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Oyster Investigations in 1941

Author

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OYSTER INVESTIGATIONS IN 1941

by

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Annual Report for 1941

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## Introduction

On May 13, 1941 the writer left the Biological Station at Ellerslie, P. E. I. and spent the greater part of the open-water season at or near Shediac Bridge, N.B. where the investigation into the causes of the low oyster productivity of Shediac bay was carried on. Brief trips were made to P. E. I. on June 11-16, July 28 - 30, Aug. 20 - 23, September 20 - 28 and November 4 - 7 and to Malagash, N.S., on September 8 - 9 and October 13 - 20 where relaying experiments were in process. Although not reported here explorations to judge potentialities for oyster farming were made in the estuarial parts of the Richibucto, Shemogue and Little Shemogue rivers - all in New Brunswick. On November 12 - 15 a visit was made to the Miramichi river and the Caraquet and Shippegan areas in company with Drs. Needler and Kerswill.

On December 3 the writer went to the Atlantic Biological station for the winter.

## SHEDIAC BAY INVESTIGATION

### Introduction

In general the investigation into the causes of the low oyster productivity of Shediac bay took the same form as that in 1940. There were added refinements, however, designed to check conclusions drawn from last year's work. Observations on adult oysters were limited almost entirely with Poirier bed stocks. The Wilbur bed was so depleted during the 1940 fishing season that it was difficult to get even enough oysters for condition tests.

### Spawning.

The adult oysters were fat and full when examined on May 21, 1941, just as they were in the spring of 1940. By July 1 they had developed large quantities of spawn and were of a rich cream colour. Judging from the appearance of the gonads and the results of examinations of plankton tows, spawnings took place in several small bursts - July 2, July 5 - 7, July 11- 15, July 20 - 25, and July 31 - August 1. The first two spawnings must have been light. This is indicated by an examination of gonads of 19 oysters on July 10. Only one-third of these showed evidence of having spawned and even those that had spawned most heavily were only one-quarter spent. On July 23 many oysters still appeared to be only half spent.

### Study of Larvae

Beginning on July 11 many tows were made with a #15 mesh plankton net. These were continued until August 25 when larvae

inside the bay had practically disappeared. A study of the catches up to the end of July served to show only one thing - that more oyster larvae were to be caught in the eddy outside the bay than inside it. In order to check this conclusion from the study of tows made in the conventional way (by towing the net behind a dory) a pump with ten feet of  $1\frac{1}{2}$ " rubber hose was obtained. With this 50 gallon samples could be pumped from near the bottom and strained through the plankton net. To prevent fouling the net with debris from the bottom an attachment was made for the free end of the hose. This was an 8" x 8" sheet of galvanized iron that was held flat across the end of the hose but about two inches from it. When a sample was being pumped from shallow water the iron could be rested on the bottom and prevented the currents from catching up dirt. The attachment was removable for sampling at other levels, but without its help no samples taken from near the bottom were free enough from debris to permit intelligent examination.

The use of the pump sampler, however, did not reveal the presence of oyster larvae in any part of the bay where they could not be obtained by towing the net in the ordinary way.

Several series of tows were made to discover the relative abundance of larvae inside and outside the bay and to see if oyster larvae were actually carried out of the bay as was concluded from the 1940 study (Medcof 1940). Table I summarizes the more relevant of these. The results of the August 5 tows agree with those made earlier in indicating that there were more larvae outside than inside the bay. No correlation could be found between larval abundance inside the bay and tidal phase or weather. The

two days August 9 and 11, differed greatly as regards weather but the abundance of larvae over the Peirier bed was practically the same

Table I

Results of Examinations of Tows

Date	Time	Tide	Weather	Type of Sample	No. oyster larvae found in a 10 min. examination	Locality and Remarks
Aug. 5	11.15 A.M.	HF	cloudy mod N.W.	10m surface tow	10	Tow was made in the channel 1 m. off G. Digue in strait.
	11.50 A.M.	HF	"	"	1	Tow was made in channel leading to G. Digue, well inside the bay.
	4.10 P.M.	LR	raining light E.	"	7	Around barrel buoy in southern Shediac Bay.
	4.30 P.M.	LR	"	"	19	At first cone buoy off E. du Chene in strait.
	5.00 P.M.	$\frac{1}{2}$ R	"	"	12	At Zephir rock buoy in strait.
Aug. 7	9.30 A.M.	HR	clear light SW	"	15	Over Peirier bed
	12.00 Noon	$\frac{1}{2}$ F	"	"	17	In channel at G. Digue outlet. Current speed 612.37P.M. 1.04' per second.
	12.37 to 1.10 P.M.	$\frac{1}{2}$ F	"	Stake Tow	5	Same place as last; some sand in catch made examination difficult.
	2.30 P.M.	LF	"	10m. surface tow	21	Same place as last.

Table I (Continued)

Date	Time	Tide	Weather	Type of sample	No. oyster larvae found in a 10 min. examination.	Locality & Remarks
Aug. 7	2.55 P.M.	LF	Clear light SW	Stake Tow	5	Same place; current speed 1.02' per sec.
	3:33 P.M.					
	5.05 P.M.	LS	"	10m. surface tow	28	Over Ioirier bed.
Aug. 9	9.45 A.M.	HF	cloudy light SW	"	18	Over Poirier bed
	11 7.45 P.M.	LH	clear light SW	"	21	" " "
Aug. 14	11.00 A.M.	LS	bright mod. SW	"	22	In channel at G. Digue outlet.
	1.10 P.M.	LR	bright Freshstrong SW	"	15	Same place; too windy to measure current speed
	1.25 to 2.40 P.M.	LR	"	Stake tow	13	Same place
	2.47 P.M.	HR	"	10m. surface tow	18	Same place; water still rougher, hard to row at all.
	3.12 to 4.12 P.M.	HR	"	"Stake tow"	2	Same place; caught a lot of sand that made examination difficult.
Aug. 15	10.10 A.M.	LS	cloudy mod. SW	10m. surface tow	18	Over Ioirier bed.

On August 7, tows were made in the narrow Grand Digue outlet of the bay on a falling tide at intervals from high to low water. The catches prove definitely that the larvae are carried out of the bay with falling tides. The current speeds calculated from repeated measurements of the time required for a float (the same as that used in current studies last year. (Medcof 1940.) to travel a measured distance, shows that carriage went on at current speeds higher than 1.0 feet per second. Such a current is strong enough to distend a plankton net. To make a "tow" it was necessary only to attach the net to a stake in the channel and let the water filter through it. In Table I these are referred to as "stake tows". It will be seen that numerous larvae were taken by this means. The observation supports Elzey and Quayle's conclusions that significant numbers of larvae are carried about by tides for considerable distances (Elzey and Quayle 1939). Frytherch (1928) has suggested that such carriage is prevented by an avoidance reaction of the larvae - that the larvae stop swimming and settle to the bottom when the current speed reaches 0.5 feet per second.

Studies of August 14th. collections showed that in like manner larvae are carried back into the bay in large numbers (Table 1)

In general, oyster larvae appeared to be much more abundant, both inside and outside the bay, than in 1940.

#### Spatfall in Shediac bay

Individual commercial collectors were hung from stakes and buoys at various places inside and outside the bay. Heavy winds were responsible for the loss of all that were placed in exposed positions. One bundle in six feet of water (at low tide) at Indian Island took 230 spat. Another in three feet of water on

Tray rearing of spat in Shediac bay

Tray rearing was attempted in Shediac bay using 1940 spat taken from Ductouche collectors on July 4, 1941. The tray measuring 4 feet by 6 feet was reared over the Poirier bed and contained approximately 2000 spat. These were removed on September 19th. Samples were measured at the beginning and at the end of the test, lengths only being taken. The results are presented below.

---

Date of measurements	No. measured	Median mm.	Semi-interquartile range
July 4, 1941	135	14	3.5
Sept. 19, 1941	155	31	3.0

---

The growth of these young oysters in this interval can be considered satisfactory judging by standards of Malpeque bay. The results of the experiment indicate that imported stocks should do well enough if an oyster farming programme were to be undertaken in these waters using foreign spat for stocking the areas to be cultivated.

Size Composition of Poirier Bed Stocks

Size-frequency distribution in a population is often indicative of irregularities in reproduction. This was examined again in 1941. On July 2 and August 29 random samples of oysters were fished from the Poirier bed and on May 29 a random sample of clams (Myn) was dug from one small plot just at low tide level on the Poirier bed flats. The results of measurements of these appear below .

Size-frequency distribution of Poirier bed bivalves

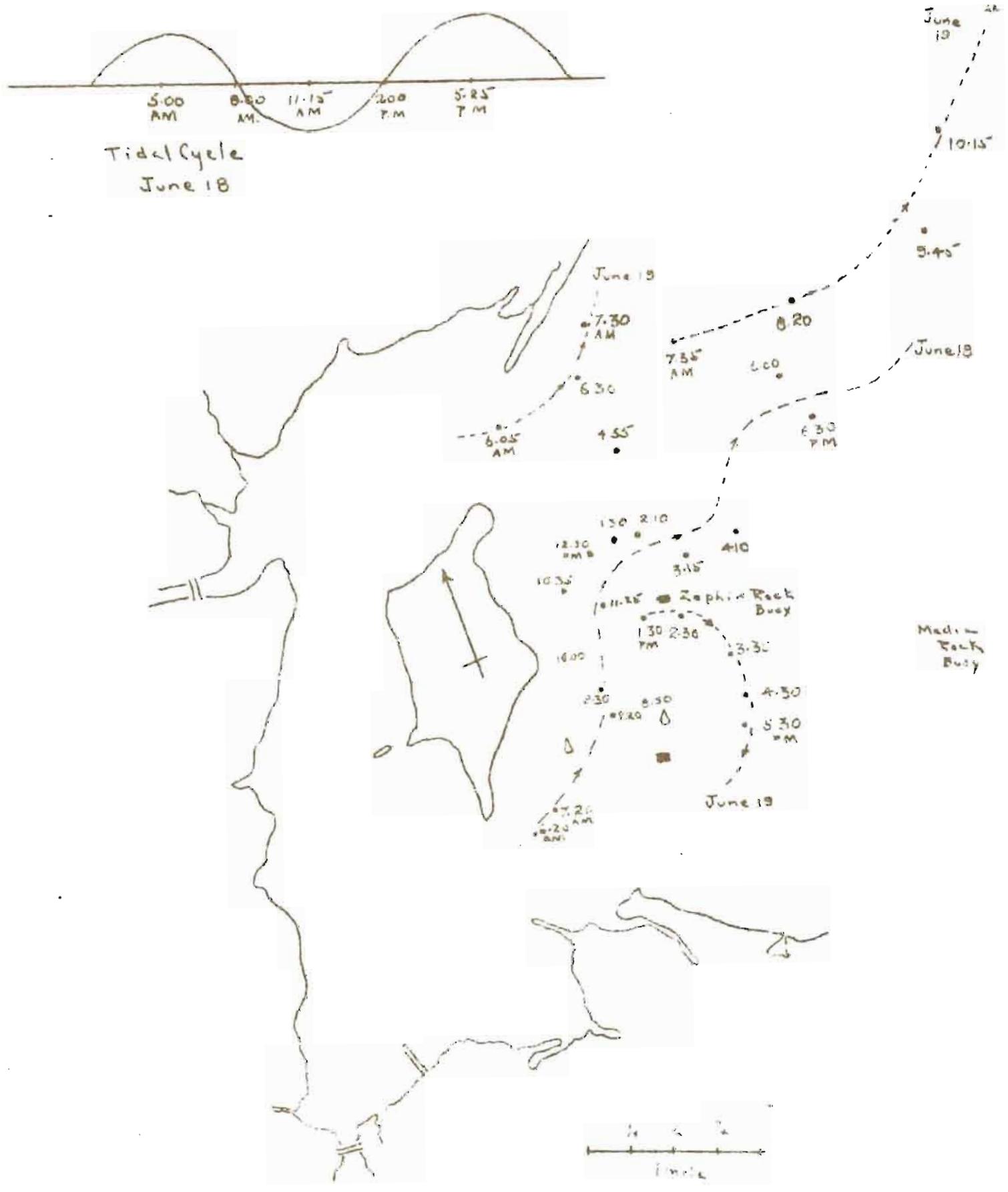
Size in cm.	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9	9-10	Total
Clams May	4	12	7	50	57	43	9	0	0	0	182
Oysters July	0	1	5	9	10	18	11	3	0		65
Oysters August	0	0	0	5	14	17	19	13	7	2	77

The composition of the oyster population this year much resembles that of 1940 (Medcof 1940). The clams show much the same picture too. In the latter species the main size class has progressed since 1940 and a not very numerous smaller class is following. The data offer additional proof that there has been a lack of regularity in reproduction of both species during the last few years. Only one 1940 oyster spat was found among the 142 oysters examined.

Current Study

A study similar to that reported earlier (Medcof 1940) was carried out to learn more about the nature of water movements off

Figure 1. Showing courses taken by floats during the current study at Shedding bay, June 18 and 19, 1941.



the entrance to the bay. Figure 1 shows the courses taken by the floats on two dates.

On June 18 the floats, released at Point du Chene, took a course similar to that observed on August 6, 1940. After this they made the turn to the east as before but then suddenly turned north. After this they headed for Grand Digue, but did not enter the bay. Instead they moved north-east once again. They were far to the north of the entrance and travelling east when the observations were brought to a close.

