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J. C. Medcof and E. I. Morrison

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INTRODUCTION

This year the writer left St. Andrews for Ellerslie in April 20th and returned on November 24th. The biggest undertaking was an experiment on the growth of oysters which took up most of the time leaving only disconnected bits for other work. Through the assistance of Miss E. I. Morrison much more was accomplished this year than would otherwise have been possible.

Relatively few excursions were made from the biological station, the chief being in June, August, and September when the survey of the Miramichi was conducted. Short visits were also paid to Shediac, Tracadie, and Shippigan. The winter was spent in working up data, preparing manuscript reports, and preparation of manuscript for publication.

SECTION I.

Survey of Miramichi Oyster Areas

New Brunswick has an annual oyster production of about 12,000 barrels of oysters, 1/3 or more of which comes from the Miramichi river system. Table I compiled from "Fisheries Statistics of Canada" shows the history and relative importance of this fishery for the 17 years preceding 1942. The figures available show that at the present time the production is recovering from a slump which reached its lowest levels in the years 1934 to 1939. The local fishery officer and the fishermen claim that this slump was brought about by overfishing carried on during the depression when the number of oyster fishermen increased greatly. The effects of the overfishing are not illustrated in the statistics by great increases in the yield although such increases are said to have taken place. This peculiarity is explained by the fact that many of the oyster men on the Miramichi at that time came from outside districts and landed their catches at their home ports. In the statistics these landings are not listed with the rest of the Miramichi production.

The New Brunswick Department of Lands and Mines have granted several oyster leases in the Miramichi area and applications have been received for others. Leases have been issued with a view to stabilizing the industry. It was hoped that the practice of oyster culture would be a conservation measure and through regular production offset fluctuations, such as that just described, which are inherent in yields of public beds.

The lessees have recently asked permission to fish small oysters from certain areas for planting on their leases. This and other matters have arisen which could not be properly dealt with because of lack of information. To remedy this situation a systematic survey of most of the producing areas was made this year. Because time was lacking the writer was unable to survey those areas on the north side of Miramichi bay that lie to the north and east of Oak point. Some of these are of growing importance, for example, Neguac and Burnt Church, and should be carefully looked over. A brief visit was paid to Neguac on August 20th as described in the section of this report "Neguac Observations" and in mid-September Dr. C. J. Kerswill went over the area in connection with his study of bar clams and collected samples of oysters that were submitted to the writer for study. Apart from this we have no precise information on the Neguac situation and there is nothing on Burnt Church.

Nature of Survey

The survey involved three periods of exploration, June 16, August 12-17, and September 8-12. With the exceptions already mentioned all the important producing areas were visited at one time or another and many of the less significant grounds were studied. In this work the local officers and guardians of the Department of

Table I. Annual oyster production in barrels 1925 - 1941 (a) Lower part of Miramichi, (b) Miramichi as a whole, (c) New Brunswick.

Year	# Lower part of Miramichi	* Miramichi system	New Brunswick
1925	3,510	4,410	12,038
1926	5,340	5,840	12,383
1927	6,415	6,815	13,574
1928	3,870	4,900	12,383
1929	4,513	5,894	14,146
1930	4,116	5,048	13,862
1931	3,766	5,613	13,443
1932	3,095	4,917	12,455
1933	2,904	4,176	10,162
1934	1,989	3,223	8,273
1935	1,228	2,478	9,109
1937	1,614	3,368	11,546
1938	2,747	3,973	12,369
1939	2,150	3,079	9,762
1940	3,059	3,337	11,285
1941	3,833	4,612	12,634

In "Fisheries Statistics of Canada" this area is described as "from Kent County line to Point-du-Quart" and includes only the oyster areas on the south side of Miramichi bay.

* These figures are for the whole of Northumberland County which includes the whole of the Miramichi area and Tabusintac. The latter area is of relatively little importance.

Table II. Description of Miramichi Oyster Areas.

