 inch mesh). Trays containing small oysters were lined with hardware cloth.

Stations were generally visited semi-monthly. Dead oysters (boxes and gapers) were removed and measured at each station visit, and live oysters were measured at intervals throughout the study. All measurements were made along the dorso-ventral axis (height) on the right valve and reported to the nearest millimeter.

Death rates were expressed as percentage per month. That is, the monthly mortality rate was the percentage of oysters alive at the beginning of a month that died during that month.

Gaper tissues were cultured in fluid thioglycollate medium containing Chloromycetin and Mycostatin for determination of Dermocystidium infection. Tissues were fixed in Zenker's, washed in tap water, and preserved in 70 per cent isopropyl alcohol. Occassional samples of live oysters were also collected and processed in the same manner as the gapers.

Aransas Bay stations were stocked during January - March with approximately 2500 oysters, including 500 from each of the following bay systems: Galveston, Lavaca, San Antonio, Aransas (Port Bay) and South Bay. The Matagorda Bay station (Coon Island) included approximately 250 oysters from Galveston Bay and 250 oysters from Tres Palacios Bay stocked in July. At the two Galveston Bay stations 1600 to 1800 oysters from Trinity Bay were stocked in April and 1000 spat from the 1965 spring spat set were stocked in July.

Oysters stocked at the Galveston Bay stations were separated by size (height) into four groups: "small" oysters (31-60 mm); "medium" oysters (61-90 mm); "large" oysters (100 mm +) consisting of the larger survivors of the 1963 mortality study at each platform; and "spat" (16-40 mm) which set in the trays during May and were culled, separated and stocked as a group in July.

RESULTS

Aransas Bay Study

Mortality rates among Lavaca, San Antonio and South Bay oysters were low during March and April but increased sharply to a spring peak in May or June (Table 1). Among Galveston Bay oysters, the mortality rate began to increase in April with the most rapid increase in May, reaching a peak in