On June 19 the floats were started at the Grand Digue opening to the bay. A fresh southwest breeze was blowing and they took the course indicated in Figure 1. After going aground on a sand bar they were taken out of the water, carried further seaward and released again in the channel. Their subsequent course was such that there seemed little likelihood of their ever returning to the starting point. It would be interesting to know more about water movements off the Grand Digue opening but no more observations were made.

In the afternoon of June 19 the floats were transferred to the position indicated in the chart. The course followed then was what had been expected from former evidence of an eddy in this region. On August 30, 1940, in calm weather, the floats made the complete circuit of the eddy and came back almost to their starting point at Point du Chene (Medcof 1940)

The 1941 results indicate that it is sometimes "hard" for the floats released at Point du Chene, to turn southward after having completed, first the northerly and then the

easterly leg of their trip around the eddy. It is surmised when they are carried furthest to the north in the earlier stages of the circuit. The difficulty seems to be encountered not because the eddy current disappears but because their position in it varies. The strong winds which sprang up about noon (12.00 - 1.00 p.m.) on June 18, 1941, seem to have created a north-easterly surface drift carrying the buoys to the edge of the eddy. When the southward turn "should have been made" as it was on August 30, 1940, the tidal currents were setting in towards Grand Digue gap. The floats were carried off by these. After this separation the eddy seems to have had little effect on the floats for they were carried far seaward with the ebb-tide currents from Grand Digue.

Reference to last year's records will show that on August 6, 1940, there was a fresh southwest breeze most of the afternoon. The floats similarly failed to make the southward turn. As on June 18, 1941, they were further north than when they made the circuit on a calm day (August 30, 1940) and were probably carried to the edge of the eddy, got beyond its influence and were travelling to the north when the tide set in towards Grand Digue at 6:00 p.m. They showed little likelihood of returning to their starting point.

The results of 1940 and 1941 taken together indicate that there is a large and stable eddy just east of Anediac Island; that under some conditions bodies of water are flung off from its edges and may be lost from it permanently; that the "throwing off" is probably related to the direction and strength of the winds. However, even very strong winds such

as those encountered on June 19, 1941, are not sufficient to destroy the eddy even though they may alter the pattern of the circulation of its surface waters. No observations have been made during a period of northerly winds. It is not impossible that they might reduce the "throwing off".

TABLE 2

Comparison of conditions during larval periods, 1940 and 1941

Spawning date	Tidal conditions	Moon phase	Settlement date	Tidal Conditions	Moon Phase	No. of days		Result for brood
						SW wind	N. wind	
1940								
July 7-8	Unequal	New	August 6	Unequal	New	6	11	Light set
July 24-26	equal	First quarter	August 24	equal	Full	6	8 <sup>1</sup>	no spat observed
1941								
July 22	Unequal	New	August 16	Equal	First quarter	8	10	heavier set
August 1	nearly equal	third quarter	August 24	Unequal	New	4	8	no set observed

Comparison of 1940 and 1941

From the above account it will be seen that there was a greater abundance of oyster larvae in Shediac bay in 1941 than in 1940 and likewise a heavier settlement of oyster spat. This is in spite of the fact that the spawning stock was much smaller than in 1940. Table 2 compares the histories of the principal

broods of larvae in the two years. The data are meagre but it appears that greater numbers of larvae remained in the bay in 1941 or were brought back into it to settle there than was the case in 1940. It suggests no reason for the differences in the success of the four broods on which observations are available except that strength and direction of winds may have influenced it. There was more northerly wind during the larval periods of the broods that succeeded in producing sets than during the larval periods of those that failed. It may be that northerly winds have a beneficial effect in preventing bay water from escaping from the eddy and being permanently lost to the bay by the "throwing off" process. If this were true north winds would help conserve the larval population.

Many more observations would be necessary before such a relationship or indeed any at all could be substantiated.

#### Summary

Whatever the explanation, it has been clearly demonstrated that there was a much heavier set in the bay in 1941 than in 1940. It is quite conceivable that even greater differences could occur. In other words, it is possible to explain the great fluctuations in the oyster productivity of Shediac bay solely on variations in the intensity of spacial.

The cause of this variation does not seem to be related to any biological peculiarity of adult or larval oysters.

Oyster larvae are carried in and out of the bay in large numbers by tidal currents as has been described.

Peculiarities in water circulation outside the bay have been discovered which under varying conditions could make the

return of larvae to the bay possible or impossible.

Wind direction and strength alter the pattern of water circulation outside the bay and may thus regulate the numbers of larvae that return to "set" in the bay.

It is not definitely proven that this is the mechanism through whose operation the extent of spatfall is regulated but it seems highly probable.

malagash relaying experiments

Oysters were fished during the first two weeks of July from the polluted parts of Pictou Harbour and relaid in various ways for purification on the malagash flats in front of the biological station. The experiment was designed by Dr. Needler. Dr. James Adams was in charge of the relaying operations and sent the writer samples of the oysters as they arrived at malagash (there were three shipments) to Shediac for condition tests. The results of these are listed below.

Date of Arrival at malagash	Date of rest	Index of Conditions	Remarks
July 7	July 11	85	shipment was of 24 bushels. several oysters tested were dry. many irregularly shaped oysters in the lot
12	15	97	these oysters were better shaped; 25 bushels in shipment.
16	19	100	some spawning may have taken place judging from the appearance of the gonad

while gathering the twenty-five bushel lots for shipment the oysters from each day's fishing were held in lobster crates in the river so that they were probably subjected to considerable abuse. When they arrived at malagash some were placed directly on the bottom ("B" plots); some on wire cloth that was spread over poles lying on the bottom ("W" plot); and some on wooden trays 4' x 6' x 4' with wire cloth floors ("M" mesh) which

Table 3.

were 4-6" off the bottom ("T" plots).

Table 3

Summary of Study on Pictou Oysters Relaid at Malagash, N.S.

Exposure to winds and level on beach	Tray or plot NO.	Thickness of layer of oysters	Mortality Dead	Counts Alive	%Mortality	Index of Condition	Remarks
Protected : low tide	1	1"	5	145	3	92	
Trays close together	2	2"	10	140	7	92	
	3	6"	4	146	3	68	Top layer 80 Middle " 65 Bottom "
Less protected: Low tide; Trays farther apart	4	1"	3	147	2	80	
	5	2"	1	149	1	104 (?)	
	6	6"	1	199	1	81	Top layer 71 Middle " 59 Bottom "
Protected: Extreme low tide	7	2"	5	145	3	116	
Protected: half-tide	8	2"	4	146	3	86	91 Sample taken from end of tray where there was least crowding.
Badly Exposed: Low tide	9	2"	3	147	2	79	
Protected: " "	B1	1"	22	128	15	73	
Protected Extreme low tide	B2	1"	7	143	5	86	
Protected: low tide	Wire rack	2"	9	141	6	71	From top 84 layer 67 From bottom layer

Table 3 (Continued)

Exposure to winds and level on beach	Tray or plot No.	Thickness of layer of oysters	Mortality Dead	counts Alive	%Mortality	Index of condition	Remarks
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Malagash Natives

Never bare, but water shallow	From inside the dyke	-	-	-	11	115	
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Extreme low tide	From end of bar	-	-	-	-	124	
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Condition tests carried out October 19-25, 1941 by J.C. Medcof  
Mortality counts during week of October 26, 1941 by M. MacDonald.

Figure 2 shows the general layout. Trays 1, 2 and 3 were crowded close together in a protected place at low tide level. They contained 1½, 3 and 9 bushels of oysters respectively. Trays 4, 5 and 6 were similarly loaded with oysters set at low tide level but spaced further apart and in a more exposed position than 1, 2 and 3. Tray 9 was even more exposed; tray 8 was at half tide level; tray 7 at low spring tide level. All these three contained three bushels of oysters each. The wire laid on poles measures 12"x17" and received 21 bushels of oysters in a layer 2" deep. The two plots on which planting was done directly on the bottom measured 10' x 10' and each received 6 bushels.

The three shipments of oysters received at Malagash were distributed evenly throughout all the plants except in the case of the two plots directly on the bottom. Each of these received one bushel more of oysters from the last shipment than from the two previous ones.

In the period, October 19-25, a series of condition tests was made on representative samples from these transplants. mortality counts on each were made by Mr. Maple Macdonald. The results of the experiment are summarized in Table 5, from which several conclusions can be drawn.

conclusions

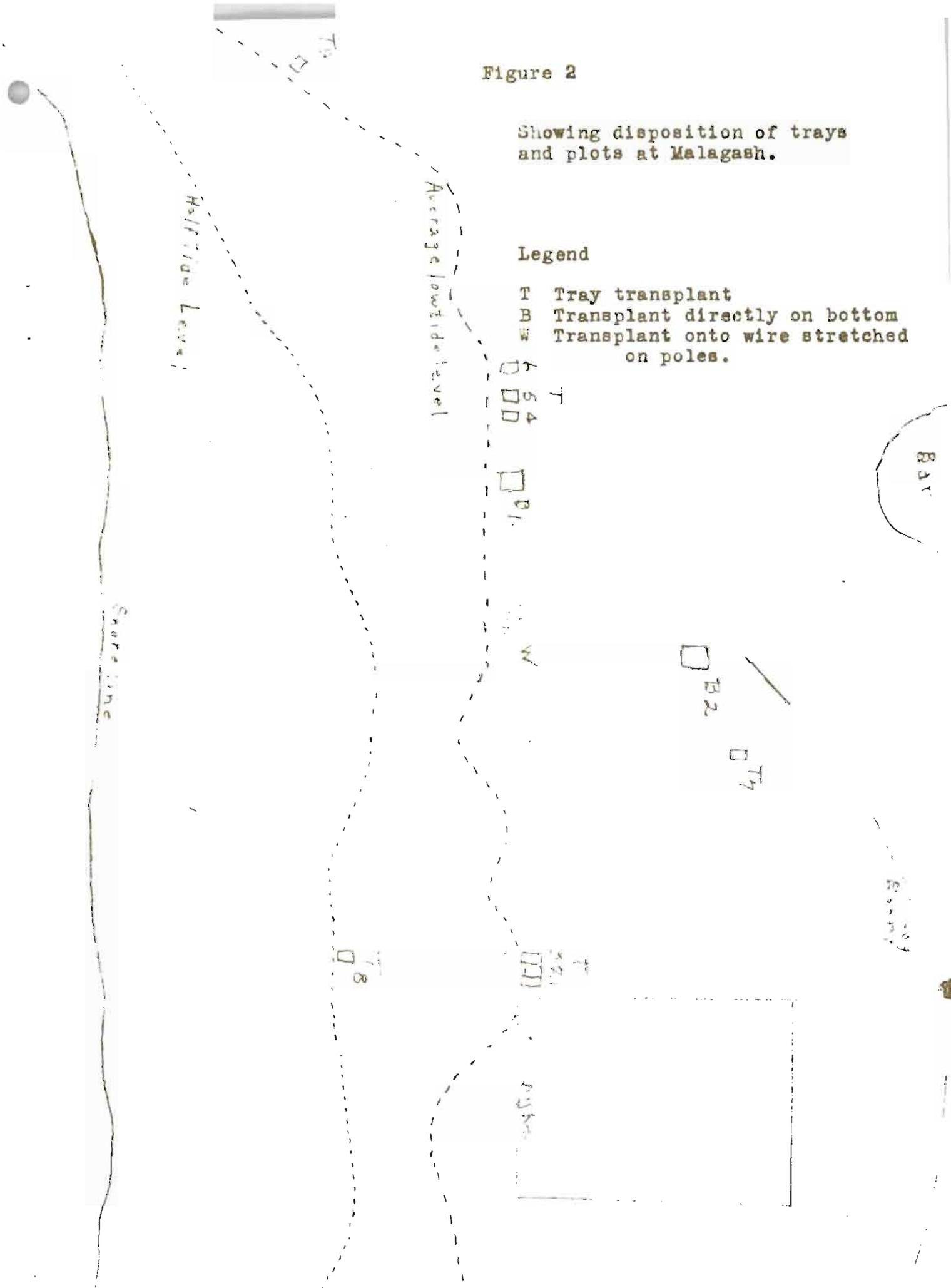
1. Crowding of oysters has a marked effect on their condition making them thin. This is reflected in the low index values obtained for oysters from the crowded trays as compared with the uncrowded trays and the very low values obtained for oysters from the bottom layers of the badly crowded trays as compared with those for oysters not so deep down.
2. There was no remarkable difference in the fatness of oysters in sheltered and exposed positions but those in sheltered positions tended to be a little fatter (compare trays 1, 2, and 3 with 4, 5 and 6, and with tray 9. These are progressively more exposed and progressively thinner.)
3. The lower on the beach the oysters are placed the better.
4. Oysters held on wire supported by poles lying on the bottom were not so fat as oysters crowded on trays to the same extent at the same level on the beach.
5. Oysters held on the wire supported by poles were of about the same fatness as those planted directly on the bottom at the same level but crowded to a slightly less extent.
6. None of the relaid oysters, regardless of the manner of handling, were so fat as native Malagash oysters growing on the bottom at the same level but crowded to a slightly less extent.

Figure 2

Showing disposition of trays and plots at Malagash.