Order	Name of Bed	Production rating of market-sized oysters	Size of oysters	Growth rate	Shell Character	Meats	Bottom Character	Depth at half-tide	Remarks
1	At Chatham	Nil; but specimens have been found	Probably stunted and small for age	Probably Low	Probably fairly strong but poor shape	Probably thin	-----	20' +	Not visited; report by Mr. Grant.
2	Lower Newcastle or Loggie bed	Low but numerous small oysters present	Almost all small and stunted	Low	Fairly strong; shape of older ones poor	Thin and fresh	Long narrow bed with spots of shell bottom on mud	15-20'	Studied populations see Tables 5 and 6
3	No name	Low	Probably small and stunted	Probably low	Shells probably weak and irregular	Probably thin & fresh	Mostly mud but some shelly spots	15-20'	Not visited; report by Alister McDonald
4	No name	Low	Small and stunted	Low	Fairly strong, shape better than No. 3	Thin & fresh	Shelly spots on mud	10-15'	
5	Schooner Pt.	Low but numerous small oysters present	Small and stunted	Low	Fairly strong but irregular in shape	Thin & fresh	Irregular shelly spots on mud	10-12'	Studied populations see Table 3 and 4
6	Shellsnake Is. bed	Low but better than No. 4, 5; fished every fall	Mixed sizes	Low	Weaker than No. 5; long and irregular typical mud oysters	Poor & fresh	Soft muddy bottom; often irregular	10-12'	Studied populations see Table 3 and 9.
7	---Once a leased area	Nil	Mixed	Low	Weak, long, irregular	Poor	Shelly but mussels have covered it of late years.	10-12'	

Table II. (Continued)

St. No.	Name of bed	Production rating of market-sized oysters	Size of oysters	Growth rate	Shell Character	Heats	Bottom Character	Depth at half-tide	Remarks
WLS SECTION									
1	Middle Ground beds	Low	Large and probably old	Probably low	Strong; well-shaped cup oysters	Said to be good	Said to be fine	16-17'	Not visited; report by Alister McDonald
2	Pointe du Quart	Small now but formerly a heavy producer	Large probably old; very few spat	Apparently slow	Strong; well-shaped	Good	Mixed shell, sand, stony	10'	These areas have gradually died out; the shells are overgrown by an encrusting sponge studied previously: see Table 2. 10 years ago considered away the best producer on Wilsfield
3	-----	"	"	"	"	"	Shelly and sandy		
4	Upper Oak Pt. bed	Good	Great variety; good reproduction but '42 spat rare	Fairly fast	Strong; well-shaped	"	Hard sand little shell	10-12'	Encrusting sponge like at #12 is common here on #14, #15.
5	Lower Oak Pt. bed	Good	"	"	Strong & well-shaped better than No. 14	"	-----		Beyond this area no more oysters are found on the north side of bay until you reach Burnt Church.
6	-----	Nil at present	-----	Probably slow	Hard; puffed	"	Sand; some rocks	15'	Bed has died out

Art and No.	Name of bed	Production rating of market-sized oysters	Size of oysters	Growth rate	Shell Character	Seats	Bottom Character	Depth at half-tide	Remarks
7	Outside Bed	Small now; formerly larger	Mostly large; no 1942 spot	Slow	Hard-cupped	Good	Shell; oc- casional rocks	15'	A regular pro- ducer of small quantities.
8	Fishrod Smith bed	Dead	None	?	Good	Once good	Firm	-----	This area was once an impor- tant producer
NEW SECTION									
7	-----	Small	-----	Pro- bably slow	Good	Good	Firm	-----	Not visited; report by W. Gibbs.
8	Cowyard Bed	Fair	Mostly large	Pro- bably fairly fast	Hard; cupped	Good	Firm sand; a few shells	-----	"
9	Ile du Vin Bed	Heavy	A variety but few 1942 spot	Fairly high	Hard; cupped	Good	Firm sand; very few shells	3-8'	
9	Gardiner Pt., Bed	Fairly good	A variety	Pro- bably high	Hard; cupped	Good	"	3-8'	Not visited; report by W. Gibbs.
1	Forbes Pt. bed	High	A variety; much small	Pro- bably high	Hard; cupped	Good	Firm sand	3-8'	"
8	-----	High	A variety; much small	Pro- bably high	Hard; cupped	Good	Firm sand	3-8'	"
1	Hills Point bed	High	A variety; much small	"	"	"	"	"	"