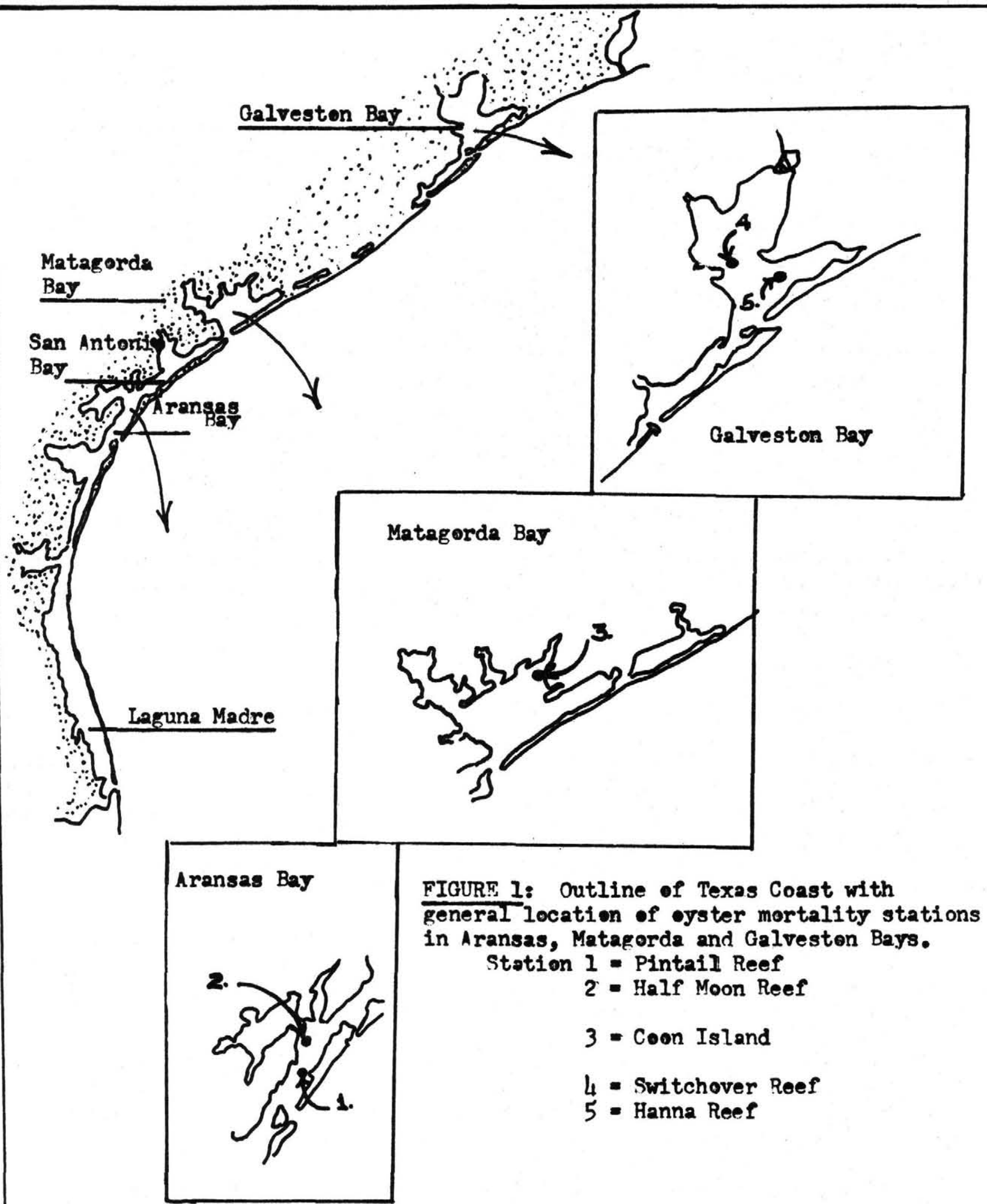

FIGURE 1: Outline of Texas Coast with general location of oyster mortality stations in Aransas, Matagorda and Galveston Bays.

Station 1 = Pintail Reef
2 = Half Moon Reef

3 = Coon Island

4 = Switchover Reef
5 = Hanna Reef

June. Aransas Bay oysters suffered high (47%) mortality in April immediately after stocking with a peak death rate in May. Generally, spring mortality rates increased as water temperatures rose above 25°C.

After the spring peak mortalities, only 22 per cent of the Galveston stock, 25 per cent of the Lavaca stock, 20 per cent of the San Antonio Bay stock and 11 per cent of the Aransas Bay stock survived compared to 64 per cent of the South Bay stock. Subsequent summer mortality rates among the small number of oysters surviving in each group may be misleading. However, mortality generally decreased to a summer low in July (although the low occurred in August among South Bay oysters) but increased rapidly in August and September. Aransas Bay oysters were gone by the end of July, San Antonio Bay stock survived through August and Galveston and Lavaca Bay stocks survived through September. The South Bay oyster tray was dropped from the platform in October and not recovered until November with about 75 per cent of the oysters lost. The mortality rate during October could not be determined but none of the survivors died during November and December.

Sporadic Dermocystidium infections were found among live oysters sampled from each group, but only Galveston Bay oysters were consistently infected throughout the study (Table 2). Among other groups, infections were very light, and several were doubtful, with a few small, dark-stained cells appearing in the tissues. Few gapers were recovered from any group, and almost all of these were found in the spring. Only gapers from the Galveston and Aransas stocks were infected. The high infection levels among Galveston Bay stock during the spring (live oysters and gapers) indicate that Dermocystidium was, at least, a contributing factor in spring mortalities.

Matagorda Bay Study

Among the Galveston Bay stock, mortality rates decreased slightly from July through September but began to rise in October (Table 3). Mortality rates increased among Tres Palacios oysters from July through September, dropping slightly in October. In both groups, brief, but high, mortalities began in early November, reached a peak in late November and dropped sharply in December. The onset appeared to follow an increase in salinity which occurred in October and early November. In mid-November, salinities began to decrease and water temperatures began to decrease from late summer highs.

The November mortality apparently did not occur throughout the Matagorda Bay system, but sampling on Middle Ground Reef near the Coon Island station in December indicated that a recent mortality among seed oyster stock had taken place as determined by the number of fresh boxes collected.

The incidence of Dermocystidium was negative among live oysters sampled from both groups in July and early August, but light infections were found in late August and early September. Unfortunately, thioglycollate cultures were not available during the November mortality period.