Legend

- T Tray transplant
- B Transplant directly on bottom
- W Transplant onto wire stretched on poles.



13. Comparing the different methods of relaying, the mortalities were least in trays, intermediate on the wire supported by poles and . . . extent here the oysters were relaid directly on the bottom.

14. Unusually heavy sets of barnacles of the 1941 spawning were found on oysters in the deep-water tray (T7). This condition would be troublesome to packers who would have to clean them off before marketing. It is important in relaying that such fouling should be avoided.

#### General Conclusions

15. Considering the three methods of relaying tested in this experiment there seems to be little doubt that relaying in trays is the most satisfactory. Besides the features mentioned above there are others which recommend this method.

16. It is much easier and quicker to recover oysters from trays than if they were placed on the bottom. This reduces labour costs.

17. When gathered, oysters from trays have clean shells and have no mud inside the shells to foul the meats. This is a good feature.

18. It is possible to recover nearly all the oysters that are exposed. This is not true when plants are made directly onto the bottom.

19. Tray purification is not a costly operation.

7. There was much more individual variation in fatness among relaid Pictou oysters than among native Malagash stocks. (None of the native stocks had been moved since 1940)
8. The "dead" shells found during mortality counts were of such an appearance as to suggest that the oysters had died early in the season, perhaps soon after the transfer.
9. In these experiments mortality rates do not seem to be directly related to the degree of crowding or to fatness of the stocks. It seems probable that some of the mortality was caused by damage in handling. This would produce (without other complicating factors) a uniform percentage mortality throughout all the stocks. Differences in the percentage mortality in the different plots must have been brought about by conditions particular to the various plants.
10. In the case of plants directly onto the bottom, mortalities were higher in shallow than in deeper water. This may have been related to the differential effects of planting in the two depths. In shallows there is less water to break the fall of oysters and more are likely to be buried or half-buried in the bottom and die than in deeper water.
11. In trays there appears to have been little difference in the mortalities at the various depths.
12. Differences in exposure to wave action, however, does seem to effect survival in trays. The strong circulation of water in exposed places reduces mortalities seeming to provide more even chances of survival no matter how badly the oysters are crowded.

Effect of Relaying at Different Seasons on the Condition of Oysters

Seven times during the season at critical points in the annual cycle of condition changes, oysters were fished from Ellis cove in Bideford river, P.E.I., and half the catch transferred down-river to separate marked plots on the barren parts of the lease of Stanley Williams. The other half of the catch was in each case taken back and planted as a "control" on a separate plot on its native bed in Ellis cove. The oysters were fished from the same depth of water each time (about 5' at half tide) and planted in the same depth. As regards shape and hardness of shell and fatness and flavour of meats, quality in Ellis cove is very low.

Concurrently with the above, similar transfers were made from the Cooper bed, where quality is high, to plots just west of the station warch use where conditions approximate those in Ellis cove. The half of each lot that was to be used in the control experiment was taken back to a marked area on the Cooper bed.

After being fished the oysters (about 200 in each lot) were always kept ashore for a proximately 24 hours before being returned to the water. In this interval the shells were cleaned in the usual way on the culling table. After this a groove was ground into the thick hinge end of the shell of each oyster. This mark identified all the experimental stocks. The plots were marked with stakes driven into the bottom 15 to 20' apart and the oysters planted about each stake so that they were scattered about 6" apart on the bottom. In cases where there were oysters on the plot to start

Condition indices for relaid Ellis cove stocks

Date	UD <sub>1</sub>	UD <sub>2</sub>	UD <sub>3</sub>	UD <sub>4</sub>	UD <sub>5</sub>	UD <sub>6</sub>	UD <sub>7</sub>	UD <sub>8</sub>	Stage in Condition Cycle
May 9	58								Middle of spring decline
June 12		45							Beginning of Spring rise
	18	80	65	66					Half way up spring rise
July 4	91	89	67	66					At Spring Maximum
	29				48				Post spawning Minimum
Aug. 21						78			Half way up full rise
Sept. 9							59		Near full maximum
	24	137	122	119	101	83	102	76	At full maximum
Nov. 6	144	131	106	124	105	104	78	62	Onset of hibernation

Date	UU <sub>1</sub>	UU <sub>2</sub>	UU <sub>3</sub>	UU <sub>4</sub>	UU <sub>5</sub>	UU <sub>6</sub>	UU <sub>7</sub>	UU <sub>8</sub>	Middle of spring decline
May 9	58								
June 12		45							Beginning of spring rise
	18	57	75	66					Half way up spring rise
July 4	58	54	65	66					At spring maximum
	29				48				Post spring minimum
Aug. 21						78			Half way up fall rise
Sept. 9							59		Near full maximum
	24	76	63	72	68	70	68	--	At full maximum
Nov. 6	71	79	66	62	69	74	55	52	Onset of hibernation

Supplementary tests -- Oct. 14. UU stock -- 67

Condition indices for relaid Cooper bed stocks

Date	DU <sub>1</sub>	DU <sub>2</sub>	DU <sub>3</sub>	DU <sub>4</sub>	DU <sub>5</sub>	DU <sub>6</sub>	DU <sub>7</sub>	DU <sub>8</sub>	Stage in Condition Cycle
May 13	101								Middle of spring decline
June 12		99							Beginning of spring rise
	24	101	93	109					Half way up spring rise
July 4	83	85	95	110					At spring maximum
	29				84				Post-spawning minimum
Aug. 21					104				Half way up full rise
Sept. 9						120			Near full maximum
	23	72	78	88	82	78	94	109	At full maximum
Nov. 6	74	73	76	66	77	91	107	114	Onset of Hibernation

	DD <sub>1</sub>	DD <sub>2</sub>	DD <sub>3</sub>	DD <sub>4</sub>	DD <sub>5</sub>	DD <sub>6</sub>	DD <sub>7</sub>	DD <sub>8</sub>	
May 13	101								Middle of spring decline
June 12		99							Beginning of spring rise
	24		109						Half way up spring rise
July 4	105	128	--	110					At spring maximum
	29				84				Post-spawning minimum
Aug. 21					104				Half way up full rise
Sept. 9						120			Near full maximum
	23	145	115	128	111	125	124	109	At full maximum
Nov. 6	115	123	108	123	--	124	97	114	Onset of hibernation

with they were removed before the experimental planting was made. No difficulty was experienced in distinguishing the stocks.

In identifying the stocks the following abbreviations were used:

UU - is Ellis cove stock planted back in Ellis cove

UD - is Ellis cove stock planted down-river.

DD - is Cooper bed stock planted back on the Cooper bed

DU - is Cooper bed stock planted up-river

The numbers, 1, 2, etc. indicate the position of the sample in the series of transfers.

A condition test was made on a sample of each of the seven lots as they were fished. In addition these series of special tests were made (just previous to the years' first spawning, just when the oysters were at their fall maximum and just previous to hibernation) on all stocks that had been transferred up to that particular date. The results of the tests appear in tables 4 and 5. From these several points are clear.

### Conclusions

#### General Conclusions

1. Cooper bed stocks were always fatter than Ellis cove stocks.
2. The results, particularly for the "D" stocks, support the conclusions set forth in the recent publication on the fatness of oysters (Medoof and Næedler 1940).
3. No careful observations were made on mortalities in the various transfers but the writer's impression is that stocks suffered losses in this order (highest to lowest) -- UU, UD, DU and DD.
4. The results suggest that UD stocks improved in the D areas even after the water temperature moved out of the 15-20°C

band which is most favourable to feeding and fattening. The reason for this is not clear.

5. The uniformity of the 1941 results for "D" stocks show the advantages of careful sampling because in other years the results for the Cooper bed were never so consistent with what we now know of the general course of fatness changes, (Kedcof 1939 and 1940).
6. In the end oysters that had been disturbed (fished and relaid on their own native beds) were fatter in most cases than undisturbed oysters in the same places. The effect was most conspicuous in stocks relaid just at the beginning of the spring rise in condition (UU<sub>2</sub> and DD<sub>2</sub>). These gained an advantage over undisturbed stocks that obtained throughout the whole season.
7. Disturbance when the water was cold (below the 15-20°C band) produced at least a temporary depression in fatness - compare UU<sub>1</sub> and DD<sub>1</sub> with UU<sub>4</sub> and DD<sub>4</sub> respectively on July 4, and UU<sub>7</sub> and DD<sub>7</sub> with UU<sub>8</sub> and DD<sub>8</sub> on November 6.

#### Conclusions from Relayings in New Areas

8. Up-river stock always fattened when taken down-river. In some cases they became even fatter than the native down-river stocks (UD<sub>1</sub> and UL<sub>2</sub> on November 6). The reason for this is not clear. Compared with the undisturbed native stock in Ellis cove (listed as UU<sub>8</sub> in table 4) the UD<sub>1</sub> stock improved over 70 points in index of condition as a result of the transfer.
9. Down-river stock always got thinner when transferred up-river. The index of condition of the DU<sub>4</sub> stock was 50 points lower than that of the undisturbed Cooper bed stock (listed as DD<sub>8</sub> in table ). This falling off may have been affected by heavy growths of algae that formed in mats over the bottom in up-river areas.

This growth must have seriously interfered with water circulation and hence with fattening.

10. The results of the UD transfers indicate that their improvement in the "D" area was roughly in direct proportion to the length of time they spent down-river. Similarly in the case of the DU stocks the fatness decline was proportional to the length of time the oysters spend up-river.
11. There were two exceptions to the above rules: (a) Up-river oysters in very poor condition after spawning (UD<sub>5</sub>) did not attain the same fatness in the fall as UD oysters transferred just before or just after this stage in the cycle of condition changes. (b) Down-river oysters shifted to up-river areas just at the time they were beginning to spawn (DU<sub>4</sub>) suffered a depression in fatness from which they did not recover. This same condition was encountered in the Buctouche-river-to-Buctouche-bay transfer made in July of 1940 (Medcof 1940)

### Discussion

There are certain features of the experiment just reported that make its repetition, at least in part, advisable. In the first place the 1941 season was typical because of abnormally low water temperatures. Although this seems to have had little effect on the general cycle of fatness changes, it is possible that some different results might have been obtained for transferred stocks had the season been warmer.

A defect in the design of the experiment is that there were not enough of the complete series of tests done to show a clear picture of changes in fatness brought about by transfers.

Ideally tests should be made on each fishing date on all stocks transferred up to that date. Such an expansion of the experiment would require much extra work.

The U stocks always showed considerably more individual variation in fatness than D stocks and were therefore less suitable as experimental stock. In any partial repetition, therefore, Cooper led stocks would be preferable to up-river oysters.

In the above conclusions and discussions it has been assumed that all the effects on fatness were introduced more or less directly by transplantation itself. This is not necessarily true. Transfer may have produced a difference in shell growth and may have thus indirectly influenced fatness as was suggested earlier (Medcof 1945). More attention should be paid to this feature in the future.

If it be assumed that conditions in the Malpeque Bay area are typical, certain points discussed above have a practical significance insofar as the fatness of the meats of oysters is concerned. If, for public health or any other reasons, oysters must be handled during the same season in which they are marketed, these precautions should be taken to avoid thin meats.

1. If possible, they should be moved down-river not up-river.
2. They should not be handled when they are spawning or when they are in the depressed post-spawning condition. This conclusion is supported by earlier experience as well as by the results of the present experiment.
3. The best time to move oysters seems to be in the spring just before the spring rise in condition or in the early stages of the spring or fall rise in condition.

Effect of light on the condition of mollusks

Further tests were made this year on samples of mollusks (preserved in formalin) from the experiments on light discussed earlier (Medcof 1939 and 1940). Samples of mussels from Cape Breton were taken on November 17, 1940. These were of the 1939 brood that settled naturally in the tray and were selected at random from large numbers. Bideford river lots were taken on September 25, 1940. The results of condition tests appear below and data on shell proportions have been kept on record by the writer and by Dr. C. J. Kerawill.

Results for Mussels in Cape Breton Experiment

Locality	Dark Section	Glassed section	Screen section
Stoney point	37	44	50
Gillis Cove	44	45	51

Results from Bideford river Experiment (by Dr. C.J. Kerawill)

Mollusk	Dark section		Section covered with "Celloglass"		Differences	
	1940	1939	1940	1939	Dark - 1940	light - 1939
Mussels	63	20	80	52	17	32
Oysters	68	73	80	96	12	23
Quahaugs	52	45	52	59	0	14

There were certain differences in the way in which the "light" experiments were conducted in 1939 and 1940 which may have influenced the results. Dr. Kerwill kept the "oelloglass" cover cleaner in the second year. In contrast the Cape Breton experiment received less attention. The covers became very dirty and the experimental animals were allowed to become matted over with growths of various types.

The results for the Kerwill test show that there is a difference in the extent to which light affects the index of condition of the three species tested. The mussels are the most sensitive, the oysters next and the quahaugs least of all. It is seen that in 1940 there was no difference whatever between index of condition for quahaugs in light and dark.

The Cape Breton experiment which was described in part last year, showed that there was little difference between the index of condition for oysters in the three compartments of the tray. The results listed above show that there was a difference in the case of the mussels. This supports the conclusion from the Kerwill experiment that the mussels are more susceptible to light than the oysters. Just why one species should be more sensitive to light than another is not apparent but differences in shell thickness and transparency to light may be partly responsible.