Station No.	Name of bed	Production rating of market-sized oysters	Size of oysters	Growth rate	Shell Character	Meats	Bottom Character	Depth at half-tide	Remarks
4	Blue Rock Bed	Heavy now; was even higher a few years ago	Mostly small but few 1 1/2" spat	Appeared to be slow	Hard; cupped	Good	Firm sand	3-5'	Not visited; report by W. Gibbs.
5	Quoi c'est ça	Low	Mostly small	Very slow	Very hard; cupped	Very fat	Hard sand, shell and sandstone	3-4'	Area discussed in detail in report.
5A	Outside Egg Id.	Low	Mostly large	Probably slow	Hard-cupped	Very fat	Hard sand	up to 5'	Area not visited; report by W. Gibbs.
6	Egg Island Bed	Very heavy; one of chief areas	Variety; considerable 1 1/2" spat	Probably very fast	Varied; good inshore poorer in mud	Very fat	Hard sand near shore; mud farther out	3-5'	Area ranks in first three
	-----	Regular producer	Variety	"	Hard; cupped	Fat	Firm sand	3-5'	Not visited; report by W. Gibbs.
	MacKinnon Bed	Regular producer but could be higher	Variety; much small stuff	Said to be slow probably normal	"	"	"	3-5'	"
	-----	Regular producer but could be higher	"	Probably normal	"	"	Firm sand	3-5'	Not visited; report by W. Gibbs.
41, 42	"	"	"	"	"	"	"	"	40 and 41 not visited.

Table II (Continued)

Chart Bed No.	Name of Bed	Production rating of market-sized oysters	Size of Oysters	Growth Rate	Shell Character	Bottom	Bottom Character	Depth at Half-tide	Remarks
13	Fox Island area (not a bed)	Small but regular	Mostly large but heavy catch of 1942 spot	Pro- bably normal	Hard-capped	Fat	Firm sand	2-5'	
14	Landon Bed	Perhaps the chief producer	Variety but few 1942 spot	"	" "	"	Firm sand much shell	2-5'	
15	Jenkins Bed	High end of growing impor- tance	Mostly med- ium or large size	"	Hard-capped single	"	Firm sand	2-5'	
<u>FAU RIVER SECTION</u>									
6	----	Regular and large	Wide range; many small; 1942 spot abundant	Apper- ently fast	Soft, shape poor to fair	Thin	Bed	8-10'	For size range see Table 3.
7	Leased ground U.S. No. 20	Not as large as it could be on account of be- ing leased	Large; fewer small than #6	"	Poorer than #6	Thin	Bed	8-12'	Not regularly fished
8	----	Low but could be higher	Mixed; 1942 spot common	"	About same as #6	Thin	Bed and shell	12-18'	For size range see Table 3. Might be a spot producing area
<u>ACE RIVER SECTION</u>									
9	MacDougall Bed	Small now, for- merly largest producer in Black River	Mostly large and old; no 1942 spot	Fairly fast	Good but not as hard as #17	Good	Sandy with rock	Varies up to 10'	Bed was smothered in sand and mud in Sept. 17' sale of 1940.

Table II. (Continued)

Part of bed	Name of Bed	Production rating of market-sized oysters	Size of oysters	Growth rate	Shell Character	Seats	Bottom Character	Depth at half-tide	Remarks
	Joe Dan Bed	Regular producer	All sizes oysters present	Fairly fast	Soft but fair shape	Thin	Firm and some shell	8-12'	
	MacDougall bed	" "	All sizes much 12-12 spot	Fairly fast	"	"	Hard and shell	on edge of channel 8-12'	
	MacKnight's Pt.	" "	All sizes	Fairly fast	"	"	"	8-12'	
	Geiffrey's Bed	" "	All sizes heavy 12-12 catch	"	"	"	"	10'	
TRANSVERSE SECTION									
	-----	Heavy producer; the principle fishing area	All sizes see Fig. 8.	"	Fairly hard fair shape	Good	"	8-12'	
	This is a leased area but not cultivated	Good	Variety of sizes; fewer spot than No. 24	"	Softer than No. 24; fair shape	Fair	Muddy	8-12'	A private fishing area.
	A group of up-river areas scattered over the 2 miles above bridge	Slight	-----	-----	Much variety	Poorer than No. 24	Varied mostly muddy	Varied	Areas not visit report by J.A. MacDonald.

Order	Name of bed	Production rating of market-sized oysters	Size of oysters	Growth rate	Shell Character	Meats	Bottom Character	Depth at half-tide	Remarks
<u>RIVER SECTION</u>									
1	Sandy Point	Of growing importance	Medium and large	Said to be rapid	Hard-capped	Fat	Fine sand	3-5'	Not visited; report by Turbide
2	Harrington Bed	Low at present	Large and old	Slow	" "	"	Shell and gravel	3-3'	This bed has died out, perhaps it has become too shoal. Some claim these best oysters in bay
3	-----	Low	Mixed	Probably normal	Soft and fair shape	Fair	Fine mud and shell	3-3'	River oysters
4	-----	Low	Mixed	"	Soft and often poor shaped	Often thin and fresh	Mud	3-12'	

Fisheries co-operated most generously. In some places the services of experienced oyster fishermen were engaged to supplement information supplied by guardians. Information was gathered on the recent history of the beds, the quantity and quality of the oysters produced, the size composition and growth rates of the oyster populations, hydrography of the inlets, the character of the bottom and the depth of the water overlying the beds. Besides this, areas suited to spat collection were sought out and other observations have been recorded that may be of use in the future if oyster culture in this region should expand.

