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Introduction

Following the practice of the last few years, the winter of 1943-44 was spent at St. Andrews and the open-water season (April 25 to Nov. 18) at Ellerslie, P.E.I., which technically was still considered headquarters.

In 1941 a four-year experiment was set upon the Sissiboo river by Dr. R. A. Ingalls who served as a summer investigator in 1941 and 1942. In 1943 he was not available for the work and that year the Sissiboo experiment "ran itself". This arrangement was not particularly satisfactory although data were gathered by the Department of Fisheries guardian who was posted there and nothing essential was lost by the vacancy. However, continued industrial expansion especially in clam shucking emphasized the Research Board's need for a full-time clam investigator to deal with the many problems that were developing. Early in the year, therefore, the writer's program was changed drastically by his being made responsible for general investigations on soft-shell clams. This did not include work on paralytic poison.

The 1944 assignment was to finish off oyster studies that were still underway, bring the Sissiboo records up to date and expand the clam work to include investigations and clam farming trials in Halifax county using funds the Nova Scotia Economic Council provided for that purpose. This change involved being made responsible for the first time, for summer assistants - two of them, both at East Peteswick, N.S., Dr. Leo P. Chiasson who had just taken his doctorate examinations and Mr. James MacMillan, a student who had just completed his "pre-medical" training.

The year's efforts proved very exercising. There was much travel from the Prince Edward Island headquarters to Halifax county, N.S., to assist in organizing the work there as well as special trips for other purposes to the Sissiboo river, Five Islands and Merigonish, N.S., and Maisonneuve, N.B.. The effort on oyster work included the making of final observations on stocks used in the writer's 1943 growth experiment and conducting an elaborate series of condition tests on stocks reared in a 1944 growth experiment conducted by Dr. James Adams. Some of these results are still unanalyzed and are not reported here or have been included by Dr. Adams in his reports. Besides these observations were made on blister worms and the occurrence of green oysters in New Brunswick.

Because Ingalls' 1941 and 1942 reports were inadequate all the Sissiboo clam work had to be carefully revised with him personally. The earlier data were then re-analyzed and conclusions from them used in planning the Ellerslie and Halifax county work. These programs diversified from the outset because there were so many tentatively-drawn conclusions from

the first three years' Sissibee investigation that needed checking.

It is hoped that some of the data both on clams and oysters that were gathered in 1944 will be sufficiently worked over to be presented in 1945 with the records for that year.

RESULTS OF THE SISSIBOO RIVER CLAM-REARING EXPERIMENTS

The writer was made responsible for the Sissiboo River, N.S., clam-rearing experiments in the spring of 1944. It was decided first to review the 1942 records presented by Ingalls (1942). They were discussed with him in detail in July at Sackville, N.S., at a meeting arranged for that purpose. Subsequently they were completely re-analyzed.

In 1943 records, ^{were} gathered by Mr. Charles Hayes, ^{They} were treated next. These included the first results from the supplementary plots that were planted 80 to the square foot. Unfortunately these were not dug as was originally planned (Ingalls 1942). Instead, the whole four sections of each of three plots (#14, 15 and 16) were dug.

Duplicate copies of the 1943 results have been placed on file at the A.B.S. so it seems unnecessary to congest this report with the elaborate tables which they comprise.

It seemed clear at the beginning of 1944 that the full four years would be required for normal $1\frac{1}{2}$ " clams to grow to market-size and that the stunted would require at least five. For this reason only half of each "c" plot was dug. In 1945 it is planned to dig the whole of each "d" plot and in 1946 the remaining half of each "c". By this device the experiment can be made to yield more results.

In 1944 plots #10, 11 and 12 of the 80 per square foot series were dug. Duplicate copies of the 1944 results are on file at the A. B.S. but are not presented here. For convenience in reference the results of the analysis of the three years' records are presented in two forms (Table (1) A and B).

Conclusions

1. The growth of stunted clams is slow. In three years they have grown as much as normals have in two.
2. Mortalities have been heavy both in stunted and normal stocks every year but were worst the first year. On the average 32% of the clams originally planted survived to the end of 1944. This reduction in the population should be considered in dealing with data on crowding. In 1944 considerable numbers of dead shells 2 - 2 $\frac{1}{2}$ " long were found in the soil.
3. Growth and survival in the 20 and 40 per square foot plots were better than in the 10 per square foot. Crowding in this tough clayey soil seems to be an advantage. Perhaps it loosens the soil.
4. Apparently the 1942-43 season was better for survival than 1943-44 and 1941-42 seems to have been poorest of all. However the very poor survival in 1941-42 may have been related to the transplanting operation.

6. The 1 $\frac{1}{2}$ " clams planted 80 per square foot in 1942 grew more in their first year after planting than any of those planted in 1941. This may be because of the extra crowding but was probably partly due to better growing conditions in 1942-43 than in 1941-42.

TABLE 1 Summary of data growth and survival of class in Hixson river experimental plots 1941-1944.

A. - In this table all percentages are based on the original sizes and numbers of the class when they were planted in 1941.

B. - In this table the percentages for each year are based on the sizes and numbers of the class found to be alive at the end of that particular year.

Type of Stock	Population density per sq. in 1941	Original length 1941 inches	First Year (1941-42)				Second Year (1942-43)				Third Year (1943-44)			
			Total Increase 1941-42 inches	%	Recovered alive	Survival % during 1st year	Total Increase 1942-43 inches	%	Recovered alive	Survival % during 2nd year	Total Increase 1943-44 inches	%	Recovered alive	Mortality during 3rd year
Normal	10		7	18	37	43	14	37	34	23	28	50	30	4
"	20		8	20	37	43	18	45	48	9	23	50	33	13
"	40	Av. 42'	8	20	50	40	17	41	47	18	24	50	37	10
"	80		10	25	39	41	18	42	49	10				
Strated	10		4	12	67	33	10	25	48	19	27	64	30	18
"	20		7	15	70	35	12	30	55	17	27	42	31	24
Average			7	18	61	35	15	35	46	17	25	51	32	14

Type of Stock	Population density per sq. in 1941	Original length 1941 inches	Average length 1941-42			Average length 1942-43			Average length 1943-44					
			inches	% gain	% survival	inches	% gain	% survival	inches	% gain	% survival			
Normal	10		49	37	37	43	58	18	60	40	64	20	64	66
"	20		50	29	37	43	60	30	89	11	65	8	69	31
"	40	Av. 42'	50	19	58	47	59	18	81	10	66	12	79	30
"	80		52	24	39	41	60	15	81	27	--	--	--	--
Strated	10		48	14	67	33	52	8	72	28	59	12	61	37
"	20		47	13	70	35	54	15	77	21	59	10	62	43
Average			49	18	68	37	57	15	77	21	61	10	68	35

These class were planted in 1942, all the rest in 1941. For more in comparison the 1942-43 and 1943-44 results for the 80 per sq. plots are listed in the 1941-42 and 1942-43 column respectively.

Growth at different levels on the beach at Sissiboo

Ingalls (1942, page 5, paragraph 5) briefly described an experiment that he set up on the Sissiboo flats in October 1941.

Lots of clams supposedly two, three and four years old were gathered and their ventral shell margins notched with a file. Nine boxes were filled with clay and arranged in three lines of three each, at low, intermediate and upper levels on the beach on the Government reserve. The first box in each line was stocked with two-year clams, the second with three-year olds and the third with four-year olds. There were 100 clams in each box.

In October 1942 a few clams were removed from each box and preserved in formalin. In October 1944 all the clams remaining were taken up. Measurements of both collections were made this fall and are reported in Tables (2,3, and 4).

In studying the data no attention has been paid to the ages attributed to the clams. It is possible to deduce useful conclusions from the data without dependence on these estimates which are at best dubious. The results show:-

(1) There is a progressive decrease in the growth rate approaching the upper levels of the beach but the differences from low to intermediate levels is much greater than that from intermediate to high.

(2) There is less difference between the growth rate of small and large clams at low levels than there is at high and intermediate levels.

(3) At the intermediate level the growth rate is almost the same but slightly higher than in the 75' plot to which it is adjacent.

(4) The increase during the first year was greater than during the second and third years.

(5) The survival in these boxes over the three year period has not been very different from that in the 75' plot.

(6) At low levels $\frac{1}{4}$ normal clams reach marketable size in three years.

Annual Rings.
These clams show shell annuli that have yet to be carefully studied. The most conspicuous one in almost all cases is at the file notch. This could be interpreted as the 1941-42 ring. It is so much more distinct than all others that it must have been caused partly by disturbance at the time of transplanting. There is less certainty about the others. One apparently corresponds to a 1942-43 winter ring. The clams grown in the low level boxes show the clearest relationships. The problem of annual rings in soft-shelled clams requires more intensive study than it has yet received.

Table (2)

-4-

Upper line boxes. Individual lengths (millimetres) of notched
Sissiboo river clams: planted in 1941: sampled in 1942 and 1944.

	2-year-olds		3-year-olds		4-year-olds		
	1941	1942	1941	1942	1941	1942	
	18	30	25	33	35	41	1942 obser- vations
	25	31	26	32	34	36	
	18	29	25	34	33	37	
	31	32	30	34	33	38	
	24	33	26	34	37	39	
			29	35			
Av. length m.m.	31.2	31.0	26.8	33.7	34.4	38.2	
Av. length 32 nds. inches	27	39	34	43	44	48	
	1941	1944	1941	1944	1941	1944	1944 obser- vations
	26	41	28	46	31	49	
	23	41	26	38	23	44	
	23	36	31	42	34	46	
	22	40	28	46	40	47	
	23	38	25	43	35	47	
			25	39	31	46	
			26	43	39	50	
			27	42	35	48	
			25	41	39	51	
			29	42	37	47	
			29	39	33	51	
			30	42	35	45	
					35	48	
					35	48	
					39	48	
Av. length m.m.	23.4	39.2	28.3	41.9	35.3	47.8	
Av. length 32 nds. inches	30	50	36	53	45	60	

Table (3)

Middle line boxes. Individual lengths (millimetres) of notched
Sissiboo river clams planted in 1941: sampled in 1942 and 1944.

	2-year-olds		3-year-olds		4-year-olds		
	1941	1942	1941	1942	1941	1942	
	25	37	32	42	33	49	1942 obser- vations
	25	35	36	42	40	52	
	26	39	35	44	41	48	
	24	32	32	41	35	46	
	27	36	33	42	35	50	
	26	37	34	44	37	51	
			35	41	39	51	
			31	39	38	48	
			36	39			
			37	40			
Av. length							
m.m.	25.5	36.0	33.9	44.4	37.3	49.4	
Av. length							
32 nds. inches	32	46	43	56	47	63	
	1941	1944	1941	1944	1941	1944	
	26	51	32	50	34	59	1944 obser- vations
	23	45	38	52	39	62	
	25	46	35	57	37	61	
	26	47	32	53	38	58	
	24	49	34	48	36	54	
	27	43	39	56	33	54	
	26	47	38	47	36	50	
	23	43	36	54	32	54	
	26	46	33	53			
			33	49			
Av. length							
m.m.	25.1	46.3	35.0	51.9	35.6	56.5	
Av. length							
32 nds. inches	32	58	44	65	45	71	

Table (4)

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Lower line boxes. Individual lengths (millimetres) of notched Sissiboo River clams planted in 1941: sampled in 1942 and 1944.

	2-year-olds		3-year-olds		4-year-olds		
	1941	1942	1941	1942	1941	1942	
	27	37	33	53	31	48	
	23	44	30	49	37	50	1942 obser- vations
	26	43	29	49	33	46	
	25	47	35	52	32	46	
	27	38	29	49	35	50	
	26	45	29	54	35	50	
	26	36	30	42	35	45	
					36	45	
					32	49	
Av. length							
m.m.	25.7	41.4	30.7	49.7	34.0	47.7	
Av. length							
32 nds. inches	33	52	39	63	43	60	
	1941	1944	1941	1944	1941	1944	
	27	61	32	67	32	68	
	28	59	32	72	35	65	1944 obser- vations
	23	61	30	61	34	68	
	24	58	29	61	33	59	
	25	69	26	56	33	58	
	25	57	29	60	33	62	
	29	49	31	58	31	74	
	27	64	30	53	37	75	
			33	48	35	68	
					36	68	
					32	70	
Av. length							
m.m.	26.0	59.6	30.2	58.4	33.5	66.8	
Av. length							
32 nds. inches	33	75	38	74	42	84	

Petpeswick Experiments on the Effect of Crowding on Growth and

Survival of normal and stunted seed clams.

Originally it was proposed to duplicate the Sissiboo river experiments (Ingalls - 1942) at Petpeswick as nearly as possible so that the results from the two areas might be strictly comparable. After consideration two important changes were introduced to make the tests more critical and these greatly increased the amount of work involved.

1. At Sissiboo each of 20 of the 25 15' x 15' plots within the 75 x 75 foot square was planted with four separate 5' x 5' plots with wide barren paths between. Each of the other 5 was planted with 4, 3' x 3' plots with still wider barren paths between. At Petpeswick the 15 foot squares were planted right out to the edge so that there were no barren strips between adjoining plots. It is hoped that by this device "border effects" on growth will be eliminated to a large extent.

2. The results from Sissiboo up to the end of 1942 indicated that there were no differences in growth rate of clams when planted in concentrations of 10, 20, and 40 per square foot. In the hope of producing a range of densities of crowding that would show adverse effects of crowding, the Petpeswick plots were planted 20, 40 and 80 per square foot.

Table (5) sets forth the comparison of the two experiments in greater detail and shows that approximately six times as many measured clams were planted at Petpeswick as at Sissiboo. Before the plots could be planted the ground had to be cleared of its native population. This work was begun in May but was such a long, arduous operation that the first plantings of measured clams were not made until July 15 and the work was not completed until September 28.

Figure (1) describes the 75' plot showing types of stock, population densities, and planting dates for each of the 25 squares it contained.

The planting stock came from different areas in Petpeswick harbour. Normal clams in plots 1, 3, 12 and 19 came from Petpeswick cove. All other normals came from the "Turn" bed just above the government wharf. "Stunted" clams in plots 2 and 4 came from Petpeswick cove, those in #9 and 18 from Bayers Settlement, those in #20, 21 and 25 from Garby Young's flat and those in #10, 11 and 13 were a mixture of Bayers' and Young's clams.

The seed was bought from the diggers at a cost that varied between \$2.00 and \$3.00 per hod. A hod is a half-bushel measure and will hold 1500 - 1800 seed clams of the size handled. The purchased clams were culled with a gauge to eliminate those outside the 38-48 mm. range. The gauge was a small board with two strips nailed across it

Figure (1)

Describing the 75' square plot at East Petpeswick, N.S. and showing the type of stock ("s" = stunted, "n" = normal), density of population per square foot (20,40 and 80) and the dates of planting.

North

s 40 Aug. 26 21	n 80 Sept. 6 -13 16	s 20 Aug. 8, 22 & 24 11	n 40 Aug. 10-12 6	n 20 July 21 & 22 1
n 40 Aug. 8 -10 22	n 20 Aug. 5 & 7 17	n 40 July 15 -18 12	n 80 Aug. 15-16 & Sept. 2 7	s 20 July 31 2
n 80 Sept. 25-28 23	s 20 Aug. 17 & 18 18	s 40 Aug. 25 & 26 13	n 20 Aug. 8 & 9 8	n 40 July 24-26 3
n 20 Aug. 4 & 5 24	n 40 July 18-20 & 24 19	n 80 Sept. 2, 4 & 6 14	s 20 Aug. 17 & 18 9	s 40 Aug. 1 & 2 4
s 20 Aug. 3 & 7 25	s 40 Aug. 31. 20	n 20 Aug. 10 & 11 15	s 40 Aug. 18-22 10	n 80 Aug. 11, 12 & 15 5

West

East

South

to form an open "V", 38 mm. apart at one end and 48 mm. at the other. Clams that entered the wide end but stuck before reaching the narrow end were used for planting stock. Planting was done by making rows of holes 1-2" deep with a pointed stick and placing the clams right-end-up in them. The spacing of the holes was correctly arranged by planting through squared grids made by lacing lobster twine across a board frame at appropriate intervals.

In order to get an accurate idea of the size composition of the stock used in each plot a double handful of clams was taken from the top and from the middle of each hodful planted. The sampled clams were measured to the nearest mm. Their size-frequency, distribution and mean sizes are shown in table (6).

Table (5)

Comparison of Sissiboo and Petpeswick plantings in the 75' square.

Description of planting	Sissiboo	No. of clams	Petpeswick	No. of clams
stunted 10 per sq.'	20 plots 5 x 5'	5,000	none	--
" 20 " "	20 " "	10,000	5 plots 15 x 15'	22,500
" 40 " "	none	--	5 " "	45,000
normal 10 " "	20 plots 5 x 5'	5,000	none	--
" 20 " "	20 " "	10,000	5 plots 15 x 15'	22,500
" 40 " "	20 " 3 x 3'	7,200	5 " "	45,000
" 80 " "	16 " 1 x 1' *	1,280	5 " "	90,000
Total no. of clams planted		38,480		225,000

* These clams were planted in 1942 in a supplementary plot outside the regular 75 x 75' plot which was set up in 1941.

Each year for the next four years it is planned to dig up, measure and replant the clams from a new quarter of each of the twenty-five 15 x 15' plots in the 75' square. The results will be useful in estimating the possibilities for the development of a clam-farming industry in that area and for comparison with those from the Sissiboo.

The proposed technique for sampling the Petpeswick plots beginning July 15, 1945, is different in some details from that applied at Sissiboo. A five-foot-square block is to be dug from the "a" position (Ingalls 1942) and all the live clams recovered are to be counted. The resulting figure will be used to calculate the percentage survival. From the lot recovered a sample of 200 clams will be drawn at random and their lengths measured to the nearest mm. and recorded. The purpose of taking uniform numbers of clams in the samples for measurement is to facilitate statistical treatment of the results.

After the counting and measuring it is planned to re-plant all the clams in the five-foot square from which they were dug so that there will be no blank spaces which might influence the growth of the undisturbed clams in adjacent parts of the plot.

The Burrowing Activity of clams at Petpeswick subsequent to planting.

Dr. R. A. Ingalls suggested in discussion with the writer in July 1944 that the high mortalities during the first year (ranging up to 42%) of the clams planted in the Sissiboo river plots (Ingalls 1942) might have been caused by winter-killing of those which had failed to burrow deep enough into the soil to avoid frosts. This suggestion drew attention to our lack of knowledge of the behaviour of planted clams in the soil after they have disappeared from sight. There was a good chance to study this on September 7, 8 and 10, at Petpeswick and the writer made several observations on the depth of the posterior tips of the clams' shells below the surface in the 75' plot. Tables (7, 8, and 9) summarize these and support the following conclusions. These should be further checked for various types of soil and at different seasons of the year.