Effect of light on the growth of mussels

On September 17, 1940, in connection with tests on the effect of light on condition of mollusks, length measurements were made on mussels that set naturally in 1939 in the various compartments of the light trays at Gillis cove and at Stoney point, N.S. The results are presented here although they cannot be regarded very critically. As explained above the glass in the lighted compartments was so badly clouded with growths of various kinds that the light probably did not penetrate very well.

Source	Dark section		Light Section		
	No. of specimens in sample	Median S.I.R. mm.	No. of specimens in sample	Median S.I.R. mm.	
Stoney point	85	25	78	25	2.0
Gillis Cove	86	25	65	22	3.5

S.I.Q.R. = semi-interquantile range

In spite of their roughness the results agree with those obtained by Kerwill in the Bideford river experiments. They indicate that where any difference occurs the mussels in the lighted sections grew less than those in the darkened compartments.

Relation of Condition of Oysters to Shell-growth and  
shell-proportions

This year observations on the 50 oysters in the submerged tray on the Poirier bed were continued. The data, summarized in table 6, support last year's conclusions and permit certain others.

Growth

During the winter there was no appreciable growth either in volume or in linear dimensions which is opposed to Galtsoff's claims (Galtsoff 1934 and 1936).

A very slight growth of shell, as thin as tissue paper and less than one sixteenth of an inch wide, was observed in a small percentage of the oysters examined on May 24. However, almost all the year's marginal shell growth took place during the spring fattening period - that is to say, after the water temperature reached 15°C but before spawning. A description of shell growth of the native stocks on the Poirier bed is to be found below in the section "Relation of Marginal Shell Growth to Condition"

Growth in volume followed a different course. The greatest increase took place during the spring fattening period but some went on during the summer period of low index of condition. A greater increase occurred during the fall fattening period and this continued into the period of fall decling.

### Thickness Changes

In addition to the observations listed last year, measurements were made of the thickness of the oysters as well as length and width on each observation date. These data permitted the calculation of the ratio Thickness : Length which shows an interesting cyclic change with season. It was high in the spring. The evidence indicates that there was probably no change in its value during the winter because there was no appreciable change in either volume or length from October 29, 1940 to May 24, 1941.

After the temperature rose to 15°C and shell growth became active the value dropped suddenly. It was observed this year as in 1940, that in spite of this shell growth, there seemed to be little increase in the "useful" space between the shells. This was because the fresh "shoot" on the upper valve remained flexible and when the oyster was closed, lay in contact throughout its whole extent with that of the lower valve. In some cases the shoots from the two valves even flared apart at their free margins, being in contact with one another only at their anterior margins.

During the summer the ratio remained almost unchanged during which time there was a very slight increase in volume but none in length. Not till the so-called "fall fattening period" was practically over did the value of the ratio show an increase. There was no observed increase in length accompanying this increase in thickness, although an increase in volume did take place. The length and volume values for October 28 (Table 6) would have been:

higher if the oysters had had better handling the last time the tray was hauled. The rough usage was reasonable for breaking the margins of several. This accounts for the apparent shrinkage of the mean length from 94 to 92 mm. in the interval September 19 to October 28, (Table 6). The 1940 data (Medcof 1940), which were not so influenced, indicate that at this stage in the annual cycle there is no marginal shell growth but that there is a slight increase in volume.

It should be noted that the final value for the thickness ratio was almost the same as it was in the spring. Had it not been for the rough handling, the approximation would probably have been even closer. This autumnal return to spring values is additional evidence, if any were needed, to indicate there is no change in thickness during the winter months.

#### Thickness Changes in Cooper Bed Oysters

It was considered that growth of oysters in the submerged tray might be abnormal and that changes in shell proportions such as the thickness : length ratio might be different in the case of oysters growing naturally on the bottom. To check this, measurements were made on samples of "cup" oysters taken from the Cooper bed at various times during 1941 and the ratio calculated. In 1939 measurements were made of all the oysters used in the conditions tests. It was therefore possible to calculate values of the ratio for that year too, although the numbers of oysters on which the measurements were made were smaller. The results of the two years' observations are listed in table 7 .

From this it will be seen that the value of the ratio

for Cooper Bed oysters goes through the same cycle as that described for the oysters in the submerged tray on the Poirier bed in Shediac bay.

#### Relation of Thickness Changes to Index of Condition

The present data show that there is a definite "Swelling up" of the shells in the fall as was suggested last year. The 1940 data proved that the value of the ratio Shell Capacity: Shell Volume varied with season in much the same way as does that of the thickness ratio just discussed. The latter change now appears to be the basis for the former. As nearly as can be judged, the shell capacity is not greatly influenced during the spring and early summer, by marginal shell growths. It may be affected to some extent by the development of chalky deposits on the insides of the shell but this is difficult to estimate. At any rate the shell capacity may still be considered as a suitable index to size during the spring and summer. This belief is supported by the values obtained for the ratio for Cooper bed oysters in 1940 (Medcof 1940). These remained almost constant until after spawning but rose again in the fall after the fattening was well on the way. The rise continued for some time after the fall maximum of the index was reached. Because of this last peculiarity it may be necessary to alter the present interpretation (Medcof and Needler 1940) of some phases of the index of condition cycle.

Table 7

Values of Ratio  $\frac{Z}{L} \times 100$  for Cooper Red oysters

Date	Mean value of ratio $\frac{Z}{L} \times 100$	No. of oysters
1939		
Spring	Probably about 36	None
July 29	31	10
August 22	32	10
October 4	33	10
November 13	34	10
November (late)	36	10
1941		
May 15	36	4
June 24	33	10
July 29	31	25
August 22	32	25
September 23	32	35
November 19	36	25

The fall decline may not involve a real loss in the weight of oyster meats because of a supposed unbalance between anabolism and catabolism. Given the fall increase in shell capacity just described, a decline in the index would be expected even if there were no change in the actual weight of the meats. Data on the shells of the Cooper bed, Wilbur bed, and Poirier bed oysters (Medcof 1940) indicate that the decline in the index of condition would amount to 5-10% of the maximum fall value if the meats remained constant in weight while the increase in shell capacity occurred. Observations indicate that the actual declines are of this order. More data should be gathered before a statement is possible, but the "fall decline" in condition may yet be explained without resort to the proposed theory of temperature regulation of feeding activity.

Relation of Marginal Shell Growth to Condition in Poirier Bed Stocks.

For comparison with results from oysters in the submerged tray, samples of "natural" oysters were gathered more or less regularly from a marked area on the Poirier bed and measurements made of the 1941 shell shoot. There was no difficulty in distinguishing this from the 1940 growth because of its cleaner whiter appearance until the end of August. By this time the 1941 growth had become discoloured and impossible to distinguish with certainty. After this date examinations were made but there seemed to be no more 1941

Table 8

Showing numbers of oysters with various amounts of 1941 shell

		Sampling date	0	0-1/16"	1/16-1/8"	1/8-3/16"	3/16-1/2"	No. of oysters in sample		
	May	21	39	1					40	
Spring	"	23	7	3					10	
decline	"	26	4	3	2				9	
	"	31	4	4	4				12	
	June	3	5	5	4	1			15	
Spring	"	7	2	6	7				15	
Fatten- ing.	"	17	0	9	9	6	2		26	
			0	0-1/8	1/8-1/4	1/4-3/8	3/8-1/2	1/2-5/8	5/8	
	"	21	1	3	7	5			16	
	"	23	0	2	10	3	2		17	
	July	2	0	12	32	19			63	
Spawning	"	10	0	0	10	5			15	
	"	17	0	1	5	6	5	1	18	
	"	23	0	0	6	4	5	2	17	
	Aug.	4	0	0	5	2	7	3	2	19
Fall	"	13	0	1	2	6	6	2	17	
Fatten- ing.	"	29	Can't distinguish 1941 shells from 1940 any more							

shell formed. The observations are summarized in table 8.

Internal growth.

Before any marginal shell growth was apparent externally it could be detected by opening the oysters. Several showed a thin lamella of new shell extending from the posterior ridges (fig. 3) to near the free edge of the shell. This lamella was white and brittle on the lower valve and pale yellow and flexible on the upper. On May 23, 80% of the oysters lacking external shell growth had formed such lamellae. Shell growth did begin therefore before spring fattening started.

External growth.

It will be seen that a small amount of shell shoot appeared during the spring decline in condition (when the water temperature was between 5 and 15°C. However, the important growth of the year took place during the spawning period and possibly a little during the early stages of the fall fattening but after this, apparently none.

Perhaps 1941 was not the best year in which to make such a study with the expectation of typical results because water temperatures were below normal. The results do agree in general with those obtained from the study of oysters in the submerged tray.

There is some evidence from the frequency distribution in table 8 to suggest that shell growth takes place in sudden spurts with considerable intervals between in which there is none.

### Summary

1. There was no appreciable change in size or shape of the oysters during the winter months.
2. Extensive marginal shell growth took place at only one time during the season and that was during the spring fattening period.
3. The value of the ratio Thickness : Length falls off during the spring period of marginal shell growth and does not increase until the fall when the valves swell apart.
4. In spite of the new marginal shell growth the shell capacity does not increase until late in the season when the thickness ratio increases.
5. The fall rise in shell capacity may explain the fall decline in the index of condition without resort to the theory of temperature effects on feeding.
6. In spite of the disturbances on the observation dates the tray oysters showed the same cyclic features as those growing "naturally" on the beds.

### Chalky deposits on Oyster Shells

During 1941 samples of oyster shells were examined for chalky deposits like those described last year (Medcof 1940)

In studying the deposits they were classified first as to whether they occurred in the upper (right) or lower (left) valve.

The position was further described as marginal or medial. There are raised areas around the margins of the shell valves that fit snugly against one another when the shell is closed. If a deposit was associated with one of these raised areas it was regarded as "marginal". All other deposits were listed as "medial". One exception to this was the deposit which forms after mid-summer in the pocket under the hinge at the extreme anterior end of the lower valve. This, although not associated with the marginal ridge, was listed as marginal.

In order to complete the description of position, the shell was divided radially into sectors as illustrated in figure 3 . The position of a particular deposit could then be described, for example, as "lower valve, marginal, posterior-ventral".

Of the medial deposits two were so regular in position and order of appearance that they were given numbers to describe them.

Number 1, the first chalky deposit of all to appear in the spring, is the long narrow one filling the depression at the anterior end of the advancing adductor muscle scar. Number 2, generally the second formed, is the one just posterior to the adductor muscle scar. Both of these have been discussed in last year's report (Medcof 1940).

The most detailed 1941 observations were made on Poirier bed shells. They are summarized in table 9, and will be used as the basis for discussion. Cooper bed

observations are summarized in table 10 and are in accord with the conclusions from the Poirier bed data. Last year's records are more comprehensive in scope since they involve Bras d'Or lake oysters. Bras d'Or oysters show certain peculiarities as was pointed out last year but these serve only to strengthen and extend general conclusions.

#### Time of Appearance

The earliest observations showed the interior of the shells to be bare and smooth as they were the previous autumn. Chalky deposits were not found in any of the Poirier bed shells examined before June 7. On this date minute number 1's, all less than one square millimetre in extent, were present in a few oysters. All the oysters with deposits showed a margin of new shell at least one eighth of an inch wide. Clearly, there was no chalk formation until after marginal shell growth was well advanced. The #1's appeared simultaneously in both valves but were commoner in lower than in upper. Soon they were to be found in almost every oyster but before the end of June their abundance fell off. Unlike chalky areas in other parts of the shell, the #1's seem to be covered over by hard nacreous shell soon after their formation. If this is true then they must continue to be formed till fairly late in the summer.

In general, the #1 deposit appears first as a small patch at the dorsal end of that long narrow depression at the anterior end of the muscle scar. A similar one forms at the

DATE	# 1		# 2		Posterior Dorsal (Exocent)		DORSAL		ANTERIOR DORSAL		L
	L	R	L	R	L	R	L	R	L	R	
	June	4	2								
" 17	15	5	8	3		1				1	
" 23	9	3	13	11	4					2	2
July 2	7	5	9	9	5			1			
" 10	7	4	11	9	6	6	1				3
" 14	6	2	13	12	7			2			2
" 23	5	3	7	9	4	6		2			1
Aug 4	8	8	14	13	12	5	5	6	1		3
" 13	4	4	12	9	4	1				1	7
" 24	1	1	5	4	2	1	2			2	1
Sept 15				2	1		1				
TOTAL	66	38	92	91	46	20	10	12	4	3	19

June 7											
" 17					1						
" 23					2		2	1			
July 2					5					2	
" 10					6	1		1			
" 14					9						4
" 23					7	1	1				2
Aug 4					12		2	2	1		5
" 13					6		1				4
" 24											1
Sept 15											
TOTAL					48	2	8	4	4	0	16

# Deposits

Location	Anterior	Ventral	Ventral	Ventral	Posterior	Number of Oysters	Notes on Deposits
R						15	4 All minute; less than 1m
						17	15 * 19 #2 / larger; rest small
1	1	2			2	18	16
	1	1				13	13
		4	2	2	2	19	16
	2	2	2	1		17	17 Confluence beginning
1	3	1ms	6	7	1	16	16 Confluence General
2	2	1ms	7	6	2	14	14 Confluence Complete
2	1		3	4	3	14	14 Coverage beginning
1	1	2	1	2	1	10	7 Coverage in progress
			1			10	6 Coverage advanced
			1			10	7 Coverage almost complete
9	8	7	28	20	10	7	2 159 133

## MAL Deposits

					2	
			2		1	6
			4			1
			5		2	6
4	2					1
2	1		13	2	2	6
7	1		3		6	6
2		2	2	1	2	4
		1				2
15	5	3	35	3	16	0
					32	0

Total no. of deposits

Medial 487

Marginal 191



Table 9

Showing the numbers and positions of  
chalky deposits on shells of Poirier-  
bed oysters on various dates.  
"R" and "L" indicate right and left  
valves respectively.