Tres Palacios oysters averaged 80 mm in height and Galveston oysters 65 mm in height when stocked in July. Growth could be followed for only a short period. Prior to the November mortalities, reduction in height was common with most oysters exhibiting regression of the bill.

From July through September, Tres Palacios oysters averaged 3 mm growth (0.05 mm per day) while the Galveston group, during a comparable period, increased by 8 mm (0.14 mm per day).

Galveston Bay Study

Among the small and medium size oysters at both stations and the 1963 survivors at the Hanna station, spring mortality reached a peak in May (Table 4). The peak spring mortality rate among the 1963 survivors at Switchover station occurred in April. Relatively low mortalities among all groups during June and July coincided with low salinities (Table 5).

Highest mortality rates were found in late summer among all size groups, coinciding with increased salinities and water temperatures. Peak mortality among the small oyster group occurred in September at Switchover; August at Hanna. Peak mortalities among the medium size oysters were found in August at both stations. Among the 1963 survivors, the peak mortality rate was found in September-October at Hanna and August at Switchover (with a lesser peak in October). Peak mortalities among spat at both stations occurred in October.

Total mortality from April through December among the size groups was as follows: Small oysters - 24.5 per cent at Switchover, 25.5 per cent at Hanna; medium oysters - 45.5 per cent at Switchover, 64.5 per cent at Hanna; 1963 survivors - 27.6 per cent at Switchover, 44.4 per cent at Hanna. The higher mortality rates (both monthly and total) among the medium size oysters at Hanna station were due, in part to conch (Thais haemastoma) predation, especially among the 61-70 mm subgroup during the spring. However, at both stations highest mortalities were found among the medium oyster groups. At Switchover, total mortality among the 1963 survivors was only slightly more than that of the small oyster group.

Total mortality among spat during the period July through December was 12.2 per cent at Switchover and 30.6 per cent at Hanna. Predation by conchs and small stone crabs (Menippe mercenaria) accounted for part of the Hanna mortality. Even though the spat trays were lined with 1/8 inch hardware cloth, small conchs succeeded in penetrating the barrier and attacking the oysters. During a comparable period of time 18.1 per cent of the small oyster group at Switchover and 12.4 per cent of the small oysters at Hanna died. Fewer conchs were observed in the Hanna small-oyster trays than in the spat trays which may account, in part, for the large difference in mortality.

Dermocystidium infection among small oysters was low in the spring, increasing to moderate levels in September and October (Table 6). Among the Switchover oysters, a noticeable drop in infection incidence occurred during June and July when salinities were low, but a corresponding drop in incidence among the Hanna group did not occur; the incidence was lower in April and May than in June and July.

Infection incidence among the medium oysters was generally higher at Hanna than at Switchover. A spring peak at Switchover was found in May, but highest incidences occurred during October and November. High infections were found among the Hanna stock in June, July and August, but peak infections were not found until October and November. Among the 1963 survivors, peak infections at Switchover were found in July and September while at Hanna, peak infections occurred during June-July and October-November.

Spat were not sampled until late in the year, but in November, when spat were six months old, both groups were found to be infected.

Average growth (in height) per day decreased with increased size at both stations (Table 7). Spat at both stations grew well in September, but the rate decreased in October (when maximum mortality was observed). The growth rate was slowest at both stations in December. Small oysters at Switchover station showed most rapid growth during summer. Growth rate decreased in the fall and dropped sharply in December. The Switchover medium oyster group also grew most rapidly during the early summer, but the rate decreased in August (during high mortalities). Growth increased in the fall but dropped in December Growth among the 1963 Switchover survivors was most rapid in May, but throughout summer and early fall the oysters generally decreased in height. Periods of growth cessation coincided with periods of increased mortality (except in December).

At the Hanna station growth among small oysters increased in June and July, decreased in August (when mortality rate increased), and increased in September-November. Growth decreased noticeably in December. Among the medium oyster group, growth was most rapid in September-November, generally following the peak mortality period but decreased in December. The 1963 Hanna survivors generally showed regression in height from May through November with best growth noted in December.

Growth among all size groups was faster at Switchover than at Hanna. However, in December, when a sharp drop in growth was observed among most size groups, Hanna oysters grew faster than those at Switchover.