1. The behaviour of normal clams in plots 8 and 15 was closely similar suggesting that it is reasonable to make other comparisons and to attribute differences to factors other than soil variation, etc. Table (7).
2. Clams continue to burrow deeper and deeper into the soil after they bury themselves. Table (8).
3. The rate of burrowing is high at first but drops off later. One month after planting, they reach practically the same level as the undisturbed native clams of the same size just outside the plot. Tables (7, 8 and 9).
4. There was no remarkable difference in the behaviour of clams planted 20 and 80 to the square foot but crowding may have interfered slightly with deep burrowing. (Tables 7 and 8).
5. Apparently stunted clams do not burrow as deeply as normals. (Table 7 and 8).
6. The presence of puddles of water on the flat seems to increase the depth to which the clams burrow. (Table 7).
7. It seems unlikely that clams planted at Petpeswick in August and September would be more susceptible to winter-killing than native stocks as a result of differences in their vertical position in the soil.

Table (7)

Comparison of size (length) and depth of normal clams in two plots (#8 and #15) one month after planting at 20 per sq. foot, and from wet and dry parts of one plot (#15).

Description of samples	Size mm.	Depth mm.	Size mm.	Depth mm.	Size mm.	Depth mm.
14 clams from a dry part of plot						
25 normal clams plot #15	39	83	49	108	44	103
planted Aug. 10-11	49	101	43	81	41	82
observed Sept. 10.	46	101	48	101	48	97
	46	92	50	113	45	73
	47	83	46	88		
	Av. size 46 mm.		Av. depth 92 mm.			
11 clams from a part of plot covered by a pool of water 2-3 cm. deep.						
	50	111	46	133	39	112
	51	66	47	73	41	96
	49	133	42	120	46	91
	47	106	45	128		
	Av. size 44 mm.		Av. depth 106 mm.			
For entire lot of 25 clams from plot #15: Av. size 45 mm. Av. depth 96 mm.						
from a dry part of plot						
8 normal clams plot #8	41	84	40	97	43	83
planted Aug. 8-9	43	95	49	115	38	100
observed Sept. 8	48	108	40	104		
	Av. size 43 mm.		Av. depth 98 mm.			

Table (8)

The size (length) and depth of clams at various times after planting 80 per sq. foot in dry parts of plots.

Description of samples	Size mm.	Depth mm.	Size mm.	Depth mm.
8 normal clams plot #16	39	27	48	24
planted Sept. 7	43	37	44	18
observed Sept. 8	44	11	50	16
<u>24 hours after planting.</u>	48	14	41	10
	Av. size 45 mm.		Av. depth 20 mm.	
8 normal clams plot #14	47	22	45	85
planted Sept. 6	46	59	41	68
observed Sept. 8	42	56	39	32
<u>48 hours after planting</u>	42	71	46	65
	Av. size 44 mm.		Av. depth 57 mm.	
25 normal clams plot #5	42	75	42	80
planted Aug. 11-15	48	70	46	80
observed Sept. 10	49	98	44	102
<u>one month after planting</u>	45	111	45	92
	48	108	48	112
	48	97	47	86
	49	79	45	101
	45	84	47	94
	40	76	47	103
	40	86	45	90
	48	51	40	85
	42	83	43	91
	44	90		
	Av. size 45 mm.		Av. depth 89 mm.	

Table (9)

The size (length) and depth of clams -- (1) planted stunted stock;
(2) undisturbed normal natives.

Description of sample	Size mm.	Depth mm.	Size mm.	Depth mm.	Size mm.	Depth mm.
26 stunted clams	47	73	40	87	40	65
20 per sq. foot						
plot 9	38	82	37	55	38	52
planted Aug. 17-18						
observed Sept. 8	44	120	43	65	40	51
3 weeks later						
	43	54	41	72	42	55
	43	62	43	80	37	69
	41	84	43	62	38	66
	43	83	40	56	43	66
	44	71	40	50	42	69
	38	59	39	54		
Average size -- 41 mm. Average depth -- 68 mm.						
	Partly from dry place and partly from a shallow pool.					
35 normal clams	40	83 x	34	92	50	105
from the undis-						
turbed native	46	113 x	44	95 x	50	103
population						
20' east of the	39	107 x	33	76	46	115 x
75' plot.						
Dug September 7-8.	44	120 x	34	115	33	77
	47	112 x	33	89	40	90 x
	35	83	48	114 x	46	98 x
	36	40	36	103	36	74
	41	103 x	46	106 x	45	88 x
	43	70 x	53	125	54	126
	42	111 x	40	102 x	51	109
	42	84 x	29	72	37	82
	34	66	33	78		
Average size of the 17 clams (marked thus x) in the 38-48 mm. group -- 43 mm.						
Average depth of same -- 101 mm.						

Commercial Scale Transplant of Seed Clams.

A clam farming experiment on a commercial scale was started in the first week of October 1944 at Petpeswick. The ground chosen for planting was on the big flat on the west side of the channel opposite the government wharf. In the past, according to local reports, this was a smooth flat and produced an abundance of high quality clams. Since the eel grass disappeared the surface has become rippled and there have been no sets of seed clams. The survivors of the last catch of seed that came down while the eel grass was present, were dug out about three years ago so that now the area is almost completely barren. A half-hour's searching and digging yields less than a dozen clams and these are all widely separated, large, old specimens. The exact nature of the changes which have lead to the present state of barrenness is a problem that has yet to be solved.

Trial Plantings

Before attempting a large-scale relay five trial plantings were made on five-foot-square plots on the flat near the half-acre area chosen for the relay. These tests were designed to show what type of seeding would be most satisfactory.

On September 12, separate lots of 100 clams, ranging in size from 37 to 60 m.m. and averaging 52 m.m. in length were dug and during the same low tide period treated as follows: (1) Broadcast at rising, through water one foot deep onto undisturbed bottom; (2) laid carefully on the dry undisturbed sand at low tide; (3) broadcast from the standing position onto undisturbed sand at low tide; (4) laid carefully at low tide on soil that was first loosened to a depth of four inches with a clam fork; (5) placed in furrows made with a hand plough so that each row of clams was covered by the soil thrown up by ploughing the succeeding furrow.

The numbers of clams successfully burying themselves as shown by counts of siphon holes at the next low tide in the five-foot plots were respectively 9, 19, 21, 45 and 88.

In broadcasting lot (3) 8 clams were cracked.

It should be pointed out that method (4) would probably have shown to better advantage if the size of the plot of loosened soil had been larger. As it was any clams that were washed beyond the five-foot square were immediately in the same position as those in lot (2) which were less successful. No test was made of broadcasting through water onto plots of loosened soil.

The last method of sowing was chosen as being the most certain for successful burial in the large plant.

The Half-Acre Plant

Small stunted clams averaging 40-45 m.m. in length were taken from several heavily populated flats well up the harbour.

These were Garby Young's flat, Mussel gully flat and the flats between the sedge banks near the middle ground at Bayers Settlement. For the most part the seed came from areas which are not fished commercially because their clams grow old and die before reaching marketable size. The clams were purchased from the diggers at \$1.00 per half-bushel hod. This price was set after trial digging to determine a fair price to the diggers. The hods used were loaned through the courtesy of Mr. Baker, the Manager of the Matthews cannery at the head of Petpeswick harbour.

On October 5 using Mussel gully stock counts of the number of seed clams per hod were made on three hods that were representative of the largest, smallest and average sized stock that were received from the diggers. In addition lots of 100 were taken from several different hods to see what percentage of the planting stock was cracked or broken. The results are summarized below.

Description of Stock	No. per hod	No. of broken clams in lots of 100	Average no. damaged %
Large	1280	7,11,12,14,15	12
Medium	1400	approximately	5
Small	1510	2,2,4	3

Planting was carried on in the same manner in which seed potatoes are dropped except that the clams were laid end to end - almost touching one another. One man furrowing with the hadd plough could keep 6 to 8 men busy dropping. The plough cut a furrow three inches deep and four inches wide and it was found impossible with the share used on the plough to reduce the space between rows below four inches.

Not all the clams were buried by the soil thrown up by the plough but the vast majority (more than 88%) were apparently successful in burying themselves before the next low tide. Their siphon holes showed up clearly and the average density of population was estimated after a few counts at 13 per square foot. This checks well enough with what would be expected from the results of counts on the hods. There were 227 hods with an average of 1400 clams, of which 5% were damaged, planted on the half acre (21, 780 sq. ft.) which should give a population of approximately 14.6 per square foot.

The planting rate using this method was measured carefully several times and found to vary a good deal depending on the weather. On cold wet days it was lower than on fine clear days when it was unnecessary to wear oil clothes at the work.

On October 2nd it rained hard but it was not cold and 5 planters (including the ploughman) working three hours and fifty minutes planted 35 hods -- an average of 0.6 man hours per hod planted. On October 5 during the afternoon low tide 8 men planted 58 hods in 4.00 hours -- average of 0.7 man hours.

Table 10.

Summary of work on half-acre transfer of seed clams at Petpeswick, October 1944.

Date	Particulars of operations	Clams Handled (hods)	
		Dug	Planted
September 30 p.m.	Fine day; 12 diggers at Mussel gully.	49	
October 2 p.m.	Poured rain; no diggers out; 5 planters		36
3 p.m.	Blew a gale; cold; no diggers out; 4 planters.		14
4 p.m.	Fine day; 12 diggers at Garby Young's.	57½	
5 a.m.	Rain; 6 planters		7
p.m.	Clear; 8 planters		58
	Diggers worked both tides, 8 Bayers Settlement; 38 hods; 5 Petpeswick 15½ hods	53½	
6 a.m.	Rainy; cold; 6 planters		18
p.m.	Drizzled; cold; 7 planters		36
	Bayers Settlement, 9 diggers; 53 hods; Garby Young's, 2 diggers, 3 hods.	56	
7 a.m.	Fine; short tide; 7 planters		16
	Bayers Settlement, 5 diggers	11	
9 a.m.	Poor tide; foggy drizzle; 9 planters		30
10 a.m.	Poor tide; foggy drizzle; 9 planters		13
TOTALS		227	227

The history of the digging and planting operations is summarized in table 10.

Expenses

Because the work was new to all concerned its cost was probably higher than it would be if it were to be repeated now. The expenditures were as follows:

Cost of seed clams (214 hods purchased; 13 dug by self and guardian).	\$214.00
Planting costs	126.75
Boating of clams and towing of diggers to and from digging areas	88.00
Incidental expenses	<u>5.25</u>
Total cost	<u>\$433.00</u>
Total planting cost per hod	1.90

Valuable experience was gained in these commercial-scale planting operations and observations on growth and survival to the clams in the plot during the next two or three years will be instructive. When they reach marketable size it is expected that the plot will be used for experiments in controlled digging. In addition information will be obtained as to yields and costs and profits of clam farming under local conditions. The plot also has potential value as a demonstration of clam-farming methods.

If the planting succeeds an important advance will have been made in the direction of expansion of the clam industry because at present there is much potential seed stock in the harbour which is useless where it grows and there are many acres of barren flat that are likewise useless. The local people are keenly and sympathetically interested in the outcome of this and the other clam work that is being done in their district.

The Yield of Shucked Meats from Clams

Last spring Mr. Ross Carey, manager of the General Sea Foods clam shucking plant at Ostrea lake, N.S., (Musquodoboit harbour) agreed to measure the yield of raw shucked meats of clams from various flats at different seasons. In making the determinations he weighed out 56 ounces of freshly fished round clams, shucked them, then separately weighed the unwashed saleable meats and the discarded parts (necks and shells) to the nearest ounce and subtracted the sum of these from 56 to give the weight of the water lost in processing. His records are the most complete ever compiled on this subject and he has generously made them all available. They are summarized in table 11 and support the following conclusions.

1. The yield varies widely from place to place. Of the three stocks studied those from Clam harbour showed the highest yield and Goose Head the lowest, amounting to only half that for Clam harbour.
2. There are clear cyclic changes in the yield in all the stocks. In spring the yield is high, it drops in mid-summer, rises in late summer and fall to a higher level than in spring. Other evidence reported below indicates a slight drop in winter and early spring.
3. Good clams show greater seasonal variation in yield than poor ones.
4. Good clams have a lower water content than poor ones.
5. The yield for large clams is far below that for clams just above the legal size limit.

Mr. Carey has supplied other information that is pertinent to this study.

6 The refuse trimmed from clam meats amounts to 10-15% by weight of the meats.
The shucking plant records show that for commercial lots the yields in May were somewhat less than those for early June when this study was begun.

The principal spawning occurred in July and August. This is recognized from marked changes in the appearance of the meats.

After June 22 it required more and more round clams of the 2 $\frac{1}{2}$ - 2 $\frac{3}{4}$ " size to weigh 56 ounces. This is attributed to spawning and rapid shell growth and to the fact that thin clams tend to draw their shells closer together when they close and thus reduce their volume. This is an important observation because it means that the yield of meat per clam probably fluctuates more than the data in the table suggest.

Figures on 1944 yields contributed by Mr. Fred Amero, manager of the International Shellfish Company's shucking plant at Digby are less instructive since they concern only yields of commercial lots which were a mixture of clams from Sissiboo River, Thorne Cove and Goat Island in approximately constant proportions. These are sum-

marized in table 12. It is important to note that after October 1st the clams processed were smaller than in earlier runs and came from higher levels on the flats. Mr. Amero states that had the source of supply remained unchanged there would have been an increase of 2-3 tenths of a gallon during this month. This opinion agrees with Mr. Carey's records which clearly show a fall increase in yield. He has also supplied data on the monthly production of meats in American gallons for 1944 summarized in table 13. Because of adverse weather conditions no attempt is made to operate during the months of January, February, and March. The drop in production after August was to some extent due to the difficulty of getting enough diggers not to scarcity of clams. It is hoped that more information of this sort can be gathered not only from shuckers but also from clam cannery and that a scale of equivalents for the two can be worked out. This would permit a comparison of fatness of clams in widely separated areas simply from the packers' records.

The data gathered so far are of peculiar interest and suggest that a comprehensive study of "Condition" such as that already conducted on the oyster (Medcof and Needler 1941) would provide information of great practical value to the industry -- shuckers, cannery and clam farmers. It would be foolish for instance to encourage development of flats like Goose Head if areas like Clam harbour were available.

In "Fisheries Statistics of Canada" the department reports clam production in barrels. Often shucking plants keep records only in pounds of meats. For the purpose of the statistical reports a conversion is made by allowing 29 pounds of meat to the barrel. Mr. Carey points out that this value is low. It seldom, if ever, drops below 30 and is sometimes as high as 40 even in Halifax county.

In reporting cannery yields 1 case of 48 tins each containing 5 ozs. of clam meat is considered equivalent to a barrel. This is also subject to some variation but so far little information on the subject has been accumulated.

Table 11.

Showing the weights of ^{trim = cd} meats, refuse and water from samples of 56 ounces of commercial catch of round clams from various flats at different seasons.

Name of Flat and particulars of samples	Weight in ounces				
		meats	necks and shells	water lost	
Goose Head Area	June	6	12	28	16
Musquodoboit	"	22	12	27	17
2½ - 2¾" clams				n. 3 oz. sh. 24	
	July	6	12	27	17
	Aug.	7	11	27	18
	Sept.	1	12	26	18
				n. 3 sh. 23	
	"	29	13	26	17
				n. 3 sh. 23	
	Nov.	1	13	28	15
				n. 4 sh. 24	
Petpeswick	June	6	18	24	14
2½ - 2¾" clams				n. 4 sh. 20	
	July	10	14	24	18
	Aug.	16	14	24	18
Clam harbour	June	6	24	28	4
2½ - 2¾" clams	July	5	22	28	6
	Aug.	10	22	28	6
	Sept.	1	23	28	8
				n. 7 sh. 21	
	Oct.	1	24	24	8
				n. 3 sh. 21	
	Nov.	1	25	24	7
				n. 3 sh. 21	
Clam harbour large clams 3½" and up	June	6	16	28	12

Table 12.

Showing yield in ^{American} $\frac{1}{4}$ gallons of meat per ^{Imperia} 2 $\frac{1}{2}$ bu. barrel of round clams from International Shellfish Shucking Plant, Digby, N.S. in 1944.

Period	Yield gals. per bbl.
April 4 - 22	4.8
May 1 - June 10	4.9
June 12 - 30	4.5
July 4 - 31	4.3
Aug. 1 - 31	4.4
Sept. 1 - 30	4.5
Oct. 2 - 15	4.6 †

* 1 gallon contains 8 pounds of drained meats carefully weighed.

† this value is lower than might be expected as explained in the text.

Table 13.

Monthly production of clam meats in American gallons of the Soffron Brothers' clam shucking plant at Digby, N.S., in 1944. Data supplied by Mr. Fred Amers from production reports.

April	1681
May	3542
June	3230
July	2654
August	2572
September	1487
October	1300
November	924
December	298
Total	17,688 gallons - 4,879 barrels*

Calculated by
* Using conversion factor 1 bbl. equals 29 lbs. meats. A better value based on the mean production per bbl. would be considerably below this.

Seasonable Growth and the Effect of Disturbance on the Growth of Clams.

Bideford River.

In April while there was still ice floating in the water a series of six 2'x2' plots was staked off on the beach of Bideford river near the biological station and 200 feet east of the site of Forbes' house. The area chosen was in the middle of a native clam bed that is exposed only during the lowest low tides each month and probably for less than 5% of the total time. The soil was a mixture of tough red clay and sand. To start with the ground was dug to a depth of about 15 cm., and the native clams removed. On April 29 each plot was stocked with approximately fifty small clams taken almost entirely from the upper part of the bar on the north side of the mouth of Claud Williams' creek on April 28. A notch about 1 mm. deep was filed in the mid-ventral margins of the shells. As far as could be judged no 1944 shell had been secreted up to this time.

At intervals throughout the open water season these plots were dug up successively and the clams measured and replanted. At the time each new plot was dug up all the lots handled up to that date were also redug, remeasured and replanted. The clams were seldom out of the water more than 3 hours at these times. In measuring, the height of the left valve from the umbone to the free margin to the nearest mm., was taken at right angles to the long axis of the shell. The original size listed as for April 29th in Table 14 was determined at the time of the first digging of each plot by measuring the height from the umbone to the file notch.

The last digging of the season on November 27th was carried out with some difficulty by the technician, Miss Morrison, after the writer had left the P.E.I. Biological Station for St. Andrews and only plot 2 was sampled. Further observations are to be made in the 1945 season.