Date	# 1		# 2		Past Dorsal (Excurrent)		Dorsal		Medial Ant. Dorsal		AN L
	L	U	L	U	L	U	L	U	L	U	
	May 15										
June 12	4	3									
" 26	2	5	2	2							
July 9	4	1	3	2	1						
" 29	6	3	4	5	5	4			1		
Aug. 21	3	2	6	6	3	1					
Sept. 9		1	2	2	2	1					
Total	24	15	17	17	11	6			1		

May 15	
June 12	
" 26	
July 9	
" 29	
Aug. 21	
Sept. 9	
Total	

Marginal		Ant. Dorsal	AN
	1		
	4		2
	2	2	3
	1	1	1
	8	3	6

Deposits

	Ant. Ventral	Ventral	Post. Ventral	Dorsal	Number of oysters	Notes on deposits
U	L				Exam-ined with	
					10	0
					10	5 all less than 1mm <sup>2</sup>
		1	1		10	9
			1		9	6
					10	8 Confluence
1	2	2	4	4	1	10 10 Confluence & leverage
			1			10 5 Coverage addressed
1	2	3	6	5	1	69 43

To submit the numbers and positions of clearly defined deposits on oyster beds of various dates. "I" and "J" indicate upper and lower valves respectively.

Deposits

		3	1		
4ms	2	2	3		
	2	3	2		
		3	1		
2	4	11	1	6	

Total no. of deposits

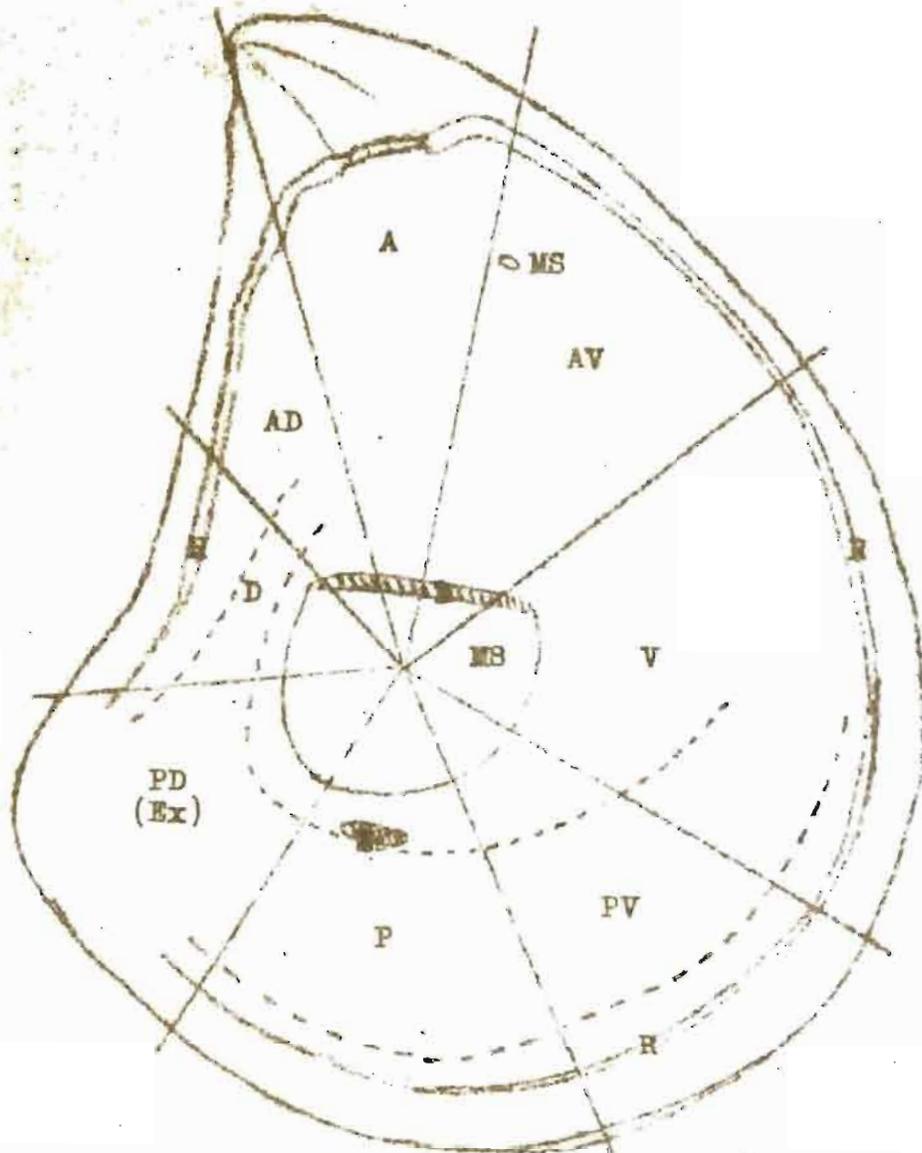
medial 109

marginal 42

Table 10.

Showing the numbers and positions of  
Chalky deposits on shells of Cooper  
bed oysters on various dates.  
"U" and "L" indicate upper and lower  
valves respectively.

Figure 3 . Diagram of lower (left) valve of an oyster shell illustrating features of interest in the study of chalky deposits.



**Legend:**

- |                               |                      |
|-------------------------------|----------------------|
| 1. Position of deposit #1.    | V Ventral            |
| 2. " " " #2.                  | PV Posterior-ventral |
| MS Muscle scar;               | P Posterior          |
| Dotted outline shows position | PD " -dorsal         |
| of grooves in oyster shell.   | (Ex) Excurrent area  |
| R Marginal ridge.             | D Dorsal             |
| Radial Sectors of Shell       | AD Anterior-dorsal   |
| A Anterior                    |                      |
| AV " -ventral                 |                      |

ventral end then the two patches extend medially until they meet. The probable significance of this deposit has been discussed already (Medcof 1940).

The #2's appeared next - first commoner in lower than in upper but by the end of July present in both valves of almost every oyster. No nacreous shell covered these until late in the season when a general coverage of all chalky areas, (except the #1's already covered) took place.

The next in order of appearance were the deposits in the excurrent area although these were followed closely by those in the incurrent regions. By the middle of July there were so many chalky areas as to obscure any order. By this time too, many deposits had extended so as to produce a confluence of formerly isolated patches. By August 4, the deposition was practically over and a general coverage of the chalk by shiny nacreous shell began. This appeared first as a narrow ring about the margin of each deposit and very thin. It gradually extended and thickened. By September 15, the end of the fall fattening period, few areas were left uncovered; by October 8 none were exposed. Medial deposits were later being covered than marginal.

#### Frequency and Position of Deposits

Tables 9 and 10 show that deposits not only occur earlier but are also much commoner in the lower than in the upper valves. They are distributed, however, in much the

same way as regards frequency and position. Some effects of this concentration of chalk in the lower valves are discussed in last year's report.

The medial deposits are commoner on the whole than the marginal and their frequency distribution in the various radial sectors is not always similar. Of the medial deposits the commonest are the # 2's; the #1's are next, then those in the excurrent (posterior dorsal) area. Those in the middle of the incurrent area (ventral) are common as are also those in the anterior region. Very few deposits were found in the medial dorsal position in the groove described last year.

When considering marginal deposits it will be seen that the difference between the frequencies in the upper and lower valves is even greater than in the case of medial deposits. There are few marginal deposits in upper valves. This may be because the soft margin of the upper (right) valve can accommodate itself to the lower without aid of chalk. The commonest marginal deposits were in the excurrent (posterior dorsal) region. There are also large but fewer numbers in the incurrent regions - ventral, posterior-ventral and posterior. Quite a few deposits form at the extreme anterior end in association with the hinge. In the lower valve the articulating surface of the hinge extends posteriorly during growth producing below it a small anterior pocket, roofed over and partly isolated from the rest of the shell cavity. For some reason the oyster abandons this recess, filling it in with shell, sometimes with chalk in late summer. This practice is reminiscent of the way certain snails abandon the smaller upper whorls of their shells as they grow larger (Medcoe 1940.)

Eventually this deposition makes the oyster shell thicker here than at any other place.

Chalky deposits are rare on the marginal ridge in the dorsal and anterior dorsal positions. In these regions there is no flow of water into or out of the shell.

Compared with the Poirier bed stocks, Cooper bed oysters develop only about half the number of chalky deposits, and these are smaller in size. The Cooper bed oysters are of a much more regular shade. This agrees with last year's observations which showed that better quality oysters have fewer and smaller chalky deposits.

#### Seasonal Changes in the Shell Interior of Oysters

Last year certain observations were made on the coverage of chalky deposits by nacreous shell. In 1941 records were kept of the appearance of the inner surfaces of all the oysters used in the condition test. Besides this, a study was made of several series of preserved shells of oysters used in the 1940 condition tests. The extent of the yellow blotches described by Orton and Amirthalingam (1927) and the sheen of the general surface of the shell interior, will be discussed.

#### Sheen

At all seasons of the year the marginal regions of the inner surface of the shell were glossy. The medial areas were sometimes glossy and at other times had a dull "flat" appearance. In the latter condition the surface was sometimes covered by a thin film of chalky material that was soft enough to be scratched off with the finger nail. This condition was described as "soft flat" in

recordings. At other times, although the surface gave this flat appearance, there was no such film. The surface then was very hard and could scarcely be scratched even with a knife blade. This condition was described as "hard flat". The observations are summarized in tables 11-16. The most detailed observations were those on Poirier bed oysters in 1941 (table 16) and these are used as a basis for discussion. The other data show the same features with only slight variations and help to complete the picture.

The central part of the shell, bordered by the glossy marginal ridge, had the "hard flat" appearance in the early spring. At the end of May before marginal growth became apparent but just when "internal" growth started (see section of this report headed "Relation of Condition of oysters to shell-growth and shell-proportions".) the whole shell interior took on a highly glossy appearance. This sheen continued until the time of, or shortly after the fall peak in condition in September. It changed fairly quickly then to "soft flat". This lasted for only a short while and during the fall decline in condition when the water temperature fell to about 10°C the "hard flat" surface appeared. It was with this shell condition that the oysters went into hibernation and apparently will so remain until the glossy appearance appears next spring.

Islands of chalky shell described in the part of this report headed "Chalky deposits on oyster shells" were

formed over the glossy surface starting in the middle of the period of marginal shell growth and continues through the post-spawning period of poor condition.

#### Yellow Areas

In studying a sample of shells the extent of the yellow patches on each valve was estimated and expressed as a percentage of the total area of the internal face. The average value for all valves was listed in tables with the dates for the sample concerned (tables 11-16). The tables show that there were yellow areas to be found on the inner surfaces of some shells at all times of the year. There was an increase in their extent during the post-spawning period of low condition. As the yellowness increased the chalky areas were covered. (See section of this report headed "Chalky deposits on oyster shells".) When the glossy appearance gave way to the "soft flat" the yellowness was greatly reduced. There was further reduction when the "hard flat" appearance developed. After this there was little change until the following spring.

Orton and Anrthalingam (1927) regard the blotches simply as regions of nacreous shell with a lime content lower than normal. They report finding it so free of lime that it could be peeled off in strips like yellow tissue paper. This extreme condition must be rare in our oysters or very transient for it was discovered in only two of the many shells examined. These were part of the Lorrain bed sample fished July 27, 1941.

The writer has found small sheets of similar flexible yellow material shutting off "chambered" parts of the shell cavity or covering some foreign object within the shell. Iunz (1941) has shown that such a film is present in the partitions built over the blister worms, *Lolydora*. The work of Brook (1905) quoted by Truitt (1931) and of Douville (1936) and others indicate that this layer is almost pure cochyolin and that such sheets are the basement membrane for the development of normal nacreous shell.

The present data show that yellow blotches occur rarely in the region of the marginal ridge but that they may appear at random in the medial regions. In many cases, however, they seemed to be deliberately formed as when found about the stopped-up ends of shell perforations caused by *Clione*.

Table 11.

Appearance of shell interiors for Cooper bed oysters

Date	Yellowness	Character of Inner Surface
1940		
July 10	Covers up to 30% of the shell	glossy
26	Common: covers up to 75% of shell	glossy
Sept. 10	Common: cover upto 50% of shell	glossy mostly: a few soft flats
24	Common but decreasing	All soft flat
Oct. 23	Much reduced: covers up to 20 or 25% of shell	all soft flat
Nov. 20	Further reduced but in some there is still as much as 20% of shell still yellow	2/3 hard flat rest soft "
1941		
June 12	Very little : 5% or less	glossy
24	" " " " "	"
July 4	" " " " "	"
29	Extensive: up to 90% in some shells	glossy: one or two show the start of soft flat surface
Aug. 22	Extensive but reduced	glossy but some few starting soft flat
Sept. 8	Extensive some up to 80%	50% glossy rest soft flat
23	Covers up to 50% of some	all soft flat
Oct. 14	Much reduced but still more than in June 1941	still soft flat

Table 12.