DISCUSSION

Seasonal patterns in oyster mortality along the Texas coast were similar, although causative agents differed. Spring mortalities among tray stock in Galveston and Aransas Bays were also found through reef sampling in Matagorda and San Antonio Bays (Hofstetter, 1966). In Galveston Bay such mortalities were associated with Dermocystidium marinum, and to a lesser extent, with predation by conchs and stone crabs. Along the rest of the coast, however, ABO was believed to be the major cause (but not yet verified).

Late summer mortalities were also common in the bay systems and the summer mortalities usually exceeded those in spring. The occurrence of a fall (November) mortality in Matagorda Bay (Coon Island and Middle Ground Reef) was unusual. However, fall-winter mortalities have occurred in Aransas Bay (Heffernan, 1964 and in Lavaca Bay (King, 1964).

Of the five bay stocks studied in Aransas Bay, "native" Aransas oysters appeared to be most succeptible to disease. The relatively low spring mortality among South Bay stock with a possible light summer peak indicates a more resistant oyster and warrants further study.

Since all oyster stocks had been brought in during the winter or early spring, the time required for stocks to build up massive infections is not known. Survival of stocks transplanted during different seasons should provide more information on infection rates.

Mortalities among Galveston Bay oysters indicated that a large percentage of sub-market and market oysters (the medium, 61-90 mm group) succumbed to Dermocystidium prior to the beginning of the harvest season (November). However, oysters which had survived at least four years of exposure (i.e. the 1963 survivors, which were considered to be at least one year old when first stocked) survived about as well as the younger(31-60 mm) group, indicating some resistance to Dermocystidium.

Late fall mortality among the 1965 spat was similar to that of the small (31-60 mm) group although the peak rate occurred one month later. Dermocystidium samples were not taken during the high mortality period, but infections were found in November. This suggests that spat became infected during their first summer when only a few months old and that Dermocystidium-associated mortalities resulted.

LITERATURE CITED

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Table 1: Monthly mortality rates among oysters from five bay areas held in trays at Pintail and Halfmoon stations in Aransas Bay during 1965. Average monthly salinity and temperature recorded at the two stations are also shown.

MONTH	MORTALITY RATE (%) AMONG GROUPS					SALINITY °/oo	TEMPERATURE °C
	G	L	SA	A	S		
J						30.4	14.3
F	1.0	-	-	-	0.0	26.4	12.2
M	0.8	8.4	2.2	-	1.4	22.3	16.0
A	10.4	3.3	4.2	47.3	1.2	25.2	22.5
M	41.6	54.5	81.1	81.2	35.4	23.2	26.0
J	65.1	58.8	43.3	53.1	12.2	25.2	29.0
J	15.4	26.0	28.9	38.5	4.3	26.2	29.0
A	67.9	34.8	77.3	0	1.7	28.4	30.0
S	72.2	80.8	-	-	6.3	32.9	29.6
O	-	-	-	-	?	31.8	28.9
N	-	-	-	-	0.0	26.0	21.5
D	-	-	-	-	0.0	-	-

Groups: G = Galveston Bay
L = Lavaca Bay
SA = San Antonio Bay
A = Aransas Bay
S = South Bay

Table 2: Incidence of *Dermocystidium marinum* infection among oysters from Galveston, Lavaca, San Antonio, Aransas and South Bays transplanted to Aransas Bay during 1965.

Month	Incidence of Dermocystidium									
	Live Oysters					Gapers				
	G	L	SA	A	S	G	L	SA	A	S
1										
2										
3	0.9	0	0	1.1	0	2.8	0	-	-	0
4	2.5	0.1	0.1	0	0.1	4.0	0	0	2.0	0
5	3.2	0	0	1.4	0.2	3.6	0	0	0	-
6	1.4	0	0	0	0	-	-	-	-	-
7	2.0	0.1	0	0.4	0.2	-	-	-	-	-
8	1.5	0.5	0	-	0	0	-	0	-	-
9	3.6	0	-	-	0	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-
11	-	-	-	-	0	-	-	-	-	-
12	-	-	-	-	-	-	-	-	-	-

Table 3: Monthly mortality rate among Galveston Bay and Tres Palacios Bay oysters at the Coon Island station in Matagorda Bay during 1965. Average monthly salinity and temperature recorded at the station also are shown.