The results to date appear in table 14.

The Sissiboo Tests.

The Sissiboo experiment was essentially like that described for Bideford river but the plots, of which there were eight measuring $2\frac{1}{2}$ ' square, were set up somewhat later. They were located 217' below the 75' plot on the beach on the government reserve where the soil is a tough gray clay. One hundred clams were placed in each plot and they were all "normal" and of identical size -- $1\frac{8}{32}$ " long -- fished from the adjacent soil. The numbers of the plots and the planting dates were -- 1, May 4; 2 and 3, May 5; 4 and 5, May 6; 6, May 8; 7 and 8, May 9. At these times there was already some indication that 1944 shell growth was beginning.

All measurements in this test were made to the nearest thirty-seconds of an inch.

The results of this experiment appear in table 15.

Newcombe's (1935) graph has been used to transform the Bideford shell heights to corresponding shell lengths (see table 16 and foot of table 14) thus permitting a more particular comparison of the results of the two experiments throughout the season.

There is much variation in the ease with which the marginal growth of new shell of the year can be distinguished from older shell. Petpeswick stocks retain the golden-yellow periostracum covering it for a long time and the Sissiboo clams for a somewhat shorter period. In Bideford it appears to be present for a long time but its natural colour is always masked by the red colour of the shells. This is produced by iron salts absorbed from the clay. For these reasons an examination of shells is not always very informing and tests like these may be required to show even the most general features of growth.

Conclusions

1. The season's growth in Bideford river was approximately twice that at Sissiboo.
2. At Bideford digging and replanting several times during the season stimulated growth. This may be related to the progressive loosening of the soil during the year by the mixture of the surface sand with the deeper clay. At Sissiboo disturbance clearly retarded growth. There the soil is a homogeneous clay of a compact but sticky nature.
3. At Sissiboo the months of most active growth appear to be June and July -- at Bideford, July and August, table 16. From what is known of the hydrography this difference suggests that temperature is probably not the controlling factor in growth regulation and that some other explanation should be sought.

From what little has been seen of Petpeswick stocks they seem to resemble Sissiboo clams in having their maximum growth in spring. It was observed there that the peak production of planktonic diatoms occurred in spring rather than summer suggesting that food supply may be controlling growth.

4. No appreciable shell growth took place after mid-October. At that time the Bideford water temperature ranged from 9 - 10°C and declined thereafter. It was below 5°C on November 27. There seems to have been a slight but almost consistent dropping off in lengths in Sissiboo lots handled in late fall such as has been noted in handling oysters and could be attributed to erosion and breakage in handling (Medcof 1942). It may be, on the other hand, that the clams erode their shells when digging in to their appropriate levels but fail to replace it by secretion after October bringing about the apparent shrinkage.

It is planned to continue both experiments into the spring of 1945. Information gathered then will show what growth, if any, occurs during winter, what effect late fall digging and planting has on survival and the significance of the shell annuli which are now supposed to be annual rings.

Table 15. Summary of results of Sissiboo river experiment on seasonal growth and effect of disturbance on growth of clams.

Lengths in 32nds Inches	Frequency Distributions														
	Plot 1			Plot 2			Plot 3			Plot 4					
	June	July	Sept.	Oct.	Nov.	Sept.	Oct.	Nov.	Sept.	Oct.	Nov.	Sept.			
	15	31	5	16	25	5	16	25	5	16	27	14	27	28	28
40	9														
41	2	1													
42															
43	20	1	3												
44	13	3	3	2	2	2	1	1	1	7	2	3	4	1	4
45	12	5	5	7	6	4	2	2	2	1	2	1	1	1	2
46	5	9	10	5	6	4	3	1	6	6	4	3	9	7	6
47	1	3	6	2	2	3	1	1	7	6	4	3	9	7	6
48	2	23	8	12	7	15	14	7	6	6	8	2	9	7	6
49	5	13	6	8	16	4	6	8	4	16	13	14	8	7	6
50	6	9	10	8	9	15	7	4	4	16	13	14	8	7	6
51	3	5	10	10	8	9	7	9	9	9	9	4	8	9	4
52	4	7	9	8	6	14	11	9	17	11	9	11	12	7	7
53	3	2	2	2	4	2	4	6	4	6	10	6	7	11	7
54		3	3	4	1	3	3	2	9	3	6	11	8	6	6
55		1	2	1	1	3	2	2	1	6	4	2	3	3	3
56		1	2	1	1	1	3	2	1	6	4	2	3	5	1
57		1	2	1	1	1	2	2	3	2	2	3	5	1	7
58		1	1	1	1	1	2	2	3	2	2	3	5	1	3
59															
60															
61															
62															
63															
64															

No.	Measured	95	85	78	74	59	80	76	67	54	85	71	70	72	55	62
Av.																
Length	43.1	47.1	48.6	49.7	49.4	46.6	49.8	50.5	50.2	51.2	51.4	51.4	51.1	51.3	51.3	51.4
Season's Increase (Original length ₃₂ ^{40"})	9.4									10.2			11.1		11.3	11.4

Table 16. Summary of data on seasonal growth of clams in Biddeford and Sissiboo rivers, 1944.

Time Interval	Number of Days	Amount of Growth	Growth per Day	% Increase per Day
<u>Biddeford river plots #1 & 2</u>				
April 29 - June 6	38	m.m. 1.4	m.m. 0.037	0.25
June 6 - July 6	30	1.9	0.064	0.39
July 6 - Aug. 21	46	4.0	0.087	0.48
Aug. 21 - Oct. 13	53	2.2	0.042	0.19
Oct. 13 - Nov. 27	45	-0.1	-0.002	-0.08
<u>Sissiboo river plots #1 - 5</u>				
May 6 - June 15	40 ^{32nds"}	3.1	32nds" 0.078	0.19
June 15 - July 31	46	5.5	0.12	0.28
July 31 - Sept. 8	36	2.6	0.072	0.15
Sept. 8 - Oct. 16	41	0.1	0.0024	0.05
Oct. 16 - Nov. 25	40	0.1	0.0025	0.05

$$\% \text{ growth} = \frac{\text{Growth during period (m.m.)}}{\text{Size at beginning of period (tables 14-15)}}$$

Possibilities of Clam Farming in Merigomish Harbour, N. S.

and

The problem of salinity controlling growth rate.

On May 4, 1944 Mr. George W. Mason of the Merigomish oyster company addressed Dr. C. J. Kerwill requesting information on the possibilities of clam farming on the sand flats inshore from his oyster lease which is situated at the upper end of the east branch of the harbour.

The area was examined by the writer on July 11th. Native clams were found in fair abundance between low and half tide level in the gravel and red clay soil of Smith's gut. These were all small averaging 1 - 2 " in length and very thick through for their length. The shells were white and rough with sharply-defined, closely-set annuli. There were few 1945 seed and clams over 2" were rare. All had unmistakable signs of severe stunting.

Ingalls and Needler (1941) report clams from Smith's gut and the small island lying opposite it but from no other area in this section of the harbour. The water temperatures at the time of the visit were well above 20°C. and there are strong tidal currents all along the shores. There are no records available but judging from the position in the harbour, the salinities must be low. Oysters thrive throughout the inlet.

There are what appear to be excellent sand flats for clams on the north side of the inlet opposite the island and extending at least a mile towards the outlet but these are completely barren of clams.

The writer's general impression from observations in the Bras d'Or lakes and elsewhere is that oysters can thrive at lower salinities than clams. Low salinity seems to be the most likely explanation of the peculiar conditions at Merigomish.

It was intended to make a trial transplant of marked Petpeswick clams to these flats but it was not done in 1944. It is hoped that it can be arranged for 1945. Their growth would be compared with that of marked natives both at Merigomish and Petpeswick. At the same time some hydrographic observations would be carried on at both places. A similar test of the effect of salinity on growth could be set up at MacKinnon's harbour and Stony point in the Bras d'Or lakes where salinity conditions are already fairly well known. The results of these tests would be valuable because they would be applied to similar situations that are not uncommon in the Maritimes.

Report on the Maissonnette Clam Fishery

In a memorandum for the Assistant Deputy Minister of Fisheries dated at Ottawa, August 11th, 1944, Mr. R. G. MacKay summarized the situation which has developed at Maissonnette. At Dr. Heedler's request the writer visited this area November 7 to 9 after discussing the matter with Supervisor Collette at Newcastle on November 6.

The flats were examined in company with the Department's local fishery guardian, Mr. Harry Godin, who is well acquainted with the ground and with all phases of the problems in question. The first visit made November 8 proved unsatisfactory because heavy northeast winds prevented the tide from dropping very low and made the water riley. The second visit was made on November 9. The wind by this time had dropped and shifted to northwest allowing the tide to drop until only 8 to 10 inches of clear water overlay the entire clam fishing area. Under these conditions it was possible to see the bottom clearly and sample the clam population with a "peche-coque" which is the standard local clam fishing tool and can be used for "wet digging".

The Flat

The area populated by clams is surprisingly large, very flat, almost level and high enough to be exposed at almost every low tide, even during neaps. Its approximate extent is represented in the accompanying sketch by stippling. In width it averages well over $\frac{1}{2}$ of a mile. Off Joe Cormier's point the soil near shore is clayey but southward it changes quickly to firm sand mud and at the southern extremity to almost pure sand which is slightly rippled. The whole area looks like excellent clam ground. There is a light growth of eel grass with short blades and a fair population of good quality oysters over the entire area. Just eastward from Joe's point a cove makes in to the northward. The bottom of the inner half of this is of soft mud, the outside part is of firm sand-mud similar to that off Jop's point except for a band along Sandy point where it is of fine sand which is brown near the surface and black below.

Clam Population

There is a sparse population of clams over the whole area but rarely does it exceed ten and probably averages no more than one per square yard. In the Fundy such ground would be considered more than "dug out" and would be left alone. Fishing with a clam hack of the regular type would have been out of the question long before the population was reduced to this level. At Maissonnette, however, the fishing is done with a "peche-coque" which is a narrow iron spade three to four inches wide and six inches long with a wooden handle three to three-and-a-half feet long. The practice is to dig up clams individually, turning over only a few square inches of soil with each clam. This method has made it profitable to pursue the fishery until this extreme state of depletion has been reached.

The clams are almost all large and old. The shells, judged by Fundy standards are thin, but they are not quite so fragile as those at Petpeswick, N.S. The spacing of their annuli indicate fast growth; the meats are of excellent quality, fat and white. The 1944 shell pile of the local clam cannery was examined. It also contained only large old shells, few of them less than three inches in length.

According to Inspector Landry of Grand Anse the clams taken from this area for the past several years have all been large and the average size has steadily increased. The local fishermen state that the abundance of the clams has at the same time steadily decreased. These reports combined with the writer's observations just reported suggest that it is several years since the last important set of seed clams took place and that the Maisonnette clam fishery will be worse before it is better. A little more fishing will be possible and after that there will be nothing left to exploit until another set occurs and a new population grows up to fishable size. This can be expected to take at least five years and probably more.

The history of the Maisonnette flats seems to be similar in all important respects to that of the big flat opposite the government wharf at Petpeswick, N.S., where a commercial scale transplant of seed clams was made in October of this year.

The Sandy point bed is not the only area in Maisonnette where there is a commercial fishery of clams. There is a heavier population at present westward along the shore right up to Riviere du Nord with a minor concentration at the Poiriers'. The soil is hard and clayey and the flats narrow and so low that they can be worked only at low spring tides. These grounds are several miles from Maisonnette proper and are inaccessible to the people of the fishing village even when tides are suitable.

Interviews

Besides examining the clam areas the writer interviewed the following people and discussed the various aspects of the Maisonnette clam fishery.

Coed fishermen (there are 40 to 50 of these in the village and they represent the main earning power of the community.)

William Hache,
Michael Hache,
Bernabe Godin.

Clam diggers, not coed fishermen, who sell to the cannery (there are about thirty of these in the village mostly women and children)

Romeo Blanchard
Alphonse Poirier.

Roxish

Others - the local priest, Pere La Montagne
the fishery guardian, Harry Godin
the cannery operator, William Boudreau.

There was general agreement among the fishermen that clams are the only satisfactory cod bait that can be used on the fishing grounds visited by the Maisonnette boats. Frozen herring, they claim, does not work. They find bar clams (Maotras) as good as, if not better than, soft shelled clams and during the occasional low spring tides they fish these on the outside of Sandy point where they abound.

All these people except Mr. Boudreau agree that the soft shelled clams are getting scarce and none but he was opposed to the idea of setting aside a reserve area from which clams might be taken for bait only. Mr. Boudreau's objection was very mild.

The proposed reserve lies shoreward, that is north and northeast up to high tide mark, from an imaginary line drawn from a point at high tide mark on the southern end of Sandy point to a point where the line fence bounding the western side of Joe Cormier's lane if extended in a straight line southward would intersect with the high tide mark on the beach. On the accompanying chart this area is hatched. The reserve would include approximately half the clam area at Sandy Point.

Conclusions and recommendations

1. From the results of the survey and discussions reported above it seems reasonable and fair to all parties to grant the request for the reserve.
2. If this reserve were established it would probably result in only temporary relief of the bait shortage because there is at present only a very scanty population of clams left and there is no promise of a regular supply from year to year.
3. For a fundamental solution of the problem one or both of two things should be done; (a) an area should be reserved with soft shelled clams to see if a dependable supply of bait could be furnished by clam farming in the area; (b) a method independent of tidal conditions should be developed for exploiting the local beds of bar clams which are said to be extensive.

of

The Problem Size Limit in the Five Islands Clam Fishery.

On file at the Atlantic Biological Station are two MS reports, "Preliminary report on the problem of size limits in the soft-shell clam fishery of the Five Islands district, N.S.," submitted in April 1944, and "Summary of information on the Five Islands Clam Fishery gathered May 7-9, 1944" submitted in May 1944. In these the writer has outlined the general situation at Five Islands and explained the need for the investigation which was carried out. The text of the account which follows consists chiefly of excerpts from these two earlier reports. However, the data on which the growth curves and the size frequency polygon (Fig. 2) are based have not appeared before. Likewise the first detailed description of the Five Islands flats is presented here and appears in the section entitled, "Surveys of Clam Flats". Only a summary account of these appeared in earlier reports.

Size-Frequency Composition of Commercial Catch.

When the writer visited the cannery he examined approximately 50 bushels of clams that were being prepared for processing. Almost all these had been fished from a single area just east of the mouth of North river where the diggers have been working all spring. The catch was so uniform that it was decided that the small sample taken (102 clams) would suffice for a size-frequency study. Figure 2A and Table 17 shows the size-frequency distribution of the clams which was approximately as follows:

Below $1\frac{1}{2}$ inches	-	6%
$1\frac{1}{2}$ " - 2 "	"	- 48%
2 " - 2 $\frac{1}{2}$ "	"	- 36%
Above 2 $\frac{1}{2}$ "	"	- 10%

The fishermen present explained that a few larger clams are to be found along channels in the flats. This condition may explain the presence in the catch of the 10% of the legal-sized clams.

Examination of Pack.

To study the cannery's product, two cans of clams of the May 1944 pack were purchased. On opening these the bouillon was found to be rather dark but otherwise good. There was a considerable amount of sand and gravel and bits of shell loose in the cans and some of the meats contained much sand. All the clams were small. The number in one can was counted and it proved to be 56.

In general, the meats were highly coloured, the mantle margins, the siphon-retractor muscles, and the bases of the siphons were a bright yellow colour. The adductor muscles were white and the visceral mass a brownish grey colour. If these two cans can be considered typical it is plain that there is room for considerable improvement in the methods of processing clams at Five Islands.

Figure 2.

A

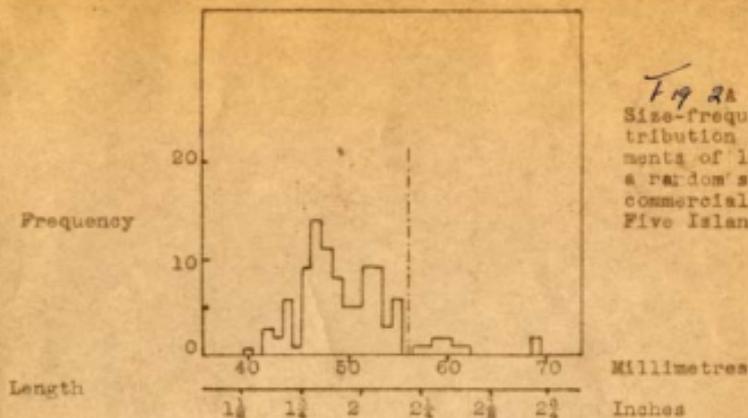


Fig 2A
Size-frequency distribution of measurements of 102 clams in a random sample of the commercial catch at the Five Islands cannery.

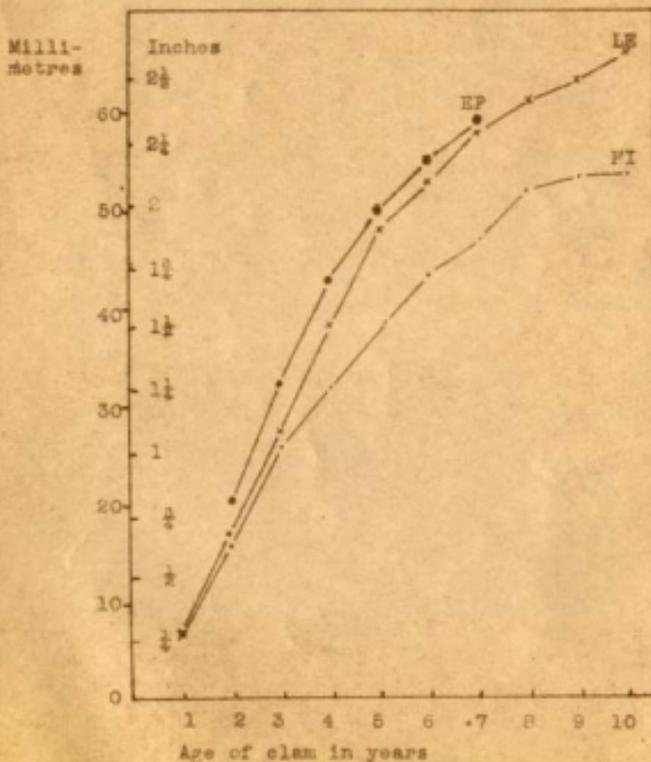


Fig 2B
Growth curves for clams as determined from a study of "annual" rings.

EP. Curve for Economy Point (After Newcombe, 1935).