Appearance of shell interiors for Gillis Cove oysters

Date	Yellowness	Character of Medial surface
1940		
May 24	Very little : up to 5%	Almost all hard flat
June 3	" " " " "	" " " " a few faintly soft flats
14	" " " " "	Almost all hard flat
28	" " " " "	" " " "
July 12	" " : but some increase	Mostly all hard flats; a few glossy
Aug. 5	Same as in July	All glossy except where covered by chalk
24	More: up to 10-15%	All glossy
Sept. 5	Quite a bit: up to 30-50% mostly in uppers since most of lowers are now covered by chalk	All glossy
19	Quite a bit	Nearly all glossy: a few soft flats.
Oct. 1	Still quite a bit	Many glossy some soft and some hard flat
16	Decreasing	Mostly soft flats; some few hard flat and a few glossy
Nov. 4	Still up to 20-30% in some shells	Mostly flat soft; some glossy and some hard flat
16	Much reduced 5-10% now	All soft flat
Dec. 9	Only a little now	Mostly hard flats; some soft flat still though

Table 13

Appearance of shell interiors for South Gut oysters

Date	Yellowness	Character of medial surface
June 27	50% of shells have blotches covering about 15% of area	Hard flat (all)
Aug. 6	Less yellow 5-10%	Almost all glossy
28	Less than $\frac{1}{2}$ show it and these have up to 5% of shell yellow	All glossy
Sept. 12	Present in less than half the oysters and covering up to 20% of shell area in these	All glossy
25	Has increased three quarters of oysters have yellow blotches and in these it covers up to 20% of shell surface	Almost all glossy
Oct. 17	Less now: those that have it are yellow over 10-15% of their area	2/3 are soft flat; rest are hard flat
Nov. 2	Only half the oysters have any yellow and these it covers only 10-15% of the shell area	Almost all soft flat; one hard flat in the lot
15	Do. 15-20%	3/4 are hard flat; rest soft flat
Dec. 11	Nearly all white but some have up to 10% of shell area yellow	Almost all hard flat

Table 14.

Appearance of shell interiors for Malakawatch oysters

Date	Yellowness	Character of medial surface
1940		
July 5	Up to 30-50% of shell surface coloured	Hard flat
Aug. 5	Slightly less: up to 30%	Glossy
24	-----	Glossy
Oct. 1	Not very common but some oysters now have up to 50% of shell area covered	Nearly all soft flats: 1 or 2 hard flat
17	Further reduced: none have more than 30% of shell area yellow now	Nearly all hard flats: 1 or 2 soft flats.
Nov. 4	Further reduced: pract.cally none	All hard flat but one
15	Present in a few covering up to 10% of shell area	All but one are hard flat
Dec. 9	Very little: up to 10%	All but one oyster was hard flat: it was soft flat

Table 15

Appearance of shell interiors for Poirier bed oysters

Date	Yellowness	Character of medial surface
1940		
June 17	Little or none	All glossy
July 9	Common: up to 80-90% of shell area covered	" "
Aug. 13	Considerable increase: yellow ones have up to 80% of shell area coloured	" "
Sept. 7	perhaps a slight reduction	" "
18	A reduction: no oysters with more than 30% of shell area coloured now	3/4 of oysters are soft flat now
27	At most 20% of shell area is coloured now	All soft flat
Oct. 5	At most 10-15% is now yellow; oysters with yellow blotches are not common	All soft flat
23	Most oysters are now white; up to 10% of area of the others is yellow	About 90% of oysters are now hard flat
Nov. 22	Do. 10 - 30%	All hard flat

Changes in Specific Gravity of Oyster Shells on Drying

The specific gravity of samples of oyster shells from the Wilbur bed, Shediac Bay, N.B., and Gillis cove, N.S. were measured on March 11, 1942. These shells had been stored for a long while in the biological station and had had plenty of time to dry thoroughly. The average values obtained together with values obtained from measurements on samples of fresh shells from the same areas are listed in the table below.

Source of Shells	Date of Determination	Date shells were removed from water	Specific Gravity of shells
Wilbur bed	May 24, 1940	May 22, 1940	2.34
"	March 11, 1942	Sept. 7, 1940	2.32
Gillis cove	June 28, 1939	June 27, 1939	1.82
"	March 11, 1942	Sept. 5, 1940	1.59

The loss in specific gravity during storage was very low in the case of the Wilbur bed shells but high for Gillis cove. It has already been shown (Wedcof 1940) that the Gillis cove shells are much more chalky than those from the Wilbur bed. Presumably the changes are due to water loss due to drying and if this is the case Gillis cove shells must be more porous than those from the Wilbur bed. An experiment was designed to test this.

Water Absorption by Dry Oyster Shells

A hacksaw was used to cut pieces of shell from the valves of Foirier bed (Shediac bay, N.B.) and Gillis cove, N.S. shells.

Table 16

Appearance of shell interiors of Poirier bed oysters,

Date	No. of oysters examined	No. of oysters with yellow	Av. % of shell area coloured in those with yellow blotches	Character of medial shell surface
1941				
May 19	3	3	18	Hard flat
23	6	4	8	" "
31	4	2	2	In half the oysters glossy in rest hard flat
June 7	4	3	4	Glossy in all oysters
23	17	9	7	Glossy
July 2	14	9	8	Glossy
10	12	11	24	Glossy
23	13	10	31	Glossy
Aug. 4	16	16	41	
13	15	15	45	----
29	10	10	42	Mostly glossy: in a few a thin soft film is starting
Sep. 15	10	10	16	All oysters soft flat now
Oct. 8	10	9	9	All oysters now hard flat

The pieces were weighed while still dry and placed in a jar filled with sea water at the Biological Station on March 10, 1942. On March 16, the pieces were taken out, wiped dry, allowed to air dry on the laboratory table for two hours, then reweighed. The results are listed below.

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Description of shell Fragments	Weight before immersion gms.	Weight after immersion gms	% Gain in weight
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Gillis cove shells fished

May 24, 1940; air dried  
till March 10, 1942

*A. Piece from central region of a left valve (very chalky)	2.4	3.0	25
B. Piece from hinge area of same valve as last (much more nacreous material in it)	7.7	8.3	8

Poirier bed shells fished

Sept. 3, 1940; air dried  
till March 10, 1942

A. Piece from medial part of a right valve (almost pure nacreous shell)	4.1	4.1	0
B. Piece from marginal region of a left valve (a small amount of chalk in it)	7.8	7.8	0

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\* This piece had such a low specific gravity that it floated on the surface of the water throughout the whole six days of the experiment.

Shell Proportions of Mya Arenaria

In the spring of 1941 it was suggested by Dr. A.W.H. Needler that some condition tests might be made in the fall of the year on soft shell clams grown in experimental plots in Nova Scotia. If the same index were to be used as in the study of condition of oysters it would require a good deal of extra work. The reason for this is that shell capacity of a soft shell clam is difficult to measure directly. The shell is never closed as in the case of the oyster and moulds would have to be made between the valves and the volumes of these moulds measured. It was considered that linear measurements of the shells might be used in place of shell capacity for an expression for size in calculating an index to condition of a clam.

To study shell proportions two lots of clams were dug from the flats opposite the Poirier bed in Shediac bay, on May 27, 1941. These were taken from the same position on the beach, one lot being of slightly larger clams than the other. The lengths (greatest measurement from anterior to posterior ends of the valves), heights (greatest measurement from ventral to dorsal (hinge) border of the valve), and thicknesses (greatest measurement from right to left sides of the closed shell) were measured after removing the meats. Putty moulds were made of the space within the valves and the weights of each of these taken. The specific gravity of the putty used was also measured and the volumes of the spaces between the valves computed from these values. The data appear in table 17 below. Various ratios were worked out and these are also included in the table.

From the table it will be seen that there is considerable variation in many of the ratios. That which most nearly approaches a constant is the ratio Shell capacity : length. height.thickness

Table 17

Shell Proportions of Mya arenaria from Poirier bed flats, Shediac bay, N.B.

L Length mm	H Height mm	T Thickness mm	$\frac{H}{L}$	$\frac{T}{L}$	L.H.T.	Shell capacity mm	$\frac{L.H.T.}{S.C.}$	$\frac{L}{S.C.}$	$\frac{H}{S.C.}$
44	29	15	.66	.34	192	7.4	26	6.0	3.9
47	32	18	.68	.38	272	9.0	30	5.0	3.6
47	31	16	.66	.34	234	8.4	28	5.6	3.7
49	28	16	.57	.33	219	7.5	29	6.5	3.7
44	29	16	.66	.36	205	7.4	28	5.9	3.9
39	27	15	.69	.35	158	5.0	32	8.0	6.4
40	28	14	.65	.35	146	5.2	29	7.7	5.0
46	36	19	.64	.34	383	13.4	29	4.2	2.7
52	35	19	.63	.36	326	12.7	26	4.8	2.6
57	35	22	.63	.39	450	15.6	29	3.7	2.3
57	36	20	.63	.35	409	15.2	27	3.8	2.4
57	36	19	.63	.33	390	13.7	28	4.2	2.6
55	35	20	.64	.36	385	12.9	30	4.3	2.7
63	41	22	.65	.35	570	19.7	29	3.2	2.1

The average deviation of t is ratio from the mean is approximately 3% which is within the limits of experimental error in its determination. It would not be unreasonable therefore, to use the value length.height.thickness in place of shell

capacity in studying condition in a limited area such as the one just described. Further criticism of the value should be made on data for clams from different localities and from different levels on the flats before the value could be justifiably employed in extensive tests.

## Appendix 1

### Meteorology

The methods of observation were the same as described in the 1940 report (Medcof 1940). The times recorded are Atlantic Standard up to June 11, after which they are Atlantic Daylight Saving.

Metereology Shediac Bridge

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
May 16	9:00 p.m.	48	41	46	Fresh NE, raining (rained all yesterday and last night)
	6:00 p.m.	48	42	44	Cloudy; mod. N.W.
17	7:30 a.m.	50	42	50	Clearing; light SW
	6:35 p.m.	44	52	52	Fair; light NE
18	8:35 a.m.	55	49	52	Light rain; light E
	--				
19	8:15 a.m.	54	37	50	Bright; mod. W.
	2:30 p.m.	52	52	52	(check thermometer)
20	8:00 a.m.	52	44	48	pt. clear; mod. NE.
	5:35 p.m.	57	48	49	Clear; mod. NE
21	8:25 a.m.	56	34	56	Clear; light SW
	--				
22	8:30 a.m.	74	50	59	pt. cloudy; fresh SW
	5:25 p.m.	73	58	68	pt. cloudy; fresh SW
23	7:45 a.m.	68	50	60	pt. cloudy; mod. SW
	7:15 p.m.	77	52	52	Cloudy; mod-fresh NE
24	8:50 a.m.	52	46	46	raining heavily; mod. NE
	7:55 p.m.	46	39	39	raining heavily; NE gale
25	8:20 a.m.	41	36	41	raining; mod. NE
	-----	heavy winds, intermittent rain all day			
26	6:45 a.m.	55	33	41	Clear; light SW.
	5:45 p.m.	61	39	54	Clear; mod. E.
27	9:55 a.m.	54	37	54	Clear; mod-fresh E.
	8:40 p.m.	60	45	46	pt. cloudy; fresh E.
28	8:45 a.m.	51	32	51	Clear; mod. NE.
	8:10 p.m.	55	51	60	cloudy; mod. SW (rained during night)

Metēology Shediac Bridge

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
May 29	9:30 a.m.	60	44	44	Cloudy; fresh NW gale by noon, rain and snow
	8:50 p.m.	46	36	40	Clearing; light NW
30	7:35 a.m.	40	36	40	Cloudy; fresh NW.
	---- Intermittent showers all afternoon				
31	7:20 a.m.	55	38	50	Clear; mod. NW.
	5:25 p.m.	64	50	58	Clear; mod NE.
June 1	8:35 a.m.	64	37	64	Clear; light W.
	---- clear all day				
2.	8:00 a.m.	73	40	58	Clear; light SE.
	9:10 p.m.	68	55	58	Clear; light SE
3.	8:10 a.m.	58	48	51	Cloudy; strong N. by E
	7:05 p.m.	62	50	50	Clear; light NE.
4	8:10 a.m.	50	32	50	Pt. cloudy; light W.
	7:25 p.m.	74	50	60	Pt. cloudy; light SW.
5	8:55 a.m.	60	41	52	Pt. cloudy; mod. E.
	5:20 p.m.	60	52	52	" " ; fresh NE.
6	8:10 a.m.	52	44	52	" " ; mod-fresh N.E.
	7:25 p.m.	64	52	56	Clear; mod. E.
7	8:05 a.m.	60	37	60	Clear; light S <sup>W</sup> .
	7:00 p.m.	72	60	64	Pt. cloudy; mod. SE
8	8:40 a.m.	64	50	58	Cloudy; light SE
	---- pt. cloudy all day				
9.	7:20 a.m.	66	55	55	Cloudy; fresh W.
	5:25 p.m.	60	50	50	Cloudy; fresh W.
10	8:10 a.m.	50	42	46	Raining; strong NW.
	---- rained off and on all day; wind became near gale from the N.E.				