Classification of Areas.

Based on the character of the oysters produced the Miramichi system falls naturally into three main sections which are best understood by reference to the chart (figure 1).

The Upper Section includes everything above a line from Point Cheval to Oak point. Relatively small yet considerable quantities of low-quality, slow-growing oysters are found on deep beds in this region.

The Middle Section includes all the oyster areas below Point Cheval and Oak point that are open to Miramichi bay such as those near Grand Dune island, Point du Quart and Bay du Vin. The oysters are mostly slow-growing, of fair quality and found chiefly on deep beds. Many of the beds show such signs of dying out as scanty populations, preponderance of older age classes in their populations and heavy growths of encrusting organisms over the shells and bottom.

The Lower Section constitutes that part of the estuary which is cut off from Miramichi bay by a chain of islands, Huckleberry, Fox, Egg and Ile du Vin. This is the centre of Miramichi oyster production as is indicated by the statistics quoted in Table I, and it is here too that interest in leasing is greatest. The water is shallow, growth is fast and quality is relatively high. In the opinion of Mr. W. Gibbs of Eel River Bridge, an oyster fisherman who acted as guide for this area, the order of importance of the beds in this area for quantity of oysters produced is Egg island (No. 36), Lauden (No. 44), Jenkins (No. 45), Ile du Vin (No. 29), and Blue Rock (No. 34). (The numbers refer to figure 1).

Besides the three sections of the Miramichi itself there are four tributary rivers that produce considerable quantities of soft-shelled, poor quality, fast-growing oysters. These are: Napan, Black, du Vin and Eel - the last being of slight importance. There are sheltered parts of the first three of these streams that may be suited to spat collection. A summary of detailed information on the several areas studied is presented in Table II.