LE. Curve for Lower Economy, based on measurements of 109 rings on 13 clams.

FI. Curve for Five Islands, based on measurements of 128 rings on 14 clams.

Growth Rate

In Figure 23 three growth curves for clams are presented. These are based on measurements of shell-rings that have been interpreted as annual. The validity of these interpretations is still in question but without other information they are the only guide we have in estimating growth rates. The Five Islands and Lower Economy curves are based on observations made by the writer. The Economy point curve is taken directly from Newcombe's report (1936).

It would be seen that the two Economy curves applying to clam populations that are not far apart, check very well. The legal size ($2\frac{1}{2}$ ") is apparently reached in 6 to 7 years which, according to Newcombe is about one year longer than at St. Andrews, N.E.

The Five Islands curve suggests that few clams there ever reach legal size. At about the age when Economy clams reach $2\frac{1}{2}$ " (6 to 7 years) the Five Islands clams attain $1\frac{1}{2}$ " and thereafter show a marked decrease in growth rate. The growth levels off at approximately $2\frac{1}{8}$ ". This condition would explain Mr. Cogswell's statement that even in 1936 after the beds had been idle for six years there were very few clams $2\frac{1}{2}$ " long.

Table 18 summarizes the measurements made on the lengths and heights of successive "annual" rings of clams taken in the commercial catches from the flats just east of the mouth of North river. Table 19 includes similar data for a sample of clams taken by the writer from the middle of the flat at Lower Economy.

In compiling such records heights can usually be determined more precisely than lengths. For comparison with published records, however, lengths are required. Accordingly, measurements were taken of both lengths and heights of the rings on several specimens (Tables 18 & 19). When heights are plotted against lengths a recti-linear curve is obtained that does not pass through the origin. For purposes of comparison the relationship for both Five Islands and Lower Economy stocks approximates $L = 2 + 1.6H$.

Summary

1. Airforce bombing and gunnery practice in Minas Basin has so seriously restricted other fishing activities that clam digging has become one of the few sources of income left to an important part of the community about Five Islands.
2. The clam-producing flats and the clam populations there are vast - much greater and potentially more important commercially than has been previously reported.
3. Canned clams from Five Islands are said to be so well received on the markets that they should command a preferential price in peace-time, thus counterbalancing the higher processing costs which their small size involves and permitting a permanently established industry.

Table 17. Size frequency distribution of lengths in m.m. of 102 clams from commercial catch at Five Islands, May 8, 1944.

Size	Frequencies	
40	1	
42	3	6
43	2	
44	6	12 ⁿ
45	1	
46	9	49
47	14	
48	11	
49	8	2 ⁿ
50	5	
51	5	
52	9	
53	9	37
54	3	
55	6	2 ¹ ⁿ
57	1	
58	1	
59	2	10
60	2	
61	1	
62	1	
69	2	

Table 18. Heights of "annual" rings in m.m. with some corresponding lengths (bracketed) on shells of clams from commercial catch at Five Islands.

Specimen No.	Corresponding Age in Years									
	1	2	3	4	5	6	7	8	9	10
1	4	11	12	17	20	23	25	29	31	32
2	4 (10)	10 (17)	17 (25)	19 (34)	25 (40)	29 (48)	31 (54)	33 (57)		
3	4	8	16	20	22	25	28	30	33	
4	2	9	14	18	21	24	26	28	29	
5	3	9	11	18	21	25	28	31	32	
6	4	10	15	20	24	26	29	29		
7	3	9	14	17	21	24	26	30	31	
8	2 (4)	7 (13)	14 (24)	18 (32)	21 (38)	26 (48)	30 (53)	32 (57)	34 (61)	
9	4 (8)	12 (22)	19 (32)	24 (40)	27 (43)	30 (46)	31 (49)	32 (53)	33 (54)	36 (56)
10	4 (8)	10 (17)	15 (25)	17 (30)	21 (39)	25 (43)	29 (48)	31 (51)	32 (54)	
11	5	10	22	28	32	35	37	39		
12	3	6	13	16	21	23	25	28	31	33
13	3	8	11	17	20	23	25	27	29	31
14	2	6	12	16	22	26	30	33	35	

Table 19. Heights of "annual" rings in m.m. with some corresponding lengths (bracketed) on shells of clams from middle of flat at Lower Economy - May 8, 1944.

Specimen No.	Corresponding Age in Years									
	1	2	3	4	5	6	7	8	9	10
1	4 (7)	10 (17)	21 (38)	26 (44)	29 (52)	31 (56)	32	34	35 (58)	
2	--	10	17	24	31	34	36	37	39	42
3	4 (9)	8 (16)	18 (31)	22 (48)	--	--	--	--	--	--
4	3 (6)	10 (18)	17 (28)	25 (39)	29 (46)	33 (52)	35 (54)	37 (58)		
5	3 (5)	9 (14)	13 (22)	27 (44)	30 (50)	35 (56)	37 (61)	39	41 (51)	
6	4	10	20							
7	3	11	21	26	27	32	35	39	41	42
8	4	9	16	26	31	32	37	39	41	
9	5	9	14	22	25	29	32	34	35	37
10	4	9	17	25	29	33	37	39	41	43
11	4	10	16	24						
12	3	12	18	28	32	33	35	37		
13	3	10	16	25	33	37	40	42		

4. At present the activity of the cannery provides gainful employment for close to 50 local people and everyone involved seems to be well satisfied with the present set-up.

5. The clams are small and occur on high clay flats that are exposed for long periods at low tide, only 10% of the catch is above the legal size.

6. The clams are slow-growing, measuring only $1\frac{1}{2}$ " in length at an age of $6\frac{1}{2}$ years when clams in most areas have reached a length of $2\frac{1}{2}$ ". Many clams probably die of old age without reaching the $2\frac{1}{2}$ " limit.

Recommendation

From the study just reported it would seem reasonable and wise to reduce the size limit at Five Islands to a length of $1\frac{1}{2}$ " at least temporarily and probably permanently.

There is no evidence to indicate that such an alteration would jeopardise the fishery resource in any way. Judging from the shape of the growth curve for these clams, $1\frac{1}{2}$ " would be the most efficient size at which to harvest the population because it is just at this size that the old-age depression in growth rate sets in. The altered regulation would not only protect the fishery resource but at the same time would provide a livelihood for the small community that might otherwise have to be partly dissolved for at least the duration of the war.

Following this investigation the size limit in the Five Islands area was abolished. Order in Council May 12, 1944 -- See Canadian Gazette of May 27.

Observations on Clams held in a Floating Tray.

On June 7, 1944, a sample of 200 clams of various sizes dug from the sand pit 200 feet west of the Biological Station landing stage was placed in a 2' x 4' floating tray with a quarter-inch-mesh, wire-cloth bottom. This was moored at extreme low tide level over a bed of eelgrass that went dry at low tide only once or twice a month.

The clams were examined several times during the season and finally removed on November 16. By this time practically all the clams less than 2½" long were dead. The wave action had tossed them about with the larger heavier animals and had broken their fragile shells.

As compared with clams freshly dug from the sand the surviving animals were thin-shelled and weak. They were unable to close their shells or withdraw their siphons normally.

In this five-month period there was no apparent growth in height or length. The only obvious shell secretion was a narrow band about 2 m.m. wide and 1 m.m. deep deposited marginally on the inner edge of the valves.

Apparently life in the floating trays is not congenial to clams and it seems unlikely that such a device would not be useful for conditioning clams if they are to be held for any length of time.

Mud Blister Worms in Oysters.

Only a few new observations were made this year on Polydora ciliata but the findings since 1938 when the worm was first reported from Canadian Atlantic oysters (Medcof 1938) have been assembled and submitted for publication in the Journal of the Fisheries Research Board, (Medcof 1945). *PLC*

On September 2, 74 oysters were fished from the muddy cove immediately west of the Prince Edward Island Biological Station warehouse in Bideford river and examined for Polydora. Of these 24 showed a total of 35 recognizable blisters of which 11 were on upper valves and 24 on lower *PLCS*

The blisters were remarkably inconspicuous, small in size and contained little mud. Sometimes they opened well back from the shell margin and were in the thicker medial parts of the shell where they could be detected only by holding the shell before a strong light.

The worms seemed smaller than those from the Bras d'Or lakes.

Several specimens were dissected out and sent to Mr. and Mrs. C. J. Berkeley of Nanaimo, B.C. who identified them as P. ciliata. Samples of Bras d'Or worms the writer submitted earlier to Mr. Berkeley were re-examined because Hartman (See Loosanoff and Engel 1943) has set up a new species P. websteri on somewhat dubious grounds. It is worth while quoting an extract from Mr. Berkeley's correspondence in this connection.

"We have been reexamining your Polydoras in the light of the Hartman paper describing P. websteri, which we had not seen until your letter of the 22nd. Inst. drew it to our attention. Taking that paper at its face value the results are these. All the specimens from Bideford River are P. ciliata. Two of those from Bras d'Or Lakes are that species, whilst two, and a doubtful third, are P. websteri! This latter finding seems very improbable and we don't believe it is true. The greater length of the caruncle in P. websteri may be a valid differentiation, though it amounts to very little, but the form of the specialized setae of the 5th setiger is known to vary a lot in P. ciliata according to age, wear, & c. and it may be practically the same as that attributed to P. websteri when they are well worn. In any case, even if constant, it is very doubtful whether the differences are sufficiently great to warrant the establishment of P. websteri as a new species."

Besides the studies outlined above several lots of oyster shells were examined in November at the Gulf Trading Company's plant at Shippegan, N.B. where oysters were being shucked. In a sample of between 150 and 175 valves of oysters from the South Branch of the St. Simon river only two with blisters were found. Sixty valves of Tracadie oysters were examined but only one of these bore a recognizable blister. No worms were obtained from either of these areas.

Occurrence of the Oyster Crab in Canada.

Dr. L. A. Stauber of the Squibb Institute for Medical Research addressed the writer on April 21, 1943, requesting specimens of and information concerning the oyster crab Pinnotheres ostreum. The writer has opened several thousand oysters from various districts during condition studies and has never found a single specimen and stated in his reply that to his knowledge the species was not present in our waters.

Since that time Mrs. A. W. H. Needler has reported verbally that one summer between 1932 and 1937 about August during her study of sex reversal in Biddeford river oysters she found one or two specimens. As well as she can remember the oysters came from one of the up-river beds, she thinks the Totten bed. To the best of the writer's knowledge this is the first and only observation of the species in eastern Canada and deserving of mention on this account. It is not reported by Rathbone (1929) in her account of Canadian Atlantic Decapoda.

Green Oysters.

On October 3, Inspector E. G. Long of Richibucto, N.B. forwarded a sample of Richibucto river oyster meats to the Atlantic Biological Station for examination. The gills of these were a pale pastel green colour. On almost the same date Inspector H. Robichaud of Shediac sent a sample of similarly tinted oysters from the mouth of the Abouchagan river to the P.E.I. Station. On December 11, Inspector B. Barnes of Salisbury forwarded a lot of oysters in the shell with much darker bluish-green gills to St. Andrews. These came from the Shemogue river, N.B. and were marketed in the Salisbury district.

There seems to be no doubt that this is the same condition reported by Hunter & Harrison (1928) and others, from the Atlantic states. It develops when the oysters ingest and extract a dye from quantities of the diatom Navicula fusiformis var. ostrearia.

Dr. A. W. H. Needler reports that about ten years ago samples of green oysters from Caribou, N.S., and Orwell river, P.E.I. were sent to him for examination.

In 1939 the writer observed a milder form of the discoloration in Bras d'Or lakes oysters but it was too inconspicuous to come to the attention of the industry.

In some cases oysters are found to be green throughout their bodies. This is generally caused by a dye that contains a copper ion (Galtsoff & Whipple 1930) and is of quite a different nature from the colouring just described.

The green colouring regardless of its nature seems to be harmless to consumers and is not an index to the sanitary condition or wholesomeness of the oyster.

recently
ARC
These findings will be more fully discussed in a recent paper, submitted for publication in the "Acadian Naturalist" (Medcof 1945).

The 1944 set of oyster spat in Tracadie Lagoon, N.B.

In the writer's 1943 N.S. report to the Fisheries Research Board, the irregularity of successful spatfall in Tracadie Lagoon was described and its bearing on the oyster industry there was discussed.

On November 9th while at Shippegan the writer washed and examined 25 adult Tracadie oysters from a lot that was being packed for shipment. These were of the same general character as those described last year. They have many young Crepidula which one of the fishermen, Mr. Hammond and many of the packers have consistently mistaken for oyster spat. In addition, however, two live oyster spat were found. These measured 3 - 4 m.m. in diameter. Thus it is possible even with the present scant population of adult oysters to get a set of seed in the lagoon. If the area were ever well stocked by importing oysters from outside sources, local spat production might be sufficient to maintain the population without further transplantations.

Association of the Snail *Gastromia* with the Soft-shelled Clam.

In the autumn of 1943 it was noticed in the laboratory while examining a clam fished from Bideford river that there were several small snails, apparently of a single species of *Gastromia*, adhering to the ends of the siphon near the two openings. When the siphon was contracted they were buried in its epidermal folds and hidden from view. At that time the association was regarded as probably adventitious because the species is commonly found living free on the tide flats. This summer, however, repeated observations of the same phenomenal association were made in the field at various points in Bideford river. Almost all the clams in the sand spit to the west of the Biological Station were found to harbour some snails and several instances were encountered where 8 to 10 snails measuring 1 to 3 m.m. in length were present on a single large clam. When the clam contracts the siphon, the snails move up and down the burrow with it apparently making no attempt to escape from their position.

Many peculiar relationships between various species of mollusks are discussed in the literature but as far as the writer is aware, this one has not been previously described. Nothing further is known of it but it is so peculiar as to warrant mention here.

Petpeswick Experiments to Determine the Digging-in Ability of Clams.

Report by Leo P. Chiasson.

Since different types of soils may affect the ability of clams to dig in, tests similar to those performed at the Siasiboo, (Ingalls 1942), were set up

The soil at Petpeswick Cove, where these experiments were set up, is sandy with a considerable proportion of mud. Even at low tides certain parts of this area retain an amount of surface water.

For these experiments the soil was not prepared in any way.

The clams to be planted were obtained from an area being dug to accommodate a Latin Square experiment on the effect of crowding and stunting on the growth of clams.

Experiment I.

On June 12 a quantity of clams was saved from the digging operations during the early morning tide. During the day these clams were kept in the shade, sorted into three size groups, (Table I), and marked along the edge with a triangular file to give a "V" mark (the large ones being excepted). At dusk these clams were placed on the surface within a small staked area. The next morning, that is, at the next low tide, the number of clams still remaining on the surface was determined. On June 22, the clams in these plots were dug, and the marked ones were counted and recorded. Table 20A summarizes the results.

Experiment II.

The purpose of this experiment was to determine whether or not clams could dig in after a period of exposure. The experimental details were the same as in Experiment I excepting the facts that the clams, which were dug on June 12, were kept in jute bags in an open shaded shed for 3 days, and that all the planted clams were marked with a file. Since other more pressing obligations demanded the workers' time during several of the low tides following planting, no record was taken of the number of clams on the surface at the next low tide. The planted area was dug up on June 25, 10 days after planting, and the numbers of marked clams recovered were recorded. Table 20B summarizes the results.

Experiment III.

This experiment was devised to eliminate the possible effect of the tide in shifting clams from the planted area. The area, 4 ft. square, was enclosed by window screening attached near the surface to four corner stakes. The clams used in this experiment were all smaller than 45 mm., and marked along the ventral border with a file. Between digging and planting, on June 26 these clams were kept out of water in the shade about 12 hours, (that is, between morning and evening tides). At the first low tide following planting, the clams remaining on the surface were counted; four days

later, the area was dug to determine the number of clams that had buried themselves. Table 20C summarizes the results.

Conclusions.

Experiment I.

1. Very few large clams were successful in burying themselves.
2. Small- and medium-sized were about equally successful and usually bury themselves soon after they are covered by water.
3. Although Ingalls' data (1942, table 18) do not permit a strict comparison it is clear that clams of small and medium size are more successful in burying themselves on undisturbed sand flats at Petpeswick than on undisturbed clay flats at Sissiboo.

Experiment II.

4. Exposure for three days in air greatly reduces the ability of the clams to bury themselves.
5. The deleterious effect of exposure is much more severe in the case of small- than of medium- or large-sized clams.

Experiment III.

6. Tidal currents and wave action are important factors in removing clams from the areas on which they are planted.

Table 20.

A. Burial of clams on undisturbed flat after 12 hours exposure in air.

Stock	No. Planted	No. on Surface at Next Low Tide	No. Recovered	% Recovered
Small (<32 mm.)	260	26	165	64
Medium (32-57 mm.)	336	41	231	69
Large (57-73 mm.)	75	75*	0	0

*10 had started to dig in.

B. Burial of clams on undisturbed flat after 3 days exposure in air.

Small	65		8	12
Medium	479		172	36
Large	228		15	7

C. Burial of clams in a screened enclosure on undisturbed flat after 12 hours exposure in air and planted.

Medium and Small (<45 mm.)	200	16	183	92
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Survival of Petpeswick clams after artificial burial in various positions and at different depths.

Report by L. F. Chiasson

To determine the ability of clams to survive artificial burial in various positions, a simple experiment, resembling that at the Sissiboo (Ingalls 1942) was set up on the flats in Petpeswick Cove. The soil here is fairly loose and sandy with a good proportion of mud and remains rather wet even at low tide. It differs radically from the heavy clay of the Sissiboo. The ultimate purpose of the experiment was to obtain an approximation of the mortality of clams accidentally buried during the turning up of soil in commercial digging.

In making the artificial burials a trench about six inches wide and of the depth specified was first prepared on the flat. The experimental animals were then placed on the bottom of the trench in the position specified -- normal, on side, or upside down. In this respect the procedure differed from that which Ingalls followed at Sissiboo where the clams were all placed singly in holes made in the soil with a two and a half-inch auger bit.

The experiment was divided into two parts; burial in mulched soil (worked up to a depth of six inches with a clam hoe) from which the native stock was first removed and burial in soil that was unprepared except as was required by the burial operation itself.

All the clams were planted on July 7. Those used in the first part of the experiment were unmarked; those buried in the unprepared soil had a "v"-shaped notch filed into the ventral margins of their shells. They were dug out on September 10. The results are summarized in table 2L.

Conclusions

1. Even when clams are planted in the "normal" position there is a considerable mortality produced by the handling.
2. The position in which the clams are planted did not greatly affect the relative numbers that survived.
3. More clams survived shallow than deep burial.
4. The mulching of the soil had no apparent effect on the survival.
5. The results of the experiment lack the consistency of the Sissiboo trials reported by Ingalls and should be repeated. The effects of burial at greater depths should also be checked.