Daylight Saving time used from here on.

11	6:15 a.m.	46	42	42	Raining; N.E. near gale
12	pt. cloudy, warm				
13.	warm				
14	warm				
15	cloudy, wet				

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
May 16	9:20 p.m.	72	37	57	Pt. cloudy; still
17	8:35 a.m.	62	54	62	Cloudy; light SW rain last night
	7:05 p.m.	74	60	70	Clear; light SW
18	5:30 a.m.	70	53	53	Clear; still
	8:20 p.m.	82	53	67	Clear; light S
19	5:50 a.m.	68	54	58	Pt. cloudy; fresh SW
	8:05 p.m.	88	58	67	Fresh W; raining heavily
20	7:25 a.m.	68	56	58	light SW; cloudy & fog
	5:45 p.m.	64	54	54	Cloudy; mod. N.
21	8:35 a.m.	64	51	74	Clear; light SW
	----- very hot day, clear all day				
22	8:35 a.m.	93	64	78	clear; mod. SW.
	----- heavy shower rain in late p.m. and thunder				
23	9:00 a.m.	65	52	58	Clear; fresh NE
	7:40 p.m.	62	54	54	Clear; light E.
24	9:00 a.m.	58	39	58	Bright; mod. SW.
	7:50 p.m.	72	58	64	Cloudy; mod. NW.
25	8:30 a.m.	64	44	50	Clear; fresh-strong NW.
	5:25 p.m.	60	50	56	hail in p.m. Pt. cloudy; mod. N.
26	8:35 a.m.	58	36	52	Pt. cloudy; light NW.
	5:10 p.m.	58	52	52	Raining; light SE
27	8:55 a.m.	52	48	52	Cloudy; fresh E. rain p
	5:40 p.m.	55	52	54	Cloudy; fresh E.
28	9:00 a.m.	54	52	54	Heavy rain in night
	----- cloudy with showers all day				
29	8:20 a.m.	62	51	55	Heavy rain in night
	----- fair and warm all afternoon				
30	8:30 a.m.	81	48	55	Clear; light SW
	Clear all day				

Date	Time	Air temperatures		Present	Remarks
		Max °F	Min.		
July 1	8:00 a.m.	74	55	60	Pt. cloudy; light SE
	10:50 p.m.	79	60	64	Pt. cloudy; mod. SE
2	8:30 a.m.	65	60	63	Pt. cloudy; mod-fresh SW
	8:30 p.m.	90	62	78	Pt. cloudy; fresh NW.
3	8:45 a.m.	78	52	59	Bright; fresh NW
	7:05 p.m.	81	59	73	Bright; mod. NW.
4	8:55 a.m.	73	50	66	clear; light SW
	7:45 p.m.	76	66	70	Clear; still
5	7:40 a.m.	70	53	60	Clear; light W.
	5:35 p.m.	84	60	79	Clear; light SE
6	9:15 a.m.	82	58	72	-----
	----	warm all day with mod. to fresh SW			
7	8:35 a.m.	88	60	66	Clear; mod-fresh SW
	5:35 p.m.	78	66	74	Cloudy; fresh SW
8	8:40 a.m.	74	61	67	Light rain; mod-fresh SW
	7:10 p.m.	80	66	67	Cloudy; mod. SE
9	8:40 a.m.	68	60	64	Cloudy; light SE
	8:50 p.m.	70	60	60	Raining hard; light NW
10	7:30 a.m.	60	54	56	Heavy fog; still
	8:55 p.m.	75	56	70	Clear; light SW
11	7:40 a.m.	70	54	59	Clear; mod. SW
	8:05 p.m.	86 spawning	59	74	Clear; mod. SW
12	10:50 a.m.	74	61	70	Cloudy; still
	7:55 p.m.	72	62	62	Cloudy; mod. NW. Showers all day long
13	9:45 a.m.	63	56	56	raining; light NE
	----	rained all day			
14	9:00 a.m.	58	52	57	Pt. cloudy; mod. NW.
	6:25 p.m.	78	72	56	Clear; light SW
15	8:05 a.m.	72	54	63	Clear; mod. SW
	7:15 p.m.	90	63	78	Clear; light SW
16	6:50 a.m.	78	56	58	Clear; still
	----	clear all day			

Meteorology Shedding Bridge

Page 5

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
July 17	9:15 a.m.	74	58	64	Foggy: mod. SE
	5:50 p.m.	81	64	74	Cloudy: fresh SW
18	8:45 a.m.	74	58	66	Bright: mod-fresh SW
	5:30 p.m.	85	66	89	Bright: mod. SW
19	8:10 a.m.	79	56	62	Raining: light SE
	4:30 p.m.	79	62	86	Light rain: fresh SE
20	9:45 a.m.	78	66	72	Pt. cloudy: mod. S.
	---	Clear all p.m.			
21	6:45 a.m.	82	56	56	Pt. cloudy: light W.
	5:45 p.m.	82	55	77	Clear: mod. SW
22	8:40 a.m.	78	54	68	Clear: mod. SW
	6:00 p.m.	84	68	81	Clear: fresh SW
23	8:40 a.m.	81	61	69	Clear: fresh SW
	6:00 p.m.	84	68	76	Pt. cloudy: fresh SW
24	8:20 a.m.	77	63	71	Bright: fresh SW
	7:30 p.m.	92	71	84	Bright: fresh SW
25	8:55 a.m.	84	69	77	Pt. cloudy: fresh SW
	5:20 p.m.	80	68	69	Heavy thunder showers in p.m. Raining: mod. SW
26	8:55 a.m.	70	62	65	Pt. cloudy: mod. NE
	8:00 p.m.	70	61	61	Pt. cloudy: mod. NE
27	9:00 a.m.	62	58	60	Pt. cloudy: fresh- strong NE
	----				
28	9:05 a.m.	68	50	60	pt. cloudy: fresh NE
	-----				
30	6:15 p.m.	80	44	70	Clear: light SW
	-----				
31	8:40 a.m.	70	55	60	Pt. cloudy: light SW
	5:45 p.m.	87	63	83	Clear: mod. SW.

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
Aug. 1	8:45 a.m.	83	62	66	Cloudy: light SE
	7:30 p.m.	80	66	69	Raining: mod. SE
2	9:15 a.m.	69	61	62	Raining: mod. NE
	---- Intermittent rain in p.m. of 2nd, and all day 3rd. some heavy SE wind in 3rd.				
4	9:00 a.m.	68	52	56	Cloudy: mod. NW.
	8:20 p.m.	60	55	56	Showers in p.m.. fog: light NW.
5	8:40 a.m.	58	50	58	Clear: mod. NW
	7:35 p.m.	70	56	56	Raining: light NW
6	8:50 a.m.	56	48	56	Bright: mod. NW
	8:35 p.m.	77	56	66	Cloudy: mod. NW
7	8:40 a.m.	66	48	64	Bright: mod. SW
	7:05 p.m.	90	64	78	Clear: mod. SW
8	9:05 a.m.	78	62	68	Cloudy: mod. W.
	---- rain during evening				
9	8:05 a.m.	88	62	63	Raining lightly: light SE
	---- Cloudy all day: rain in evening				
10	10:15 a.m.	75	60	64	Raining heavily: light NE
	7:55 p.m.	65	57	58	Raining heavily: fresh NE
11	7:55 a.m.	58	50	56	Bright: fresh NW. Heavy rain last night
	7:05 p.m.	76	67	56	Clear: light SW
12	8:50 a.m.	68	48	58	Cloudy: fresh SE
	5:30 p.m.	62	56	60	Cloudy: strong SW
13	8:55 a.m.	60	42	53	Bright: fresh NW
14	9:05 a.m.	66	42	56	Clear: fresh SW
	6:15 p.m.	70	56	68	Bright: fresh SW
15	8:15 a.m.	68	56	58	Cloudy: light SW
	---- Fresh wind from SW all p.m. Clear and bright				

Date	Time	Air temperatures		Present	Remarks
		Max. °F	Min.		
Aug. 16	9:05 a.m.	78	58	62	Light rain; fresh SW
	6:40 p.m.	64	61	62	Showers all p.m. Rainings; light SW
17	8:35 a.m. ---- rained intermittently all day	62	57	57	Mod. N.E.; raining
18	9:15 a.m. ---- Mod. westerly winds and bright all day	60	45	58	Bright; fresh W
19	9:10 a.m.	73	50	64	Bright; mod. SW
	8:10 p.m.	78	66	66	Cloudy; light S
20	7:50 a.m. ----	64	56	59	Cloudy; mod. S.
23	3:10 p.m. ---- shower in evening	80	46	65	Bright; mod. SW
24	9:40 a.m. -----	72	55	65	Bright; mod. SW
25	10:00 a.m.	80	46	55	Cloudy; light S
	5:35 p.m.	62	54	62	Clearing; light SW
26	9:40 a.m.	68	56	64	Heavy rain this a.m. Pt. cloudy; fresh SE
	7:15 p.m.	79	64	70	Clear most of day Clouding up; fresh SW
27	9:00 a.m.	71	50	64	Bright; fresh SW
	5:45 p.m.	72	62	69	Bright; mod. SW
28	8:50 a.m.	70	46	52	Bright; strong SW
	5:30 p.m.	64	52	62	Bright; strong NW
29	9:55 a.m.	62	46	57	Bright; fresh NW
	6:15 p.m.	70	57	65	Bright; fresh NW
30	8:55 a.m. ---- showers intermittently all p.m.	66	48	57	Cloudy; mod. NW
31.	7:50 a.m. ---- fair all day	66	53	57	Clear; mod. NE
Sep. 1	8:05 a.m. ---- heavy showers in p.m. cloudy all day	70	51	52	Cloudy; mod. SE
2	8:55 a.m. ---- near Nw gale all day	61	52	54	Cloudy; fresh-strong NW

Date	Time	Air temperatures		Present	Remarks
		Max. °F	Min.		
Sep. 3	4:40 a.m. ----	59	50	50	Cloudy: mod. NW bright most of day with fresh NW winds.
4	9:00 a.m. 7:05 p.m.	72 73	47 58	58 59	Bright: mod. NW Pt. cloudy: still
5	8:50 a.m. 7:00 p.m.	60 58	52 54	55 54	cloudy: light SE Cloudy: mod. SE
6	8:30 a.m. ----	54	50	52	Cloudy: mod. SE heavy showers in afternoon
7	----				fair all day with mod. wind
8	8:20 a.m. ----	78	50	50	Pr. cloudy: mod. NW
9					Day clear with bright winds
10	7:35 a.m. ----	70	40	44	Pt. cloudy: light NW clear day with light winds
11	8:40 a.m. ----	67	43	59	Raining: mod. SW shower in p.m. rest of day mostly clear
12	8:20 a.m. ----	80	39	46	Bright: mod. NW day mostly clear: showers in evening.
13	8:30 a.m.	66	38	45	Clear: mod-fresh NW
14	10:10 a.m. ----	62	32	48	Cloudy: mod. SW clear all day: showers during night
15	8:40 a.m. ----	66	41	58	Raining hard: mod. SW raining in evening
16	8:45 a.m. ----	66	52	57	Clear: fresh NE fair most of day with fresh winds
17	8:30 a.m. ----	65	49	50	raining: mod. SE cleared in afternoon
18	9:00 a.m. ----	68	49	54	Bright: mod.-fresh NW clear all day with fresh breezes

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
Sep. 19	8:45 a.m. -----	62	39	43	Cloudy: mod. EW
20	9:00 a.m. -----	58	33	48	Bright: mod. NW
Oct. 8	8:30 a.m. ---- Cloudy in p.m. and rain in evening	85	28	55	Bright: mod. SW
9	8:40 a.m. ---- cloudy most of day: showers in p.m.	68	42	44	Cloudy: mod. NW
10	8:10 a.m. ---- cloudy all day: heavy rains at night	55	38	42	Cloudy: mod. SE
11	8:45 a.m. ---- strong winds all day rain and <u>snow</u> in p.m.	50	42	46	Cloudy: strong NW
12	---- clear all day with mod. winds: rain at night				
13	8:30 a.m. ---- fair all day with little wind	32	40	54	Clear: mod. NW
14	9:30 a.m.; ---- clear till evening then heavy wind and showers	56	30	50	Clear: mod. SW
15	8:45 a.m. -----	58	48	56	Clear: mod. SW
22	11:00 a.m. ---- clear all day	69	27	59	Clear: light NW
23	8:00 a.m. ---- clear most of day: heavy rain in evening and night	63	40	45	Clear: light SW
24	8:00 a.m. ---- clear all day with strong winds	60	34	38	Bright: fresh NW
25	8:30 a.m. ---- clear most of day with fresh and 2½" snow at night	42	29	38	Bright: light NW
26	11:30 a.m. ---- clear most of day	46	28	38	Clear: mod. NW
27	8:05 a.m. ---- clear most of day with fresh W.: rain at night	40	26	40	Pt. cloudy: light SW
28	8:00 a.m. ---- rained most of afternoon and evening	62	40	60	Light rain: fresh W.