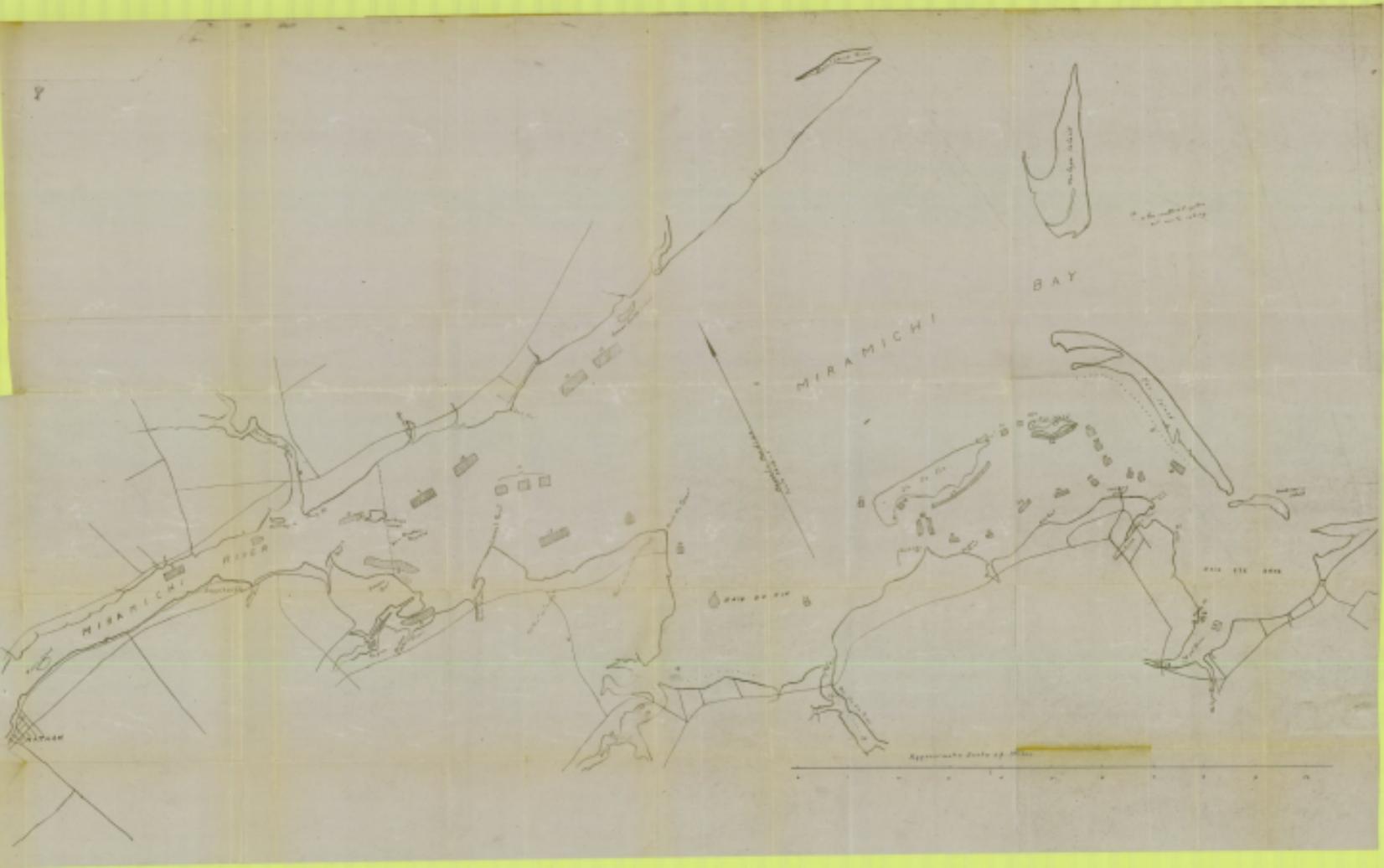


Table III (Continued)

Length ft.	Area No.																		
	Green-Mountable Nov. 11, 1942	Schooner Point Nov. 15, 1942	Schooner Point June 15, 1943	Shell-drake Island June 15, 1943	Pointe du Quart Aug. 13, 1943	Lower Oak Point Aug. 14, 1943	Curti's nest on Aug. 15, 1943	West end Egg Id. Aug. 15, 1943	East end Egg Id. Aug. 15, 1943	Funkies, Bal. River Sept. 15, 1943	MacKinnon Aug. 23, 1943	Beside MacKinnon on sand flats Aug. 15, 1943	Jenkins Aug. 17, 1943	Bed No. 8, Sapsen river, Aug. 13, 1943	Bed No. 6, Sapsen river, Aug. 13, 1943	McDuff's point Sept. 5, 1943	MacDougall Sept. 5, 1943	Mouth of Bal. du Vin R., Sept. 8, 1943	Above bridge, Bal river, Aug. 1, 1943
see chart	2	5	5	0	12	15	25	28	35	45	38	28	45	8	8	21	20	24	40
60 - 64	10	10	13	7	3	0	5	13	10	1	13	3	0	3	3	1	11	14	4
65 - 69	12	15	12	10	1	4	2	10	0	0	0	0	4	3	7	7	6	0	2
70 - 74	14	14	20	0	2	1	2	7	0	2	4	1	5	0	10	2	12	14	1
75 - 79	11	13	14	7	3	.4	2	12	5	0	4	3	10	11	0	4	12	3	6
80 - 84	9	0	7	13	4	2	0	6	0	7	0	4	7	0	0	0	15	4	1
85 - 89	11	4	6	0	2	4	1	1	6	5	0	4	6	1	14	6	11	7	2
Market size																			
90 - 94	7	0	7	2	4	0	0	3	4	5	4	7	0	1	3	0	7	7	0
95 - 99	3	2	5	4	3	0	0	3	2	1	1	2	3	2	3	3	7	4	1
100 - 109	4	0	3	1	1	0	0	4	0	2	0	4	0	0	3	5	7	1	0
110 - 119	0	1	5	1	1	1	0	0	0	0	0	2	3	2	0	2	1	2	1
120 - 129	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	1	0	1
130 -	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
Totals	193	218	#270	#429	29	54	127	25	96	45	121	101	#24	79	#122	75	122	132	22
% above market size	7	0	7	2	23	4	0	11	6	18	4	15	21	16	5	25	10	10	10

Samples fished by dredges; * Samples fished with rakes; Other samples fished with ordinary oyster tows.