Table 21. Survival of Clams after Artificial Burial

Stock	Depth of Burial	Position	No. Planted	No. Recovered	% Recovered
<u>Mulched Soil</u>					
Large (over 55 mm.) (unmarked)	2"	On side	65	34	52
	2"	Upside down	65	55	85
Medium (32-51 mm.)	2"	On side	140	111	80
	2"	Upside down	140	91	65
	2"	Normal position	140	92	66
<u>Unprepared Soil</u>					
Medium (marked)	2"	On side	97	64	66
	2"	Upside down	98	71	72
	2"	Normal position	65	35	54
	4"	On side	150	57	38
	4"	Upside down	150	77	51
	4"	Normal position	70	30	43
Large (marked)	4"	On side	59	59	100
	4"	Upside down	58	12	21
	2"	Upside down	41	14	34

Depth of burrow relative to size of clams

The depth to which clams bury themselves in the soil may be of importance in survival. This possibility suggested itself this summer while the writer was at Petpeswick studying the "Big Flat". The surface soil on this flat is shifting sand and the few clams found there, although vigorous, are deep in the soil and all large and old suggesting that conditions are unfavourable to the survival of small stock. General observations indicate that the depth of clams in the soil varies directly with their size and is effected by the character of the soil, the level on the beach and the nature of the clams themselves i.e. whether they are stunted or normal. Some fishermen claim, furthermore, that clams alter their depth with season being deeper in the soil in winter than in summer and with the stage of the tide. However, as far as the writer is aware, there have never been any precise measurements to substantiate any of these conclusions.

During the past summer several sets of observations were made that should clarify some of these problems. In making these a trench was dug in the flat at low tide and the walls carefully dug away so as not to disturb the positions of clams in the soil when they were encountered. When one was found its depth from the surface of the soil to the upper end of the valves was measured with a millimetre scale. To get an accurate idea of the level of the soil surface a planed board was laid flat on the soil and its end allowed to project over the trench. The "depth" measured was the distance from the valves to the lower edge of the board. To date the pressure of other work has prevented the analysis of the data gathered. These are reported in tables 22-30.

Other data pertinent to this problem are reported in the section entitled, "The burrowing activity of clams subsequent to burial".

From the appearance of the burrows it was concluded that the clams do not change their vertical positions in the soil very frequently. The burrows always conformed very neatly to the shape of the shell and siphon and the walls were packed hard both above and below the shells. If the clams changed their levels at short intervals these conditions would not be expected.

Table 22. Size-depth relationship of normal clams from intermediate beach level, Siasiboo, June, 1944: tough clay soil.

Shell length		Depth in soil		Shell length		Depth in soil	
m.m.	32nds.	m.m.	32nds.	m.m.	32nds.	m.m.	32nds.
13	16	19	24	52	66	56	70
14	18	14	18	53	67	51	64
16	19	19	24	53	67	71	89
16	20	11	14	53	67	71	89
16	20	16	20	57	72	78	98
16	20	19	24	61	77	78	98
16	20	32	40	65	82	59	74
17	22	25	32	75	94	52	66
17	22	25	32	75	94	57	72
18	23	24	30				
18	23	25	32				
21	26	19	24				
26	33	40	50				
27	35	35	44				
31	39	22	28				
32	40	32	40				
33	42	36	45				
33	42	49	62				
33	42	40	50				
34	43	30	38				
35	44	51	64				
36	45	38	48				
36	45	48	61				
37	47	27	35				
37	47	30	38				
38	48	40	50				
39	49	28	36				
39	49	49	62				
40	50	38	48				
40	50	56	70				
41	51	48	61				
41	51	57	72				
41	51	59	74				
42	53	57	72				
42	53	64	80				
44	56	63	79				
45	57	49	62				
45	57	51	64				
45	57	57	72				
46	61	63	79				
48	61	76	96				
49	62	70	88				
51	64	73	92				

Table 23. Size-depth relationships of normal clams from a level on the beach near experimental plots on the Forbes area, Eilerslie, P.E.I., June 6, 1944. The soil is a mixture of sand and clay.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
9	9
10	7
10	11
11	12
32	45
33	43
34	56
35	56
36	57
36	59
37	56
39	66
40	53
40	71
41	62
43	80
44	49
45	69
45	76
50	61
50	70
62	70
67	94
68	102
70	82

Table 24. Size-depth relation of normal clams from high level flat on the Forbes area, Ellerslie, P.E.I., June 6, 1944. The soil is a mixture of clay and sand.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
24	25
27	47
29	43
30	42
31	31
31	39
32	41
32	39
32	46
33	43
34	49
37	51
41	53
52	47
53	80
54	63
57	71
63	50
63	57
63	79
65	77
66	78
66	96
70	115
72	110

Table 25. Size-depth relationships of normal clams at mouth of Williams Creek, (Ellerslie, P.E.I.), Lot III. Sandy soil with a small amount of mud, low level. June 6, 1944.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
16	35
22	33
37	25
40	69
42	68
43	67
46	61
46	62
48	54
50	59
51	54
51	73
51	83
52	78
53	66
53	77
55	82
56	57
59	89
61	63
63	91
64	109
68	92
70	109
72	57

Table 26. Size-Depth relationships of normal clams at Williams Creek (Ellerslie, P.E.I.), Lot IV. Sandy soil with a small amount of mud. High level. June 6th, 1944.

<u>Shell length m.m.</u>	<u>Depth in soil. m.m.</u>
13	7
23	44
27	43
31	56
33	49
36	28
35	72
36	56
41	54
45	72
47	99
58	122
59	118
66	88
71	128
71	137
72	128
73	106
75	127
77	121
77	132
79	89
81	134
81	159
81	165
83	150
83	161
83	167
84	92
88	132

Table 27. Size-depth relationships of normal clams from low level on sand spit 200' west of P.E.I. Biological Station landing stage. The soil is sandy with a little mud. Sept. 1, 1944.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
11	10
11	14
16	23
18	19
21	36
27	39
35	29
37	55
38	49
39	45
39	59
40	61
41	58
43	56
44	61
45	65
45	33
46	48
46	73
46	77
47	71
47	75
47	75
50	67
50	71
50	74
50	79
52	96
52	98
53	74
53	76
54	59
54	76
56	87
66	109

Table 28. Size-Depth relationships of normal clams from intermediate level on sand spit at middle stake P.E.I. Biological Station. Sept. 1, 1944. The soil is sandy with a little mud.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
14	13
15	19
18	9
18	18
19	31
23	27
24	31
27	37
38	55
44	61
47	64
47	66
50	85
55	112
60	84
61	80
62	80
64	104
66	85
66	116
67	129
70	91
71	97
71	139
74	114
87	121

Table 29. Size-depth relationships of normal or very slightly stunted clams from high level on sand spit P.E.I. Biol. Station. September 1, 1944. The soil is sandy with a little mud.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
14	16
14	21
16	17
17	21
17	26
18	7
18	17
18	37
19	18
20	29
20	32
21	28
21	38
22	36
23	29
34	41
40	60
40	85
41	62
56	128
60	96
62	78
62	138
69	119
70	116
73	144

Table 30. Depth of stunted clams in soil relative to their size. Sample from high-level experimental flat south of freezer in gravel soil, St. Andrews, N.B. July 25, 1944.

<u>Shell length m.m.</u>	<u>Depth in soil m.m.</u>
15	2
27	6
34	47
35	46
35	44
38	31
38	50
38	41
39	48
41	46
42	54
43	34
44	28
44	24
44	53
44	34
45	44
45	44
46	47
46	49
47	55
47	56
47	33
48	35
48	47
49	34
52	37
52	31
55	59
55	43

The Ability of Clams to Repair Broken Shells.

In 1943 Mr. Charles Hayes planted several clams with cracked shells in a plot in the government reserve at Sissiboo. He dug these in 1944 but found that none had survived in the tough clay.

On April 29, 1944, a similar lot was set up in Bideford river. It is planned to dig these in 1945 and see how survival there compares with that at Sissiboo.

In addition several shells that show repair of damage have been collected during the summer's work.

It is planned eventually to make a comprehensive study of the facility with which clams repair various sorts of damage. The importance of this to clam farming operations is obvious.

The 1943 Set of Seed Clams at Sissiboo.

This year Mr. Hayes, the guardian at Sissiboo, noticed large numbers of very small clams while sampling the 75' block. These he presumed to be the 1944 brood. The writer's examination of two samples of these taken July 7th showed that almost all bore a clear shell annulus. Further it was believed that their mean size was too great for seed-of-the-year and that they represented the 1943 set. The size frequency distribution of these is indicated in table 31. It is proposed to follow the growth of these small seed to supplement results obtained from the experimental plots.

Table 31.

Size frequency distribution of seed clams (1943 set) screened from mud at Sissiboo River, Weymouth, N.S., July 7, 1944, measured in 2 lots, (1) to nearest half m.m., (2) to nearest m.m.

<u>Length in m.m.</u>	<u>Lot 1 Frequency</u>	<u>Lot 2 Frequency</u>
2.5	2	
3.0	4	5
3.5	3	
4.0	5	7
4.5	8	
5.0	13	5
5.5	6	
6.0	11	6
6.5	14	
7.0	14	12
7.5	8	
8.0	14	6
8.5	3	
9.0	3	5
9.5	2	
10.0	3	3
10.5	1	
11.0		1
<hr/>		
Average length	6.3 m.m.	6.4 m.m.

Clam mortalities

Mortalities of clams in various inlets about the Gulf of St. Lawrence have been observed. There was a heavy killing in the Malpeque bay area, for instance about the year 1932 and Ingalls and Needler (1940) discovered evidence of recent mortalities all along the Northumberland Straits coast.

During the course of the year a few observations were made in Bideford river that are worth recording.

May 1. In digging specimens in Forbes cove for setting up plots it was found that about 30% of the clams of all sizes were dead with the meats still in a good state of preservation. The neck was protruding and seemed to have been damaged in some way. The worst conditions were found in Forbes cove where ice lay for a considerable period and where the beach freezes to a considerable depth. The condition was less remarkable in other areas. Very few dead clams were found on the bar at the mouth of Claude William's creek where the currents are strong and the clams are very deep in the soil.

The general opinion of local people is that these are frost killings. Others say it is because the ice lies there and shuts off circulation. The ice left the shore this year on April 28.

August 28. In recent diggings almost no clams were found that gave evidence of recent mortality. Empty shells still glossy on their inner faces (i.e. fresh) with stinking, greenish juice or a few decayed bits of body were commonly found in July. It is assumed that these were the product of the spring mortality. In a sample of 50 taken from Forbes cove today there only one clam with dead meats. Its neck looked pinched at the top and the space between the epithelium and the muscular part of the siphon was filled with a watery fluid.

August 31. In sample of 30 clams from the same area no dead were found.

Enquiries among clam fishermen in the Fundy area and on the outer coast of Nova Scotia indicate that similar mortalities do not occur in those areas.

The writer is of the opinion that the southern part of the Gulf of St. Lawrence is not as congenial a habitat for clams as some of our more temperate waters. The extremes of both high and low temperature occurring there may be important in this relationship. Periodic mortalities of scallops in the Gulf area might be explicable on the same grounds or on grounds similar to those described by Huntsman (1918).

Disturbance of clams by fish.

On August 31 the reactions of Bideford river clams to disturbance by small fish was observed. The morning was perfectly calm with bright sunlight and the tide was such that there were only 8" of water over the clam bed for a long period. Under these favourable natural conditions and by the use of polaroid glasses to eliminate surface reflections it was possible to observe movements of such minute things as specks in the water and siphon tentacles. The clams were all siphoning water with the siphon tips 2-3 mm. above the level of the bottom. Periodically schools of small fish about 2" long, apparently young silversides (*Menidia*), would swim over the flat close to the bottom exploring it carefully as they went, possibly searching for food. Not infrequently a fish would brush the tip of a clam siphon with its tail or nose it momentarily. This seemed to disturb the clam very little. It immediately stopped pumping, withdrew the siphon to the level of the bottom for 5 - 10 seconds. Then slowly extended it again opening it only part way for the first two or three seconds then going ahead "full blast".

For comparison of reactions the siphons of several clams were touched as gently as could be with a light wire held in the fingers. Even this stimulus was strong enough that the siphon was retracted half-inch or more into the burrow and raised and opened only 30 - 45 seconds later.

From the above observations it would seem that small fish do not disturb clams in a serious way.

According to Stafford (1902) flounders are frequently found with clam (*Mya*) necks, but makes no suggestion as to how they attack the clams. Some of the fishermen claim that flat fish "nip off the necks" and eat only this part of the clam.

Mr. H. C. White states that eels "dig" clams by grasping the siphon end and whirling their bodies about until the clam is withdrawn from the burrow. He believes this process accounts for the broad shallow conical excavations often observed on sandy clam flats. He states that the process of eels digging clams has been described to him by fishermen who claim to have witnessed it.

The starting date of clam growth in Bideford river.

(Supplementary to study of seasonal growth and effect of disturbances on growth.)

Samples of clams about 25 mm. long were taken April 28, May 5, 12, 22 and 26 from near the experimental plots in Forbes Cove and preserved. The purpose was to determine when the season's growth began and whether or not a clear winter shell annulus was formed that might be useful in age determinations. They were examined at St. Andrews, N.B., in the autumn of 1944 with the following results:

April 28.

The clams collected on this date and planted in the experimental plots showed no growth whatever.

May 5.

Twenty clams examined. Seven showed no growth, thirteen showed a narrow band of 1944 shell averaging less than 1 mm. wide, at mid-ventral margin. In no case did it exceed 2 mm. in width. There is no difficulty in distinguishing the 1944 secretion because of its glossy peristrotocum which makes it distinct from the dull earlier deposition.

May 12.

Twenty clams examined. All showed some 1944 growth still averaging less than 1 mm. in width.

May 22.

Twenty clams examined. All showed some 1944 growth. It averaged 2 mm. wide but in no case exceeded 3.5 mm. in width.

May 26.

The sample shows little difference from the lot taken May 22. In several cases the winter annulus is not very clear but the 1944 shell is distinguishable because of its external appearance, as described for May 5.

Apparently growth begins in Bideford River very soon after the ice leaves. It might be possible to relate the initiation of this activity to water temperatures which were recorded at the landing stage of the P.E.I. Biological Station nearby.

The possibility of using winter annuli for age determination seems good but will require more careful study before the procedure can be considered valid.

The weight-length relationship of clam shells.

In their 1936 report, Newcombe and Kessler described variations in the length-weight relationships of clam shells from various parts of the Atlantic Coast of North America. The data they presented suggest that Canadian shells are peculiarly heavy. The writer's impression is that this is not so conspicuous as the data indicate. To settle the matter samples of typical shells were taken from intermediate levels on the clam flats at Ellerslie, P.E.I., MacKinnon's Harbour (Bras d'Or lakes), East Prestwick (cove flats), N.S., and from three different areas about the biological station at St. Andrews, N.B.

Most of the measurements were done by Miss Naomi Fitch of Montreal, who visited the station during the summer. The Ellerslie data was gathered by Miss Esther Morrison, Technician, of the P.E.I. Biological Station.

The clams were first steamed using fresh water to remove the meats; hinge ligaments joining the two valves were left attached; before weighing the shells were then allowed to air-dry in the laboratory for two weeks, which was required for drying to constant weight. Measurements were made to the nearest mm. and weights to the nearest 0.1 gms. The results appear in tables 32-36.

So far pressure of other work has prevented a proper analysis of the data but they apparently substantiate the writer's opinions on the subject in question.

Table 32. Weight-length relationship of St. Andrews clam shells.

Lot 1 - stunted clams from gravel bed in workshop cove.
 Lot 2 - same from rocky soil.
 Lot 3 - normal clams from gravel plot in workshop cove.

Collected August 3, 1944.

<u>Lot #1</u>		<u>Lot #2</u>		<u>Lot #3</u>	
<u>Length</u>	<u>Weight</u>	<u>Length</u>	<u>Weight</u>	<u>Length</u>	<u>Weight</u>
<u>mm.</u>	<u>gm.</u>	<u>mm.</u>	<u>gm.</u>	<u>mm.</u>	<u>gm.</u>
49	5.2	28	1.2	43	6.4
54	15.9	34	1.9	43	4.6
56	12.6	34	2.0	43	5.0
57	15.0	37	2.8	45	4.8
57	13.3	37	2.7	45	3.8
58	13.1	38	5.1	46	9.2
61	11.7	39	4.1	46	5.5
61	14.3	39	4.4	47	5.1
63	15.8	39	3.1	48	5.2
64	23.0	40	3.4	48	5.7
66	19.0	41	3.9	50	4.5
66	16.5	42	4.1	52	5.7
67	15.6	44	3.6	52	6.6
68	21.6	44	4.1	53	7.7
69	18.8	45	4.5	53	9.1
70	15.9	46	7.9	53	7.1
70	20.6	46	6.6	53	8.1
71	24.3	46	7.1	53	9.3
72	26.5	47	6.5	54	7.0
73	18.3	51	10.4	57	8.4
74	19.7			57.	11.5
				59	8.0

Table 33. Weight-length relationship of Sissiboo River Clam Shells
from Government reserve collected August 29, 1944.

<u>Length</u> <u>mm.</u>	<u>Weight</u> <u>gms.</u>
11	4.0
12	4.0
14	0.2
30	1.6
31	1.5
32	1.8
38	2.4
39	3.2
40	3.2
41	3.2
42	3.0
43	3.7
45	4.5
47	4.6
53	7.5
56	8.7
58	9.5
59	8.8
69	14.5
70	15.6
72	18.2
75	24.7
76	18.2
77	17.1
80	22.7

Table 34. Weight-length relationship of East Frestwick Cove, N.S., clam shells. Approximate collection date August 30/44.

Length mm.	Weight gm.	Length mm.	Weight gm.
31	1.6	51	4.3
31	1.0	52	3.9
32	1.2	53	4.2
32	1.3	54	5.6
32	1.2	55	5.1
34	1.7	57	6.5
35	1.8	57	8.4
35	1.7	57	6.3
36	1.6	58	7.6
37	1.7	58	7.5
42	3.2	60	8.5
44	2.7	63	8.3
44	3.0	63	10.2
44	2.7	64	11.5
45	2.8	64	8.3
45	2.6	68	11.2
45	3.4	69	18.2
45	3.6	70	12.4
45	2.8	73	12.4
45	3.5	75	15.4
45	3.3	77	18.9
46	3.1	79	10.7
46	4.6	79	18.8
47	3.7	79	18.9
47	4.0	81	18.2
48	3.4	82	22.4
48	4.7	84	21.6
49	4.0	84	20.8
49	4.3	85	8.5
50	3.8	87	30.2
50	4.7	88	21.5
50	3.8	91	25.9
50	3.7	100	48.3

Table 35. Weight-length relationship of MacKinnon's Harbour
clams collected by R. F. Morrison, August 26, 1944.