Meteorology Shediag Bridge

Date	Time	Air temperatures		Present	Remarks
		Max.	Min.		
Oct. 29	8:15 a.m.	64	29	30	Cloudy: mod.-fresh NW
	-----	clear most of day			
30	7:50 a.m.	42	22	27	Clear: light NW
	-----	clear all day with lightwinds			
31	9:15 a.m.	42	27	34	Raining and snowing: light wind
	-----	cloudy most of day			
Nov. 1	10:10 a.m.	40	31	36	Cloudy: light NW
	----	heavy rain during night			
	2.	Cloudy all day but warm			
	3.11:00 a.m.	53	32	46	Clear: mod. SW
		Week was clear and fair except Nov. 7 when very heavy rains fell			
8	9:00 a.m.	57	32	48	Cloudy: fresh NW
	----	clear most of day			
9	10:10 a.m.	57	32	46	Cloudy: light SE
	----	pt. cloudy most of day			
10	9:30 a.m.	51	36	40	Light rain: light SW
	----	cloudy most of day			
11	9:00 a.m.	49	32	38	Clear: light W
	----	clear most of day			
12	7:55 a.m.	46	32	32	Cloudy: light SW
13	-----	clear most of day with snow an evening			
14	-----	cloudy most of day cold with snow and later rain			
15	8:50 a.m.	41	14	31	Clear: light W
18	8:50 a.m.	32	15	23	Cloudy: mod. SW
	----	cloudy all day			
19	9:00 a.m.	32	20	22	Cloudy: still
	-----	cloudy most of day			
20	8:45 a.m.	55	30	55	Clear: mod. SW
25	8:00 a.m.	55	14	18	Bright: fresh NW
29	8:20 a.m.	44	10	18	Snowing: light W

## Appendix II

### Hydrography

The observations this year were made in the same manner as described in 1940 (Medoof 1940/). The times recorded are Atlantic Standard up to June 11, after which they are Atlantic Daylight Saving.

Hydrography Shediac Bay (where not otherwise stated the  
observations were made at the  
Poirier bed)

Date	Time	Tide	Weather	Depth	Temp.	Hyd. Read	T.	Sal%	
May 19	10:30	H.F.	Cloudy mod. W.	Sur.	9.3	16.5	16.3	21.3	
	a.m.			5'	9.2	19.6	16.0	25.3	
20	2:20 p.m.	L.	Bright Mod-fresh NE	Sur.	10.9	16.3	16.0	20.9	Wilbur bed
				8'	10.2	16.9	16.2	21.7	
22	11:00 a.m.	--	Pt. cloudy Mod. SW	Sur.	13.1				
				5'	13.1				
23	9:15 a.m.	H.F.	Bright Light SW	Sur.	11.8				
				5'	11.7				
26	9:45 a.m.	HS	Bright mod. N.	Sur.	10.2	13.3	16.0	17.1	
				5'	9.1	18.1	16.1	23.3	
31	3:30 p.m.	H.S.	Clear light E.	Sur.	11.9	18.3	16.0	23.6	
				5'	10.3	19.5	16.2	25.1	
June 2	8:05 p.m.	LF	Clear light SE	Sur. 3'	15.2 15.2				
3	2:25 p.m.	H.R.	Bright fresh NE	Sur. 5'	15.1 14.1				
4	5:00 p.m.	H.S.	Bright mod. SW	Sur. 6'	12.7 12.2				Wilbur bed
7	11:30 a.m.	$\frac{1}{2}$ F	Bright mod. E.	Sur. 6'	15.3 15.4	20.2 20.7	16.0 15.8	26.0 26.7	
11	8:40	H Very	Strong NE raining	Sur.	9.4				
17	10:35 a.m.	H.F.	Pt. cloudy light N.W.	Sur.	14.4	19.8	19.3	26.5	
				5'	14.2	20.4	19.0	27.1	
18	7:30 p.m.	H.S.	Bright light SW	Sur.	17.8	20.1	19.6	27.0	
				6'	17.7	20.1	19.0	26.7	
19	5:50 p.m.	H.R.	Raining mod. SE	Sur.	17.3	20.3	19.0	27.0	
				6'	17.4	20.6	18.8	27.4	
21	9:45 p.m.	H.F.	Bright mod.-fresh SW	Sur.	15.4				
				5'	15.8				

Date	Time	Tide	Weather	Depth	Temp.	Hyd. Read.	T.	Sal%	
June 25	9:30 p.m.	½F	Clear light SW	Sur.	14.8	19.2	23.8	24.1	
				5'	15.5	19.1	24.0	27.0	
29	9:15 a.m.	½R	Foggy light NW	Sur.	14.2	17.2	23.4	24.2	
				5'	14.0	19.2	23.2	26.0	
30	5:50 p.m.	½F	lt. cloudy mod. SE	Sur.	17.2				
				5'	17.2				
July 2	1:50 p.m.	L.S.	Mod. SW	Sur.	18.8	19.3	23.3	27.0	
				5'	18.6	19.3	23.1	27.0	
3	7:45 p.m.	H.S.	Light NW Clear	Sur.	19.7				
				5'	18.5				
4	1:30 p.m.	L.S.	Light NE Clear	Sur.	19.4				
				4'	19.5				
5	7:35 p.m.	½R	Light SW bright	Sur.	21.4				
				5'	21.3				
7	7:35 p.m.	L.S.	Mod. SE Cloudy	Sur.	20.2				
				4'	20.3				
8	9:25 p.m.	H.R.	Light SE Cloud.	Sur.	19.3				
				5'	19.2				
10	9:20 a.m.	H.R.	Light S. bright	Sur.	17.4	19.6	23.2	24.4	
				6'	17.4	20.2	23.3	28.3	
11	9:15 a.m.	H.F.	Mod. SW bright	Sur.	17.4				
				5'	17.4				
14	1:15 p.m.	H.F.	Light NE	Sur.	20.4	6.4	23.4	9.9	Succeed ed a heavy rain
				5'	16.8	18.7	23.6	25.0	
16	7:30 a.m.	L.F.	Still bright	Sur.	18.0				
				5'	18.8				
17	5:00 p.m.	½R	Mod. SW	Sur.	22.1				
				5'	22.0				
18	10:35 a.m.	½F	Mod. SW cloudy	Sur.	19.1				
				5'	19.2				
21	12:00 noon	½F	Mod. SW bright	Sur.	20.6	20.0	23.6	28.0	
				5'		19.7	23.7	26.5	

Date	Time	Tide	Weather	Depth	Temp.	Hyd. read.	(T)	Sal ‰
July 21	12:00 noon	½F	Mod. SW. bright	Sur.	20.6	20.0	23.6	26.0
				5'	--	19.7	23.7	26.5
21	8:40 p.m.	H.S.	Light SW clear	Sur.	21.1			
				5'	20.6			
22	2:00 p.m.	L.F	Mod.-fresh SW; clear	Sur.	22.1			
23	11:30 a.m.	H.F.	Fresh SW bright	Sur.	19.6			
24	3:20 p.m.	½F	Fresh SW bright	Sur.	22.6			
				5'	22.3			
28	12:00 Noon	H.F.	Fresh SE bright	Sur.	17.9	19.0	24.3	24.1
31	11:00 a.m.	½F	Mod. SW clear	Sur.	--	19.7	24.0	27.1 near red barrel buoy in S. end of bay
				5'	20.6	19.6	27.9	
Aug. 4	4:45 p.m.	L.R.	Mod-fresh N.	Sur.	17.3	16.4	15.8	21.1
				4'	15.7	17.2	15.2	22.0
7	9:50 a.m.	--	Clear light SW	Sur.	17.7			
9	9:45 a.m.	H.F.	Cloudy light SW	Sur.	19.1			
				5'	19.0			
11	7:45 p.m.	L.R.	Bright light SW	Sur.	18.7	18.3	16.4	23.7
				5'	18.4	20.1	15.7	25.9
13	11:45 a.m.	L.R.	Bright	Sur.	16.3			
15	9:45 a.m.	L.M.	Cloudy Mod. SW	Sur.	16.0			
16	3:00 p.m.	L.R.	Bright fresh S.	Sur.	18.3			
				3'	17.8			
20	10:15 a.m.	H.S.	----	Sur.	16.7			
				9'	16.4			
25	a.m.	H.F.	Cloudy SE	Sur.	16.4	21.0	16.6	27.4
				5'	16.7	21.2	16.2	27.4
29	11:00 a.m.	L.R.	Bright fresh SE	Sur.	13.4			
Sept. 3	3:55 p.m.	H.S.	Bright Mod. SE	Sur.	15.8	20.1	16.0	25.9
				4'	15.6			

Date	Time	Tide	Weather	Depth	Temp.	Sp.Gk.	T	Sal.
Sept. 19	9:00 a.m.	—	Cloudy fresh N.W.	Sur.	11.2	19.7	16.7	25.7
								Temperature measured near shore
Oct. 8	9:30 a.m.	½F	Bright	Sur.	10.9	20½6	18.0	27.1
10	2:30 p.m.	L.R.	----	Sur.	10.6	22.1	9.6	27.2
								Wilbur bed
26	a.m.	--	--	Sur.	6°			
28	11:00 a.m.	L.R.	--	Sur.	9°	23.1	12.3	28.9
30	a.m.	--	--	Sur.	4.2°			
Nov. 11	4:15	H.F.	Bright light SW	Sur.	6.6	22.3	11.3	28.7
29	Bay frozen over today							

Miscellaneous observations

Date	Time	Tide	Weather	Depth	Temp.	Hyd. Read.	(T)	Sal.‰	Locality
May 22	2:55 p.m.	--	Bright med. SW	Sur. 6'	16.5 15.3	11.8 12.6	16.3 16.3	15.1 16.2	Buctouche transplant
25	3:00 p.m.	HF	Bright fresh NE	Sur.	11.3				Middle of Buctouche bay
June 18	8:35 a.m.	HF	Bright light SW	Sur. 8' 18'	12.3 11.0	20.5 21.1	19.7 20.0	27.5 28.5	1 m. off pt. du Chene Northumberland Strait
18	12:20 p.m.	LS	Bright light SW	Sur. 8' 18'	16.4 11.0	20.3 20.7	20.2 20.6	27.4 27.6 28.0	Northumberland Strait near Zephyr Rock
19	6:25 a.m.	HF	Bright fresh SW	Sur. 8'	16.0 15.7	17.9 18.5	20.7 21.5	24.3 25.4	At Grand Digue entrance to Bay
19	3:15 p.m.	LR	Cloudy light SW	Sur. 8' 18'	12.6 12.3 10.9	21.6 20.8	22.0 21.5	28.3 28.4 28.8	1 m. E of Shediac Id. in Northumberland Strait.
July 14	3:25 p.m.	H	Clear still	Sur. 8'	16.7 16.8	0.4 0.2-3	19.3 19.3	1-- 1--	Scoudouc R. and Caissies Camp
21	11:30 a.m.	HF	Med. SW bright	Sur. 9' 20'	18.2 17.8 17.7	20.5 21.0	19.3 19.3	27.4 28.0 27.5	Point du Chene 1st red can buoy
21	7:45 p.m.	HS	light SW clear	Sur. 9' 20'	19.1 18.6 18.3	21.1 21.2	19.3 19.3	28.1 28.3 27.7	Same as 11:30am
31	11:00 a.m.	LF	Bright med. SW	Sur. 9' 15'	19.0 18.7 18.2	20.5 21.2	19.3 19.5	27.4 28.3 28.5	Same as July 21
Aug. 8	4:30 p.m.	LR	Cloudy med. SE	Sur. 6' 12'	18.0 -- 17.4	18.5 20.4	16.6 15.7	23.9 26.2 26.6	1st red can buoy off pt. du Chene
9	11:05 a.m.	HF	Cloudy still	Sur. 1' 2 1/2' 8'	17.6 -- 18.4 18.7	1.6 16.0 18.4	15.3 14.7 15.1	1.7 20.3 23.6 23.7	Deep hole opposite Caissies Camp Scoudouc R.
14	11:00 a.m.	LS	Bright med. SW	Sur. 8'	15.5 15.2	19.4 19.3	15.8 16.7	25.0 25.0	Grand Digue channel at gap

Miscellaneous observations

Date	Time	Tide	Weather	Depth	Temp.	Hyd. Read.	(T)	Sal. ‰	Locality	
Sept. 4	3:00 p.m.	LS	Bright mod. SW	Sur.	15.8	15.7	15.5	20.0	Richibucto River	
				9'	---	15.8	14.9	20.0		
				25'	15.4	16.6	15.6	21.2		
4	F			Sur.	---	13.1	15.3	16.6	Richibucto R.	
				9'	---	13.3	15.0	16.9	and Indian	
				25'	---	13.3	15.7	17.0	reserves	
4	R			Sur.	---	18.8	16.7	24.3	Richibucto R.	
				9'	---	18.8	15.7	24.3	opposite Barton	
				35'	---	19.4	16.7	25.1		
Oct. 27	2:30 p.m.	LR	Fair		---	21.2	10.5	26.0	Little Shemogue at Simpson's creek	
Oct. 30	11:00 a.m.	1/2 F	Cloudy Calm	Sur.	6.2	9.8	11.6	11.6	Big Shemogue	
				3'	---	19.7	9.2	24.1	1/2 m. up from	
				6'	---	20.9	9.2	25.7	Leo Dorell's (fell. recent rains)	
Oct. 30	2:00 p.m.	LR	Cloudy calm	Sur.	---	11.7	10.0	13.8	Big Shemogue where the two channels meet below Cormeau point	

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