Month	Mortality Rate (%)			
	Tres Palacios	Galveston	Salinity $^{0}/_{00}$	Temperature ^{o}C
July	6.4	7.9	18.8	
August	11.8	6.2	20.4	
September	14.6	5.3	25.4	28.9
October	13.8	13.2	28.6	26.0
November	46.5	45.4	22.4	22.8
December	19.5	14.1	19.2	15.8

Table 4: Monthly mortality rate among four size groups of oysters at Switchover and Hanna Stations in Galveston Bay during 1965.

Month	Mortality Rate (%) Among Size Groups							
	Switchover Station				Hanna Station			
	Spat	31-60	61-90	1963	Spat	31-60	61-90	1963
A		1.8	3.3	2.9		3.8	15.1	6.0
M		2.4	9.4	1.1	[redacted]	~~15.7~~ 5.0	~~8.7~~ 15.7	8.7
J		0.5	5.0	1.9	[redacted]	~~10.1~~ 2.7	~~3.4~~ 10.1	3.4
J		2.1	5.8	2.6	[redacted]	~~13.6~~ 2.6	~~4.5~~ 13.6	4.5
A	0.8	6.8	15.5	8.6	7.0	5.0	18.2	8.7
S	3.4	7.0	11.8	5.0	6.6	4.2	16.0	12.8
O	4.4	4.1	6.3	7.2	12.4	2.7	5.7	12.6
N	3.4	4.1	2.7	4.1	7.0	3.9	7.3	0.6
D	0.8	0.6	1.0	0.8	2.0	0.6	1.5	3.0

Table 5: Average monthly salinity and temperature recorded at Switchover and Hanna Stations in Galveston Bay during 1965.

Month	Salinity °/oo		Temperature °C.	
	Switchover	Hanna	Switchover	Hamma
A	14.7	17.6	25.0	25.3
M	18.8	21.1	26.7	26.5
J	12.3	16.4	28.6	28.8
J	13.4	11.2	29.7	30.0
A	21.3	20.0	29.4	28.7
S	23.9	25.3	29.0	29.0
O	23.7	21.6	23.6	22.0
N	22.6	21.8	20.6	20.6
D	20.6	20.8	17.8	18.8

Table 6: Incidence of Dermocystidium marinum infection among four groups of oysters at Switchover and Hanna stations in Galveston Bay

Month	Dermocystidium Infection Incidence							
	Switchover Station				Hanna Station			
	Spat	31-60	61-90	1963	Spat	31-60	61-90	1963
A		1.0	0.8	2.5		0.1	2.1	2.8
M		1.4	2.9	2.5		0.3	2.8	3.2
J		0.2	2.0	2.2		1.3	3.8	4.0
J		0.7	2.7	3.5		1.0	3.7	4.0
A		1.2	2.8	2.0		1.1	3.7	2.5
S		2.8	2.8	3.5		2.3	3.3	1.5
O		3.5	3.3	1.0		3.3	4.3	4.0
N	2.5	2.3	3.7	1.0	1.6	0.5	4.7	4.0
D	-	-	-	-	-	-	-	-

Table 7: Monthly growth increment (height) among four oyster groups at Switchover and Hanna stations during 1965.

Month	Average Growth Increment (Height) in MM							
	Switchover Station				Hanna Station			
	Spat	31-60	61-90	1963	Spat	31-60	61-90	1963
A								
M		5.2	4.1	4.6		2.3	1.2	0.6
J		8.4	5.2	1.6		4.9	1.7	-1.0
J		8.4	5.2	1.6		4.9	1.7	-1.0
A		7.8	2.3	-1.9		2.7	1.0	-1.8
S	8.5	8.3	3.6	2.9	7.9	5.6	2.3	0.4
O	7.8	5.8	3.8	-0.8	5.6	4.8	2.1	-0.3
N	8.2	4.5	4.4	3.3	4.7	4.8	2.1	-0.3
D	3.8	1.1	1.6	-0.2	4.3	3.5	2.9	2.0
Average Growth/Day	0.22	0.20	0.12	0.04	0.18	0.14	0.06	-0.01