<u>Length</u>	<u>Weight</u>	<u>Length</u>	<u>Weight</u>
<u>mm.</u>	<u>gm.</u>	<u>mm.</u>	<u>gm.</u>
33	1.1	56	5.6
34	1.1	57	5.2
35	1.1	58	6.7
36	1.4	59	9.8
38	1.6	60	4.7
39	1.8	61	6.4
40	2.1	62	8.8
42	2.4	63	9.0
43	2.5	64	8.4
44	2.7	65	7.1
45	2.7	67	11.5
47	2.7	68	8.2
48	3.2	70	10.7
49	3.4	71	13.8
50	3.0	72	17.7
51	4.9	73	13.4
53	4.2	74	15.2
55	4.8	75	15.4

Table 36. Weight-length relationship of clam shells from Forbes Cove plots, Bideford River, P.E.I., Sept. 16, 1944.

<u>Length</u>	<u>Weight</u>	<u>Length</u>	<u>Weight</u>
<u>mm.</u>	<u>gm.</u>	<u>mm.</u>	<u>gm.</u>
18	0.13	40	1.8
19	0.16	40	1.9
19	0.16	41	1.5
20	0.24	41	1.7
21	0.29	42	2.1
21	0.25	42	2.1
22	0.27	42	2.3
22	0.26	42	2.5
24	0.34	43	2.0
24	0.34	45	2.6
24	0.36	47	2.5
24	0.36	47	2.7
26	0.38	48	2.9
27	0.40	48	3.0
27	0.41	51	4.7
35	0.9	52	4.5
35	1.5	52	4.0
36	1.3	56	5.6
36	1.3	60	7.0
37	1.5	60	7.1
38	1.5	62	10.0
38	1.6	65	10.6
38	1.6	66	10.6
38	1.6	66	11.0
39	1.4	68	11.0
39	1.6	68	10.3
39	1.6	72	12.8
40	1.6		

Growth of seed clams at Ellerslie and St. Andrews.

In addition to the observations on 1943 seed at Sissiboo a few were noted at Ellerslie, P.E.I., and at St. Andrews, N.B.

Ellerslie, P.E.I.: Seed apparently of the 1943 set were collected on several dates in 1944, from Bideford river. They all came from Forbes cove near the seasonal growth plots. Their lengths to the nearest mm. were as follows:

May 29. 1 specimen 13.

July 6. 9 specimens 12, 12, 13, 13, 14, 14, 15, 16 and 16.

October. 19 specimens 20, 22, 22, 22, 22, 23, 23, 24, 24, 25, 25, 25, 25, 26, 26, 26, 26, 27 and 27.

St. Andrews, N.B.

A sample of seed apparently of the 1943 set was gathered July 28, 1944, from an intermediate level on the Pottery Bridge flat. The 1943 shell was white, chalky and opaque, the 1944 shell, glossy, transparent and golden. The two types of shell were separated by a clear annulus. Two length measurements in mm. were made on each of 12 specimens. The first was the size at the end of 1943 as judged by the annulus; the second was total length on date of collection. The results were as follows:

Specimen No.	Length mm.	
	1943 Annulus	Total Length
1	4	9
2	6	12
3	6	10
4	6	11
5	7	12
6	7	12
7	7	13
8	8	14
9	8	14
10	8	12
11	9	13
12	10	16

From a comparison of the records for Sissiboo and St. Andrews and Ellerslie, it appears that the growth rate of seed is almost twice as great at Ellerslie as at St. Andrews or Sissiboo where they are much alike.

This conclusion accords well with the results for larger clams used in the experiment on seasonal growth at Ellerslie and Sissiboo.

Rate of burial of clams of various sizes - Ellerslie.

On August 28 at 9:15 a.m. four size classes of clams were dug from the sand spit 200 feet west of the P.E.I. Biological Station landing stage. These were examined carefully (damaged specimens discarded) measured and within three quarters of an hour set out on 2' x 2' plots of uniform sandy soil on the spit 4" - 6" of water. The morning was calm so that the conditions of the test approximated what might be found in tanks. In the afternoon there was a light ripple that interfered with burial very seriously. There was bright sunlight throughout the test. The tide rose until it was 5" higher by noon and then dropped away to the original level by 5:00 p.m.

During the test the temperature of the water over the clams varied between 22° and 24°C.

The various lots and the treatments given were as follows:

1. Thirty-four clams 15-25 mm. long; mean 18 mm.; planted on sand whose surface was loosened with a clam back half an hour before planting.
2. Same as #1 above except that the surface sand was not loosened. Lots 1 and 2 were all of the 1943 set.
3. Eight clams 29-45 mm. long; mean 37 mm. planted as #1.
4. Twenty clams 49-62 mm. long; mean 55 mm., planted as #1.
5. Twenty-four clams 62-78 mm. long; mean 69 mm., planted as #1.

When clams are first placed in motion lying on their sides they rest for a while then protrude the siphon, draw in water and later put out the foot. As the first step in burial they anchor themselves by inserting the foot into the ground. Then by a sudden contraction of the foot they "flip" into a vertical position and go down rather quickly. The only movement in this whole process that can be described as instantaneous is the flip. Almost all clams that manage this flip succeed in completely burying themselves. The other parts of the process are protracted and are not readily susceptible to measurement because there is much individual variation. The time required for complete burial is not a good measure of burrowing rate. Some clams may dig themselves in quickly and completely others will work rapidly until only a quarter of an inch of shell is showing then rest for many minutes or even hours. In this test the time when the clams were scattered was considered zero. At stipulated intervals thereafter counts were made of the number of clams in each plot which were still lying on their sides, i.e., those which were still "unflipped". The results appear in table 37. They support the following conclusions which accord very well with Chiasson's observations at Petpeswick described in another section of this report.

Table 37. Results of burrowing test, August 28, 1946, showing numbers of clams still "unflipped" (UF) and % "flipped" (%F) at various times.

Time from start minutes	Lot Number									
	1		2		3		4		5	
	18		18		37		55		69	
Mean size mm.	UF	%F	UF	%F	UF	%F	UF	%F	UF	%F
0	34	0	34	0	8	0	20	0	24	0
10	17	50	--	--	8	0	20	0	24	0
15	8	76	18	47	8	0	20	0	24	0
20	5	86	10	71	8	0	20	0	24	0
30	2	94	7	80	5	37	20	0	24	0
50	1	97	2	94	5	37	19	5	23	4
75	1	97	3	91	5	37	18	10	22	8
110	0	100	3	91	3	63	17	15	22	8
180	0	100	0	100	1	87	14	30	20	17
240	0	100	0	100	1	87	14	30	20	17
300	0	100	0	100	1	87	12	40	20	17

This is the only observed case of a clam having "flipped" and then failed to bury itself at once.

Conclusions:

1. Small clams bury themselves more rapidly than large. On firm sand 50% of the yearlings had "flipped" within 15 minutes; 50% of 37 mm. stock in 90 minutes (Interpolation); 30% of 55 mm. clams in three hours and only 17% of the 70 mm. stock after 5 hours.
2. Loosening the soil reduced the flipping period of the smallest stock by one third.
3. Even the light ripple that developed in the afternoon was a serious impediment to burrowing.
4. More observations should be made to determine the relationship between the period required for "flipping" and for complete burial.

Survey of Clam Flats

For various reasons surveys of clam flats were made in several parts of the Maritimes in 1944. Information was gathered as to their size, nature of their soil exposure to wave action and the size-composition, quality and extent of their clam populations. Charts of the areas have been prepared to aid in the descriptions that follow.

Halifax county, Nova Scotia.

The five inlets, Clam, Musquodoboit, Petpeswick, Chezsetcook and Cole Harbours were surveyed mostly in May by Dr. Leo P. Chiasson and the writer to provide information requisite to the proper selection of an area in that general region for the experiments that were eventually set up at Petpeswick. The selection narrowed down to the Musquodoboit and Petpeswick areas and to make a final choice the flats in these two inlets were more intensively studied than anywhere else. Clam Harbour flats have very fat, fast growing clams that are not intensively dug and Chezsetcook has many flats that are exploited to the stage where they are suffering from severe depletion. These two inlets therefore should receive early attention because of their industrial importance.

Notes on the Halifax county flats compiled by Dr. Chiasson during the survey formed the basis for most of the present summary but some information was gathered by the writer both before and after Dr. Chiasson's stay at Petpeswick.

Musquodoboit Harbour Flats (Figure 1.)

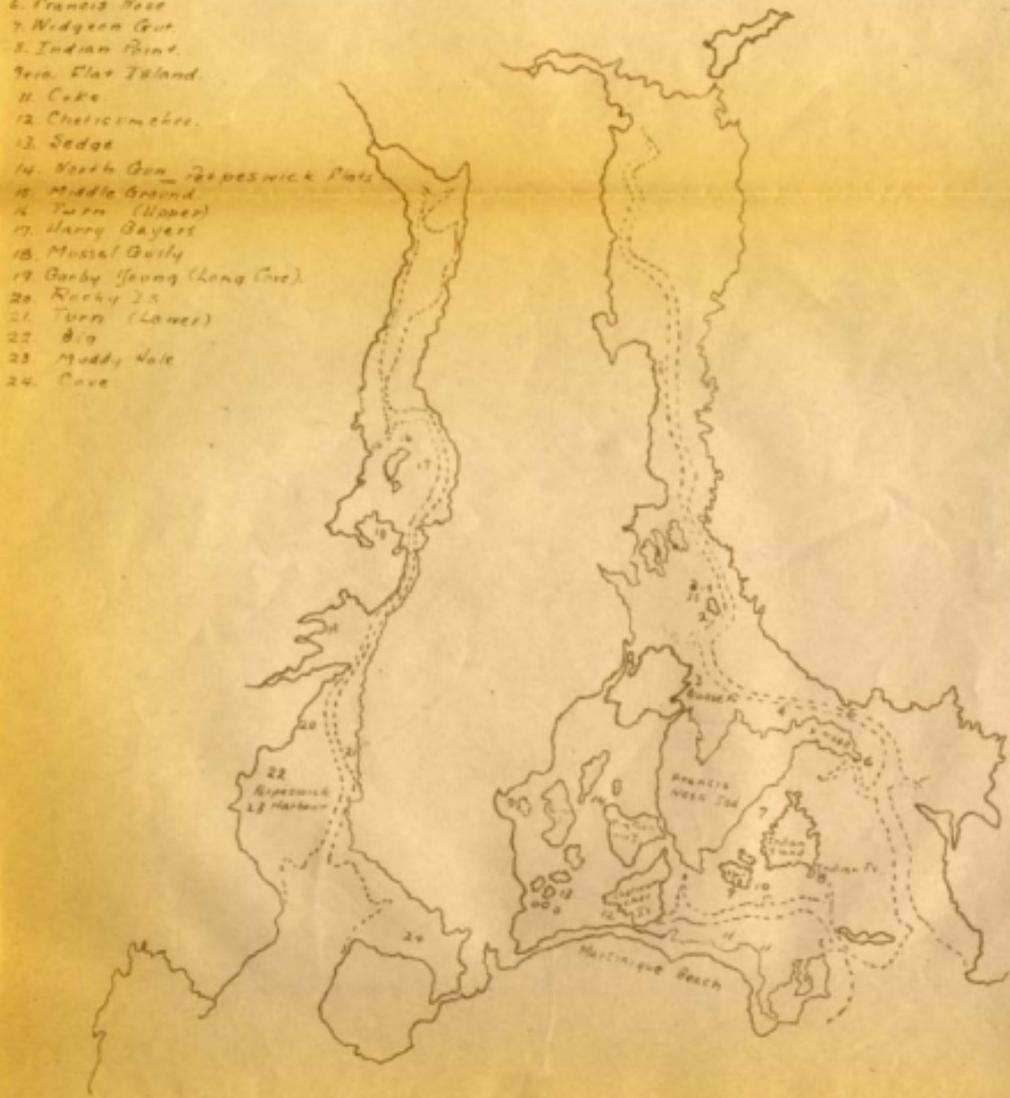
1. Pea Island (not visited). About twenty years ago there was a good fishery of large white clams on the western side of the channel. Since then the beds have died out.
2. Big Island. This is perhaps the largest single flat in the upper harbour and lies to the west and northwest of Big Island. It has not been dug intensively for the last few years. The soil is a muddy sand but when visited in May it was covered with a dense and tough carpet of filamentous algae half an inch thick -- locally called "slub". The area was heavily populated with clams. These were mostly seed of the 1943 set, 8 - 12 m.m. long and averaging in many places upwards of 60 per sq. foot. Almost all the rest were of about the same size, 2 - 2½" long. Fishermen claim that the clams never grow large on this flat even when they are left undug for several years. The seed clams were apparently suffering from the slub and many had left the soil entirely and moved up into the slub in an attempt to reach the water with their siphons. If the slub moves off the flat later in the season the chances are it takes the seed clams with it.
3. Goose Head. This is a large flat east of Goose point. Some dig-

Musquodabuit Flats

1. Ice Island.
2. Big Island.
3. Goose Island.
4. Baker's "
5. Ledge
6. Francis Nose
7. Widgeon Gut
8. Indian Point.
9. Flat Island.
10. Cake
11. Cheticomehe.
12. Sedge
13. North Gun, Repeswick Flats
14. Middle Ground
15. Turn (Upper)
16. Harry Bayers
17. Mussal Gully
18. Garby Young (Long Cove)
19. Rocky Is.
20. Turn (Lower)
21. Big
22. Muddy Salt
23. Cove

Figure (1)

Showing Positions of important clam flats
in Repeswick & Musquodabuit Harbours.



ging goes on here when the fishermen do not want to go further down the harbour. The soil is muddy sand but the flat is so low that much of it does not drain off at ordinary tides. The clams were not abundant and nearly all just below legal size. There was practically no 1943 seed. The meats of these clams were conspicuously poor, watery and dark.

4. Baker's. This is a small flat of average height and dug regularly. The soil is muddy sand. The clam population is of average density and is composed almost entirely of clams 2 - 2½" long and, apparently resulted from the same set. Seed of 1943 are rare.

5. Ledge. This is a small flat inside the ledges just north of the wharf at Ostrea lake. The area is being dug over this year after lying untouched for several seasons. The soil is muddy clay. The population is heavy. There are many clams just above legal size and a heavy catch of 1943 seed. Those of intermediate size are rare. The shells of these clams are bluish.

6. Francis Nose. (not visited). This is not an extensive flat and it is very low. Consequently it is seldom fished. It has a fairly good population of large old clams.

7. Wigeon Gut. There are several small sandy flats in the eastern part of the gut and some muddy ones to the west. None are being dug at present. On the sandy flats there is an abundant population of apparently fast-growing clams about one inch long and a good catch of 1943 seed. Larger clams are rare.

8. Indian Point. These are large and important high flats. They were intensively dug last year and are still being worked. The soil is a pure brown sand which rippled in some areas.

In the northeastern parts there is a fair population of clams all 2½" or more in length. Seed of 1943 is scarce. It is here that the commercial fishery centres at present.

Immediately to the south west of the area being exploited there is a heavy population of clams of all sizes up to 2½". There is a good catch of 1943 seed and practically no large clams. The older ones show evidence of mild stunting. The clams here are stratified in the soil -- the smallest above and the larger ones below.

Still further to the south and west there is an enormous area of clean rippled sand that is practically barren. In certain areas it is riddled with annelid worms which form sand tubes.

9 and 10. Flat Island. The flats here are large and rather high extending from the SSE to the NE of Flat Island. There has been intensive digging here during the past two seasons. In the western parts there is a good population of large clams that appear to be fast-growing. To the north east there is a great abundance of small stunted clams 1" long and over.

11. Coke. This is a large flat that has been exploited during the past two years. The soil is a clear compact sand. A large part of

the flats have been intensively dug so that except for a few large old clams they are now quite barren. There are no 1943 seed clams. The quality of the meats and the growth rate are comparatively high.

On the highest parts at the western end of the flat there are extensive populations of severely stunted clams ranging from 1 - 2" in length. This seems like a suitable site for a commercial-scale transfer experiment.

12. Cheticumchee. These flats are not large, lie to the south of the island and face Martinique beach. The ground has not been dug recently. The soil is largely sand near the channel but towards the upper levels of the beach there is more and more mud mixed with it. Clams are found only in the sandier parts. There is a fair population of 3" clams near the channel and a large bed of mildly stunted clams $1\frac{1}{2}$ - 2" long at intermediate levels.

13. Sedge. This is a composite of several rather small high flats that have not been dug heavily for some time. The soil is sandy. There is a heavy population of 1 - $1\frac{1}{2}$ " clams showing good growth. There is a scarcity of all other sizes.

14. North Gum. This is a composite of flats lying to the north of Big Gun Mountain Island in the northern part of the area generally called Butney Gum. The soil is a sand-mud with the mud predominating more and more towards the north. There are numerous sedge banks that are encroaching on the clam flats. Formerly these were heavily and uniformly populated and highly productive. They are not dug extensively now because there are few marketable clams and no seed. Here and there in the area sparse populations of $1\frac{1}{2}$ - 2" clams of average growth rate still persist.

General remarks.

Although there are enormous areas of flats in Musquodoboit harbour the production of clams is not as high as might be expected. Furthermore the stock on the whole is of poor quality as shown in the section entitled "The Yield of Shucked Meats from Clams".

A striking feature of the area is that each flat seems to be populated with clams of only one size. (The southern part of Indian point flats is a notable exception to this). This suggests that there are irregularities in spatfall that have as yet no satisfactory explanation.

Petpeswick Harbour (Figure 1.)

15. Middle Ground. This is a moderate sized flat encircled by water as a result of a forking in the channel. It lies on the western side of the main channel opposite Burton and Vernon Bayers' at Bayers Settlement. Of late years it has produced very little but 15 - 20 years ago it was regularly and intensively dug and considered a good producer.

The soil is sandy and the flat is rather high. There is a heavy population of mildly stunted, poor-meated clams of mixed sizes

all the way from 1943 seed up to 2½". Because so much sorting of the catch is required to select the marketable clams few fishermen dig here now. They prefer to row down the harbour to the areas where all the clams are large and marketable.

16 and 17. Turn. This is a composite of flats lying east of the middle ground and broken up by sedge banks. There has been little digging here except for ood bait in recent years. The soil is a fine velvety sand with mud below. To the east the mud increases and near shore there are extensive beds of eel grass and mussels. The clams are mildly stunted but there are considerable quantities of two size groups, one 2 - 2½" and the other about 1" long.

18. Mussel Gully. There are long narrow flats bordering the gully and expanding at its western end. It is many years since any commercial digging was done here. The soil is sandy on the northern side of the gully and to the south becomes increasingly muddy. The flats are high so the whole area goes dry at low tide. A particularly heavy population of small clams occupies about two acres of the flat mostly on the northern side of the channel. Concentrations of 100 per sq. foot are common and an average of 60 is found over wide areas. The size ranges from 1 - 2" and there is moderate stunting.

19. Long Cove or Garby Young's. This is a composite of flats, the most productive lying just east of the Roman Catholic church. They have not been fished except for ood bait for several years. The soil is sand-mud with mud predominating in the south. The flats are high and much cut up by winding channels and sedge banks. There is considerable variety in the sizes of the clams but they are mostly under 2". There is severe stunting in the southern areas but in the sandy soil to the north growth is better. There are heavy catches of 1943 seed in isolated patches.

20. Rocky Island. This is a fair-sized flat just west of Charles P. Young's property and on the western side of the channel. The soil is sandy near the channel and becomes muddy at higher levels and in the cove to the westward. There is a good supply of marketable clams about 3" long and smaller quantities of two other size groups one 2" and the other 1". The growth rate seems to be about average for the district.

21. Turn. Opposite Harris Anderson's property to the east of the main channel but separated from the mainland by a lesser channel. This ground is a flat of 2 - 3 acres that is being dug regularly now although it lay almost idle until the "Big Flat" was dug out. The soil is a sand-mud with sand predominating. In the southern parts there is a good population of marketable clams; and to the north a heavy and evenly distributed population of 1 - 2" clams. On the western edge the surface of the sand is rippled and the ground is quite barren. In general the growth rate is high and the meats are fat.

22. Big Flat. This is the largest clam flat in the harbour comprising at least fifty acres. It lies on the western side of the channel opposite the government wharf at East Petpeswick. Up until three years

ago it was intensively fished and produced large quantities of good quantities of good quality clams. Of late years it has failed to re-seed itself and it is now completely barren. The soil is a fine brown rippled sand throughout. This is where the commercial-scale transplant of seed clams was made in 1944.

23. Mud-Hole. In the cove S.W. of Big Flat. This is being dug regularly. The soil is sand-mud but mostly sand except next the shore. There is a good population of marketable clams in the northern parts of the flat but there is a decrease in the abundance and size towards the south. There are some areas with heavy populations of 1 - 2" clams but 1943 seed is generally scarce.

24. Cove or Petpeswick Beach. This is a large area lying east of the harbour mouth and north of the barrier beach. The soil is sandy with very little mud except in the extreme southern parts where the eel grass grows. The ground is somewhat broken up by channels and sedge banks. In the north eastern parts there is a good population of marketable clams that is being fished hard. Near Lobster gully there is a good population of medium sized clams 1½ - 2". Westward from Lobster gully there are scattered beds of smaller clams 1 - 1½". The growth rate everywhere seems to be fairly high. There is practically no 1943 seed anywhere in the cove.

It was here that the Latin square experiment was set up and other tests were conducted.

General remarks.

The Petpeswick flats are smaller in total area and more accessible than those at Musquodoboit but show the same segregation of age groups of clams but to a less striking degree. The commercial catch comes mostly from the lower parts of the harbour and these are good quality clams -- better on the average than those from Musquodoboit harbour. If the Big Flat could be brought back into production the area could be a heavy producer.

Clam Harbour (Figure 2.)

1. Muggy's Cove. This is a small area on the western side of the harbour which is seldom dug now but was a good producer 15 - 20 years ago. The soil is mud-sand. The clams are not abundant mostly about 2" long and mildly stunted. There is no catch of 1943 seed.

2. West Lower Cove. This is a deep cove between the cranberry barrens and Lebel's point. The soil is sand-mud with sand predominating. The clam population is like that in Muggy's cove.

3. Indian Cove. This is an extensive area east of Muggy's cove. The ground has been well dug over recently. At lower levels towards the east there is a fair population of marketable clams. On the higher flats to the S.W. the clams are abundant but smaller and stunted. There is no catch of 1943 seed. On the average the growth

Figure (A) (Clam Harbour N.S.)

Showing position of clam flats

(In British Admiralty chart of 1849)
"Anthonis"

Scale 1/2 inch to a mile

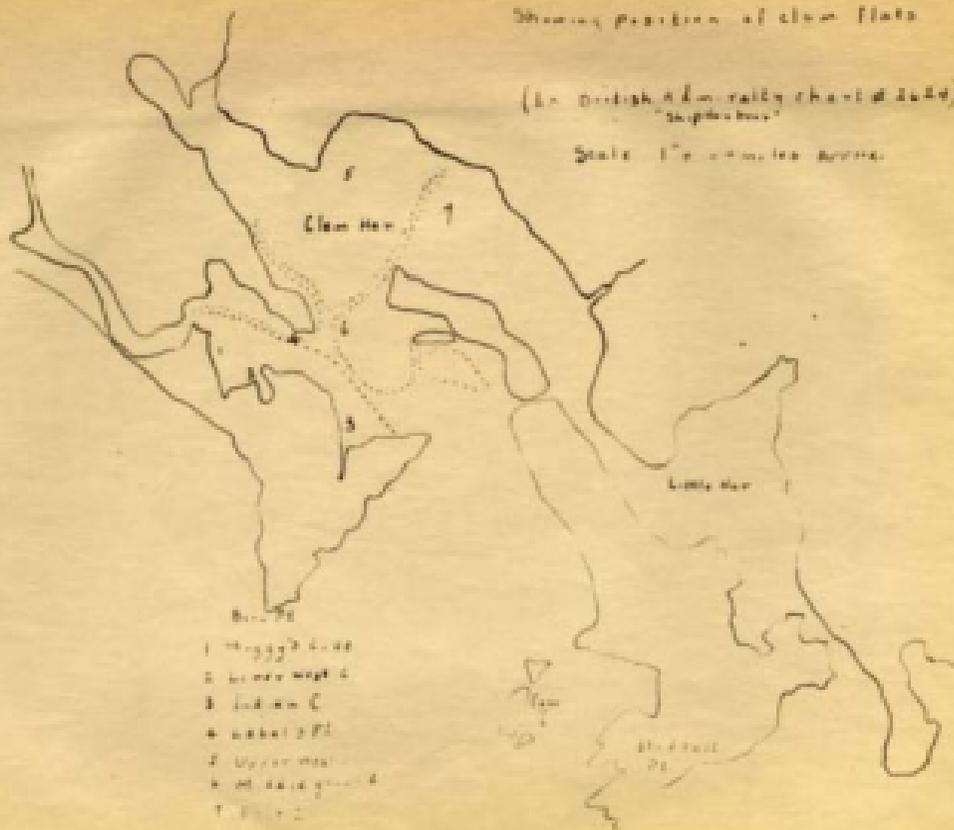
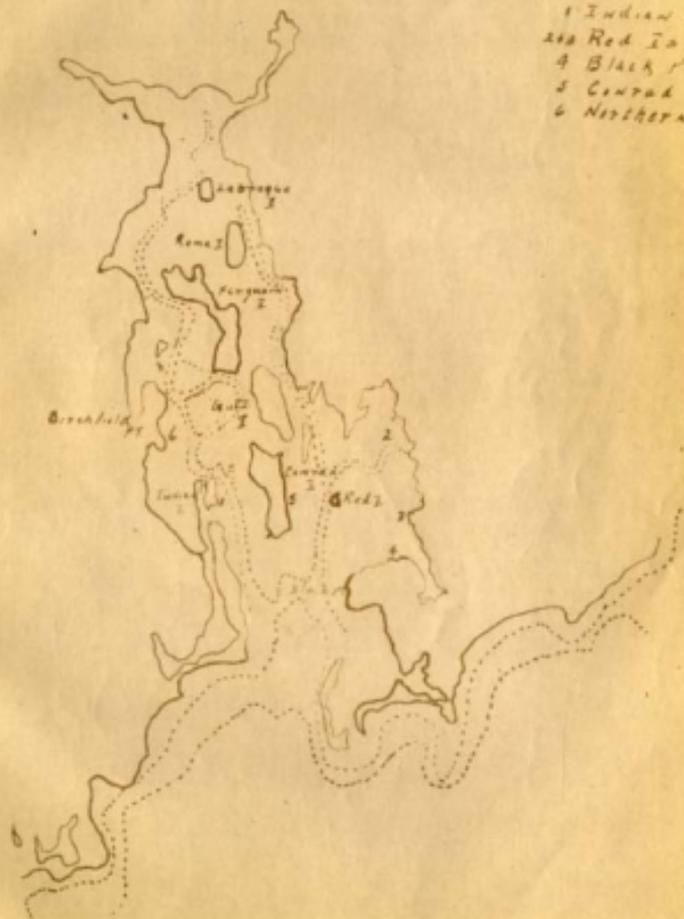


Figure 3 Chesapeake Inlet
Showing important clam flats



- 1 Indian Island
- 2a Red Island
- 4 Black Point
- 5 Central Island
- 6 Northern Flats

Coast Pilot Admiralty Chart 2439 Nova Scotia
Scale 1 inch = 1 mile approx.

rate and quality is high.

4. Label's Point. This flat is of moderate size and lies due north of West Lower Cove. This area has not been dug recently. The soil is almost pure sand with very little mud. On the north eastern side of the point there is a heavy population of 2" clams and there is a fair quantity of 1" stock everywhere. There is no quantity of 1943 seed. The growth rate and quality of meats is high.

5. Upper West Cove. This is a large flat that is not dug very much. The soil is sand-mud with sand predominating. Clams are abundant and of mixed sizes with a good scattering of market-sized. The growth rate is somewhat lower than at Label's point.

6. Middle Ground. Just east of Label's point and separated from it by a deep channel. Not being dug at present. The soil is pure fine brown sand. The flat is high to the north and has a heavy population of small clams with a fair growth rate. To the south the flat is lower and the clams are larger and faster-growing although somewhat less abundant. There is no quantity of 1943 seed to be found anywhere.

7. East or Central Cove. This is the largest single heavily populated bed and lies south of Homan's store. It is high ground cut into several sections by channels but the soil everywhere is fine sand. The clams are mostly 1½ - 2" long, show mild stunting and are shallow in the ground. There is very little 1943 seed. To the eastern end there is a long arm of this flat that extends southwards between sedge banks and the eastern shore. There is some mud in this soil and the clams are slightly stunted.

General remarks.

Clam harbour clams are the best meated and appear to be the fastest growing clams so far examined. These characters are probably the result of good water circulation made possible by the openness of the harbour. At the same time the ground is not shifting seriously enough to interfere with reproduction as it does on Big Flat in Petpewick. Something should be done to increase production in this area. The possibility of using the vast stocks of slightly stunted small clams in East cove should be carefully examined.

Chezzeetook Harbour (Figure 3.)

1. Indian Island. There are rather muddy flats about this island which are barren of clams but thick with Macoma.

Red Island. This name is loosely used to refer to flats running out from the eastern shore towards the island.

2. To the northeast -- There are enormous flats here composed chiefly of sand with a little mud. The clams are black-shelled and scarce. Half of them are market-sized, the rest between 1 and 2".

There are no 1943 seed. Growth seems to be good and the meats are moderately fat.

3. To the southeast -- There are great flats of mud which are barren.

4. Black point. An enormous area of barren rippled sand flat stretches southward from Red island almost to Black point. Close to Black point the surface is smooth and there is a scattered population of small somewhat stunted clams. This is fairly well dug.

5. Conrad Island. Lying on the eastern side of the island there are extensive barren sand flats that appear to be shifting.

6. Northern flats. These are extensive and follow the shore northward. There is considerable digging here by the local people for shucking and sale in Halifax. The soil is heavy sticky gray clay. The clams are black-shelled, full-meated and fairly fast-growing but their abundance drops off towards the north.

General remarks.

This inlet is as yet very incompletely explored. Fishing is intense and there is much ground such as that north of Black point that might benefit by planting if seed stock could be found. The local co-operative association has expressed itself anxious to undertake a programme of relaying if ground could be leased for that purpose. It is planned to give this area particular attention in 1945.

Cole Harbour (Figure 4.)

1. Lower East Cove. There are extensive areas of flat here that have been dug out more or less recently. There is a mixed stock of small clams of the 1942 and 1943 sets above the half tide mark. Among these there is an occasional larger clam showing poor growth.

2. Lower West Cove. There is a considerable flat north of the dyke. The soil is a fine sand near the channel with increasing amounts of mud towards shore. Near the dyke the clams are scarce but large and black-shelled with a moderate growth rate. Further north there is a good mixture of sizes with 7 or 8 year classes well represented.

3. Middle ground. This is a great sandy flat with considerable growths of sedge in the central parts. The clam population is scattered unevenly. In some places the density reaches 80 to the square foot. Large - and medium-sized are rather scarce but there are great quantities of 1942 and 1943 seed.

4. Middle ground above railway. There is a small flat here that was explored on a rising tide. The soil is sand-mud with a sparse growth of eelgrass. The clam population consists of fairly old clams. There is a strong current here at ebb and flood tide that should provide good circulation.

General remarks.

Figure (-). Cole Harbour
showing positions of clam flats



(Ex British Admiralty chart # 2410)

Cole Harbour has been incompletely explored. According to Mr. Ross Carey of the General Seafoods shucking plant at Ostrea lake the meats of Cole Harbour clams are of even poorer quality than those from Musquodoboit Harbour. None of the Cole Harbour people fish clams except for cod bait but clam fishermen of the West Chezzetcook co-operative society come here every year to fish clams for their cannery. For the present it seems to be an area deserving less attention than others in Halifax county.

On the Proposed re-establishment of tide gates at Cole harbour.

It seems significant that it is Cole harbour which has the narrowest harbour mouth of all the inlets in Halifax county and that it produces the poorest meated clams; that it is Clam harbour which has the widest entrance and that it produces the fattest clams and that Musquodoboit and Petpeswick harbours have intermediate conditions both as regards topography and quality of clams. It is probable that water circulation is better in harbours with wide mouths and that the poor condition of Cole harbour clams can be safely attributed to poor water circulation.

At the November 1943 meeting of the Maritime Fishermen's Union held in Amherst, N.S., Mr. Brian Meagher stated that the Eastern Shore Cooperative Society of West Chezzetcook (Victor La Pierre, Pres., Rev. L.L. Surette, Secretary) were interested in the possibilities of re-establishing the tide gates at Cole harbour to lengthen the low-tide period available for digging and asked that an investigation be made to determine the feasibility of the undertaking. At this time very little can be said on the subject with certainty but setting up tide gates would further reduce the poor water circulation in the harbour. It might be expected as a result that the quality of the clams would drop still lower than it is at present. This would probably offset any advantage that might be brought about by extending the low-tide digging period. If any work were done it might be advisable to remove the persisting parts of the old dyke thus widening the harbour mouth and improving circulation rather than restricting it with tide gates.

The effect of regulating the water level of inlets with tide gates on clam population would well repay study because the proposition has been made for several areas besides Cole harbour.

Appendix

Hydrography in Petpeswick Area 1944.

Dr. Chiasson and Mr. MacMillan jointly made records of water temperatures and salinities and of soil temperatures on the clam flats using thermometers graduated in degrees C., and a hydrometer calibrated finely enough to permit the calculation of salinities to 1 in 10,000.

Water temperatures -- Water temperatures are recorded with soil temperatures in Table 1. During the period June 12 to October 6, the surface temperature showed a minimum of 8.8°C and a maximum of 21.5°C. From this it will be seen that Petpeswick temperature conditions are intermediate between those observed in the southern parts of the Gulf of St. Lawrence and Passamaquoddy, N.B.

Soil temperatures were recorded at low tide since their changes are presumed to affect clams. Two readings were usually taken; one at the surface with the bulb of the thermometer just buried and the other with the bulb 5" below the surface. These appear in table 1.

Except where otherwise stated these were taken in the eastern part of Petpeswick cove although not always at exactly the same place. The differences in position, however, were so slight that any effects they may have had on the results are assumed to have been significant.

The records show that the flats may be warmed at low tide to a considerable depth. At times when there is bright sun and afternoon low tides the soil temperature at the end of the low tide period even at a depth of 5" may be as much as 6°C higher than that of the water (See records for Aug. 4). More often, especially in cloudy weather early in the season or when the tide is low early in the morning or late at night the soil temperature approximated that of the water or ranged only one or two degrees above it.

Temperatures of the surface soil fluctuated more violently than at a depth of 5". Presumably clams living at different levels in the soil would be differentially affected by hydrographic and meteorological phenomena which affect soil temperatures. The importance of the effects are incompletely understood but have been examined by Battle (1932).

Salinity observations -- Salinity fluctuations proved to be so slight that water sampling at close intervals seemed unnecessary. The observations (except where otherwise described apply to Petpeswick cove) are summarized in table 2.

There was a slight rise in the salinity from about 30‰ in June to about 31‰ in August. Depressions occurred following heavy rains but these were minor and transient. The lowest was 25‰ which is well above the level which is considered hazardous to clams.

Table 1. Water and soil temperatures at East Petpeswick Cove in 1944.

Date	Time	Tide	Water	Soil Temperature at low tide			
			Temperature °C	Time	at surface	5" below surface	
June	12	9.00 a.m.	HR	12	9.00 a.m.	16	13
"	13	10.00 a.m.	HR	13	10.00 a.m.	16	12
"	14	7.30 a.m.	L	8.8	11.00 a.m.	15	11.0
"	14	3.00 p.m.	H	12.5			
"	17	1.30 p.m.	L	10	2.00 p.m.	15.5	13
"	18	10.00 a.m.	HP	14			
"		4.30 a.m.	HR	16			
"	19	1.45 p.m.	HP	12.5	4.00 p.m.	17.0	14
"	20	2.00 p.m.	HP	9.8	4.00 p.m.	10.5	10.5
"	21	2.30 p.m.	LF	9.8	4.30	12.8	12.0
"	22	10.00 a.m.	H	11.0		12.5	12.0
"	23	5.00 p.m.	LF	14.0	7.00 p.m.	13.0	12.0
"	24	11.00 a.m.	H	9.5	7.30 p.m.	14.	13.0
"	25	4.00 p.m.	HP	12			
"	26	11.30 a.m.	LR	12.2	1.00 a.m.	12.5	11.8
"	27				10.00 a.m.	16	13
"	28	4.30 p.m.	HP	17.2	11.00 a.m.	21	16
"	29	3.30 p.m.	F	16.5	11.00 a.m.	21	17
"	30	2.30 p.m.	HP	18.1	11.30 a.m.	22.3	17
July	1	7.30 p.m.	HP	20.8	12.30 Noon	25.1	17
"	3	7.00 p.m.	F	17.2	5.30 p.m.	27	21
"	4	10.00 a.m.	F	17.4	4.30 p.m.	27.5	22
"	5	10.00 a.m.	F	17.3	5.00 p.m.	21.5	21
"	6	10.00 a.m.	F	17.0	5.45 p.m.	24	21
"	7	9.30 p.m.	F	18.8	6.30 p.m.	22	20
"	8	10.00 a.m.	F	17.2	7.15 p.m.	22.5	19.5
"	10	2.00 p.m.	HP	17.4	8.30 a.m.	19.8	18.0
"	11	4.00 p.m.	HP	15.6	9.00 p.m.	17.3	14.5
"	12	8.00 p.m.	HP	14.8	10.00 a.m.	15.9	15.0
"	13	3.30 p.m.	F	15.0	10.45	18.8	15.5
"	14			16.4	11.30	20.0	17.0
"	15	7.30 p.m.	HP	17.1	12.15	24.0	20.5
"	16	8.00 p.m.	HP	16.3	1.00	23.5	20.0
"	17	2.30 p.m.	F	16.8	2.00	23.4	19.0
"	18	7.30 p.m.	F	17.2	3.00 p.m.	27.2	21.0
"	19	8.45 p.m.	HS	18.8	4.30	24.5	20.5
"	20	8.30 p.m.	HR	18.2	5.30	22.3	18.5
"	21	8.30 p.m.	HP	18.5	5.45 p.m.	21	18.5
"	22	9.00 p.m.	HR	19.8	5.15 p.m.	22.0	19.0
"	23	4.30 p.m.	R	21.5	4.30 p.m.	17.5	15.0
"	24	8.00 p.m.	F	20.4			
"	25	8.00 p.m.	R	18.7	8.00 a.m.	19.5	17
"	26	8.00 p.m.	R	18.8	8.30 a.m.	18	17
"	27	7.30 p.m.	HP	19.2	9.00 a.m.	21	18
"	28	8.00 p.m.	LS	14.5			
"	29	8.00 p.m.	LS	16.8	12.00 Noon	20	17
"	30	10.00 a.m.	LS	16.8			
"	31	8.00 p.m.	HP	17.2			

Table 1 (continued)

Date	Time	Water Tide	Temperature °C	Soil Temperature at low tide °C		
				Time	at surface	5" below surface
August	1 8.30 p.m.	HF	19.0		27	24
"	2 9.00 p.m.	HF	20.5		29	25
"	3 10.00 a.m.	HF	19.0	4.00 p.m.	26	25
"	4 10.00 a.m.	HF	19.4	5.00	27	25
"	5 10.00 a.m.	HS	20.0			
"	6 8.00 p.m.	HR	19.5			
"	7 11.00 a.m.	HS	19.3	7.30 p.m.	21	19
"	8 11.30 a.m.	HS	18.8			
"	9 1.00 p.m.	HS	19.0			
"	10 1.00 p.m.	HR	19.5	9.30 a.m.	21	19
"				8.00 a.m.	19.6	18
"	11 2.00 p.m.	HS	19.5	8.45 a.m.	21	20
"	12 2.00 p.m.	HS	19.8			
"	13 2.30 p.m.	HR	19.6			
"	14 7.00 p.m.	HF	19.5	1.30 p.m.	25	21
"	15 8.00 p.m.	HF	19.8			
"	16 8.30 p.m.	HS	19.8		27.5	26
"	17 8.00	HR	18.5	4.00 p.m.	21	21
"	18 8.45 a.m.	HS	18.0		20.5	19.5
"	19 8.00	HR	19.3			
"	20 7.30 p.m.	HR	18.0		16	14
"	21 11.30 a.m.	HS	18.0		14.8	4.0
"	22 1.00 p.m.	F	16.5			
"	23 1.00 p.m.	HF	17.0			
"	24 1.30 p.m.	HF	16.8			
"	25 2.00 p.m.	HS	18.4			
"	26 2.00 p.m.	HS	17.5			
"	27 2.30 p.m.	HS	17.2			
"	28 7.38 p.m.	HR	17.4	10.30 a.m.	16	14
"	29 5.00 p.m.	Nearly F	18.3	11.00 a.m.	16	16.5
"	30 6.00 p.m.	F	19.0	12.00 Noon	18.5	16.5
"	31 7.00 p.m.	F	17.5	1.30 p.m.	19.0	16.
pt.	1 5.00 p.m.	HF	17.8			
"	2 6.00 p.m.	HF	18.0	4.30 p.m.	18.5	17
"	3 6.00 p.m.	HF	17.6			
"	4 10.00 a.m.	F	18.3	4.30 p.m.	22.5	17
"	5 11.00 a.m.	F			18.5	17
"	6 7.00 p.m.	HF	17.5			
t.	6 10.50 a.m.	HR	11.0			
9					17.5	15

Table 2. Salinity Determinations.

Date	Time	Tide	Depth	Temp. of Sample	Hydr. Read- ing	Salinity ‰	Remarks
June 20		F	Sur.	12.0	24.5	30.8	East Petpeswick
" 22		HS	Sur.	12.8	20.0	25.1	Day after heavy rain
" 24		HS	Sur.	12.0	24.0	30.1	
			Bot- tom				
			10'	12.0	23.8	29.9	Opposite Chas. T. Young's wharf.
" 27		F	Sur.	21.6	21.0	28.8	
" 29		F	Sur.	18.1	22.3	29.3	
July 3		F	Sur.	18.7	23.8	31.6	
" 6		F	Sur.	21.0	22.7	30.8	
			Bottom				
			10'	19.9	22.9	30.6	C.T.Y.'s wharf
" 8		HS	Sur.	24.0	21.5	30.3	
			Bottom				
			10'	23.2	22.1	30.6	
" 10		SP	Sur.	23.6	21.3	29.7	
" 13		F	Sur.	19.5	22.8	30.4	After $\frac{1}{2}$ hr. heavy rain
			Bottom				C.T.Y.'s wharf
			10'	18.2	23.0	30.3	
" 18		F	Sur.	22.8	22.2	30.6	
" 24		F	Sur.	20.8	23.2	31.4	
" 27		F	Sur.	20.2	23.3	31.3	
" 31		SP	Sur.	21.8	22.5	30.8	Heavy rain yesterday
Aug. 3		SP	Sur.	23.2	21.8	30.4	
" 7		HS	Sur.	23.8	21.5	29.6	
" 18		HS	Sur.	19.0	23.5	31.2	
" 21		HS	Sur.	21.6	23.0	31.3	
" 28		SR	Sur.	20.8	23.5	31.7	
June 16	3.10pm	SR	Sur.	14.2	25.0	32.1	Mouth of Cole Harbour
		LF	Sur.	14.6	24.8	31.7	" " " "
		LF	Sur.	14.5	24.8	31.7	At R.R. Bridge Cole Har- bour

Meteorology. Dr. Chiasson and Mr. MacMillan jointly made morning and evening weather observations, and recorded air temperature readings from a Sixes type maximum-minimum thermometer mounted at eye level on the north side of a building. The only instrument available until June 28 was faulty so that it was impossible to record the customary three readings after it was replaced. The observations are summarized in table 3.

The data show the tempering effects of the Atlantic throughout the season. There are no really violent fluctuations.

The incident sunlight is greatly reduced during the early part of the year by fog. This may well effect the time and extent of the phytoplankton maximum.

The relationship of such biologically efficient factors as soil temperature of clam flats has already been touched on on page 1.

Table 3. Meteorological observations at East Petpeswick Cove 1944.

Date	Time	General Observations	Air Temperature °F		
			Max.	Min.	Present
June	12 10.00 a.m.	Clear, sunny, calm			57°
	6.00 p.m.	Clear, sunny, lt. S.wind	69°	62°	64°
"	13 7.00 a.m.	Clear, calm			54°
	6.00 p.m.	Cloudy, strong N.wind			52°
"	14 7.00 a.m.	Cloudy, strong N.wind with rain.			43°
	18 10.00 a.m.	Foggy, sun, lt.wind			61°
"	4.30 p.m.	Cloudy, strong S.W. wind	81°		69°
	19 5.45 p.m.	Cloudy, med. S.W.wind			53°
"	20 9.15 a.m.	Cloudy, with fog, rain, S.wind			45°
	6.00 p.m.	Cloudy with rain, E.wind			48°
"	21 9.00 a.m.	Rain, S.wind			46°
	6.00 p.m.	Foggy			52°
"	22 9.00 a.m.	Foggy, calm			52°
	8.00 p.m.	Foggy, calm			52°
"	23 9.00 a.m.	Foggy, calm			53°
	5.00 p.m.	Foggy, after clear spell			57°
"	24 8.30 a.m.	Fog clearing up			54°
	9.00 a.m.	Foggy, light E.			49°
"	6.00 p.m.	Foggy, light E.S.E.			53°
	25 9.00 a.m.	Foggy, rain, strong E.S.E.wind			50°
"	6.00 p.m.	Foggy, rain, strong E.S.E. wind			53°
	26 9.00 a.m.	Foggy, calm			54°
"	6.00 p.m.	Foggy, lt. S.wind			59°
	27 11.00 a.m.	Clearing, lt. W. wind			57°
"	6.00 p.m.	Clear, lt. S.W. wind	72°		64°
	28 11.00 a.m.	Clear, lt. W.S.W.wind	64°	49°	56°
"	6.30 p.m.	Clear, lt. W.S.W.wind	66°	58°	63°
	29 7.00 a.m.	Clear, lt. S.W.wind	63°	52°	55°
"	6.00 p.m.	Clear, Med. S.W.wind	70°	55°	66°
	30 8.00 a.m.	Clearing, calm	66°	50°	56°
July	6.00 p.m.	Clear, calm	72°	56°	65°
	1 9.00 a.m.	Clear, N.E.wind	68°	56°	66°
"	7.00 p.m.	Clear, lt.S.W. breeze	79°	56°	63°
	2 9.00 a.m.	Clear, lt. N.wind	64°	48°	64°
"	6.30 p.m.	Clear, lt. S.wind	75°	64°	72°
	3 9.00 a.m.	Clear, very lt. N.N.E.	72°	45°	63°
"	6.00 p.m.	Clear, lt. S. wind	74°	63°	69°
	4 9.00 a.m.	Rather cloudy, lt. S. wind	70°	50°	61°
"	6.00 p.m.	Clear	76°	61°	76°
	5 9.00 a.m.	Clear, lt. S. wind	76°	52°	66°
"	6.00 p.m.	Cloudy, med. S.W.wind	78°	64°	66°
	6 9.00 a.m.	Clear, lt. S. wind	66°	52°	65°
"	6.45 p.m.	Clear, N. wind	92°	65°	76°
	7 11.30 a.m.	Clear lt. N. wind	77°	52°	77°
"	7.00 p.m.	Clear, lt. W. wind	80°	65°	65°
	8 9.00 a.m.	Clear, calm	65°	53°	63°
"	7.30 p.m.	Clear, S.W.wind	74°	65°	66°
	9 6.30 p.m.	Clear, calm	72°	55°	65°
"	10 9.45 a.m.	Clear, calm	74°	55°	72°
	6.15 p.m.	Clear, very lt. S.W.breeze	80°	71°	71°

Table 3 (continued)

Date	Time	General Observations	Air Temperature °F		
			Max.	Min.	Present
July	11 7.00 a.m.	Cloudy, lt. S.wind	74°	56°	60°
"	12 11.00 a.m.		66°	56°	61°
"		p.m. FOGGY, lt. S.wind	69°	61°	61°
"	13 9.00 a.m.	Foggy, S.W.wind			
"	6.00 p.m.	Clearing, strong W.wind	67°	58°	60°
"	14	a.m. Clear, calm			
"		p.m. Clear, lt. S.W.wind	72°		
"	15 8.30 a.m.	Foggy, lt. S.E.wind	72°	49°	60°
"	7.30 p.m.	Foggy, lt. S.wind	78°	59°	61°
"	16 9.00 a.m.	Foggy, lt. S.wind	66°	54°	66°
"	6.00 p.m.	Cloudy, S.W.wind	76°	64°	66°
"	17 9.30 a.m.	Cloudy, calm	68°	55°	58°
"		p.m.	78°		
"	18 7.00 p.m.	Clear, N.wind	76°	62°	68°
"	19 9.00 a.m.	Clear, N. wind	68°	45°	65°
"	7.00 p.m.	Clear, lt. N.wind	75°	64°	68°
"	20 8.30 a.m.	Partly cloudy, lt. W.wind	68°	46°	60°
"	7.00 p.m.	Cloudy, S.W.wind	73°	60°	62°
"	21 9.00 a.m.	Fog and rain, E.wind	63°	55°	61°
"	22 9.30 a.m.	Partly cloudy, calm	76°	70°	58°
"		p.m. Clear, strong W.S.W.wind	74°	64°	64°
"	23 7.00 p.m.	Clear, calm	74°	64°	66°
"	24 10.30 a.m.	Clear, calm	68°	68°	48°
"	25	p.m.	74°		
"	26 10.00 a.m.	Foggy, clearing, lt.W.wind	74°	57°	67°
"	5.30 p.m.	Clear, lt. S.W.wind	74°	69°	66°
"	27 6.00 p.m.	Clear, calm	75°	54°	61°
"	28 6.00 p.m.	Clear, calm	74°	58°	64°
"	29 7.00 p.m.	Cloudy, foggy, rain, strong E.wind	76°	53°	67°
"	30 9.00 a.m.	Cloudy, rain, strong S.E.wind	63°	57°	59°
"	6.00 p.m.	Cloudy, foggy, lt. S.E.wind	66°	59°	64°
"	31 9.00 a.m.	Foggy, lt. southerly breeze	62°	58°	62°
"		p.m. Clear, lt. S.W. breeze	79°	62°	68°
Aug.	1	a.m. Cloudy, calm	69°	54°	69°
"		p.m. Clear, calm	79°	69°	74°
"	2	a.m. Clear, lt. S.W.breeze	74°	58°	70°
"		p.m. Clear, calm	82°	70°	72°
"	3 9.00 a.m.	Clear, calm	73°	60°	71°
"	6.00 p.m.	Clear, S.W.breeze	78°	71°	72°
"	4 8.45 a.m.	Fog clearing, lt.S.W.breeze	73°	59°	69°
"	6.30 p.m.	Fogging up again, lt.S.W.breeze	80°	68°	71°
"	5 10.00 a.m.	Fog clearing, lt. S.W.breeze	76°	62°	76°
"		p.m. Fogging up, lt. S.W.breeze	84°	71°	75°
"	6	a.m. Clear, lt. N.W.breeze	80°	60°	73°
"	7 9.00 a.m.	Clear, lt. N. breeze	72°	62°	54°
"	8 8.30 p.m.		75°	56°	62°
"	9 8.30		73°	53°	61°
"	10 9.00 p.m.		76°	55°	59°
"	11 9.00 p.m.		70°	53°	60°

Table 3 (continued)

Date	Time	General Observations	Air Temperature °F			
			Max.	Min.	Present	
July	12	7.30 p.m.	Clear, strong S.W.breeze	77°	66°	68°
"	13	a.m.	Clear, strong S.W.breeze	70°	60°	69°
"		p.m.	Clear, strong S.W.breeze	76°	61°	61°
"	14	9.00 a.m.	Foggy, lt. S.W.breeze	67°	54°	67°
"		9.00 p.m.	Cloudy, strong S.W.wind	76°	62°	62°
"	15	a.m.	Foggy, clearing, lt.S.W.wind	72°	56°	69°
"		p.m.	Fogging up, lt.S.E.wind	76°	64°	64°
"	16	p.m.	Fogging up, lt. S.S.breeze	76°	64°	64°
"	17	p.m.	Foggy, thunder during day	66°	59°	61°
"	18	a.m.	Foggy, wet, almost calm	65°	61°	64°
"		p.m.	Foggy, lt. S.W. wind	69°	62°	62°
"	19	p.m.	Clear, N.wind	77°	55°	68°
"	20	a.m.	Clear, N.wind	70°	48°	69°
"		p.m.	N.wind	78°	61°	61°
"	21	11.00 a.m.	Clear, lt. W.wind	66°	49°	66°
"		8.00 p.m.	Cloudy, med.W.S.W.winds	72°	57°	57°
"	22	8.00 a.m.	Cloudy, med. S.W.wind	57°	53°	55°
"		p.m.	Cloudy, strong W.S.W.wind	64°	54°	56°
"	23	8.00 p.m.		66°	52°	54°
"	24	7.00 p.m.		69°	54°	58°
"	25	7.30 p.m.		68°	51°	63°
"	26	9.00 p.m.	Cloudy, N.wind	71°	64°	60°
"	27	9.00 a.m.	Clear, N.W.wind	60°	50°	59°
"		8.00 p.m.	Partly cloudy, N.W.wind	73°	59°	60°
"	28	8.00 a.m.	Clear, lt. N.W.wind	60°	47°	52°
"		p.m.	Cloudy, N.E.wind	73°	51°	66°
"	29	9.00 a.m.	Cloudy, rain, N.wind	66°	54°	61°
"		6.00 p.m.	Cloudy, rain, W. wind	62°	58°	69°
"	30	6.00 p.m.	Foggy, S.W.wind	70°	51°	64°
"	31	7.00 p.m.	Cloudy, N.wind	75°	53°	64°
Sept.	1	6.30 p.m.	Clear, lt. N.wind	72°	54°	66°
"	2	6.00 p.m.	Cloudy after heavy rain, S.W.wind	75°	51°	63°
"	3	6.00 p.m.	Clear, lt. S.wind	67°	51°	64°
"	4	9.30 a.m.	Clear, lt. S.wind	71°	52°	64°
"		6.30 p.m.	Clear, lt. S.E.wind	71°	64°	64°
"	5	9.00 a.m.	Fog clearing, lt. S.wind	64°	55°	62°
"		p.m.	Clear, W.wind			
"	6	9.00 a.m.	Cloudy, strong S.S.W.wind	69°	55°	61°
"	7	11.00 a.m.	Clear, S.wind	68°	51°	68°
"	9	11.00 a.m.	Clear, S.W.wind	72°	51°	66°

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