T
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Lower Newcastle
Nov. 12, 1942

Schooner Point
Nov. 12, 1942

Schooner Point
June 16, 1942

Shellrocks Island
June 16, 1942

Pointe du Quart
Aug. 12, 1942

Lower Oak Point
Aug. 14, 1942

Coal c'iest ca
Aug. 16, 1942

West end Egg Id.
Aug. 18, 1942

East end Egg Id.
Aug. 16, 1942

Jenkins, Eel River
Sept. 16, 1942

Mackinnon
Aug. 22, 1942

Beside Mackinnon
on sand flats
Aug. 16, 1942

Jenkins
Aug. 17, 1942

Bed No. 2, Napan
river, Aug. 12, 1942

Bed No. 6, Napan
river, Aug. 12, 1942

McKnight's point
Sept. 9, 1942

MacDougall
Sept. 9, 1942

Mouth of Sais du
Win R., Sept. 9, 1942

Above bridge, Eel
river, Aug. 17, 1942

Area No. see chart	1	2	3	4	10	12	13	14	15	16	17	18	19	20	21	22	23	24	25
0 - 9	75	85	44	178	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0
5 - 9	4	23	30	100	3	0	0	0	0	0	3	5	1	7	21	1	2	0	0
10 - 14	0	2	5	6	5	0	58	4	1	0	3	16	9	9	52	7	7	14	1
15 - 19	1	0	0	0	0	0	58	2	0	0	1	20	4	4	17	7	14	18	2
20 - 24	5	0	6	3	0	4	21	0	1	0	2	12	2	3	5	6	5	22	0
25 - 29	1	0	12	2	0	1	2	0	0	0	2	3	2	3	1	2	0	2	0
30 - 34	2	2	12	12	0	3	1	0	2	0	2	1	1	1	1	0	0	1	0
35 - 39	7	2	9	12	2	1	0	2	4	0	2	1	1	0	4	1	0	2	0
40 - 44	2	5	12	4	1	4	0	2	2	1	2	0	0	1	4	0	2	1	0
45 - 49	3	3	11	11	2	5	2	2	7	0	2	1	2	0	4	0	1	2	0
50 - 54	5	9	11	6	0	5	2	2	15	1	14	2	7	0	7	1	3	0	0
55 - 59	2	11	11	10	2	5	5	2	2	4	20	2	2	2	4	2	5	5	1

Oyster Populations

In order to form clearer ideas of the oyster populations in the different parts of the bay than may be gained from Table II, random samples of stocks were taken from 18 different beds. The size-frequency distribution of the oysters comprising the samples is shown in Table III. In a rough way the size of each sample corresponds to the density of the population on that bed. An examination of the results shows that at present, areas Nos. 2, 5, 6, 9, 35, and 38 are populated by large numbers of small and relatively few large oysters. Areas Nos. 12, 21, and 49 show the reverse tendency. The interpretation of these observations is subject to some question but together with other observations they indicate that areas Nos. 2, 5, 9, and 35 do not offer conditions suitable for maturation and that area No. 12 is no longer suited to spat fall and is probably dying out.

Hydrography

The hydrographic observations made during the survey are summarized in Table IV. All the salinities are probably below average for the areas concerned because there were many heavy rains during the open water season of 1943. Everywhere in the system the water was riley and discoloured by the river discharge. In spite of this irregularity the results are valuable for comparative purposes. The data indicate that the lower section is the only part where good quality oysters can be expected and even there salinities are below what are considered optimum. This observation agrees with the opinion frequently expressed that Miramichi oysters are "fresh".

Opportunities for Oyster Farming.

Because of low quality it would be unwise to encourage oyster culture anywhere in the upper section of the river.

The middle section provides a few borderline cases such as the Oak point, Point du Quart areas and the ground just east of the mouth of Black river in Bay du Vin where deep water culture might be carried on. Quality here is not high enough to provide really good prospects to oyster culturists.

The lower section provides the best conditions found anywhere in the system. There are extensive areas of good ground in shallow water whose present oyster populations are so scant that they may be classed as barren or nearly so. These could be made productive of large quantities of oysters of as good quality as any the Miramichi provides. The shoreward side of Fox Island is the most conspicuous of all these and Baie Ste. Anne provides others. The Baie Ste. Anne co-operative group has already made certain efforts to lease ground near Fox Island from the New Brunswick Department of Lands and Mines but they have not yet succeeded.

Factors Regulating Spatfall

It was proposed to study factors regulating spatfall in Bideford river in 1937 using the same type of collectors as those employed in the Bras d'Or lakes (Medcof 1939 & 1940). The Bras d'Or collectors proved unsatisfactory as Miller (1940) also found. No satisfactory substitute for the vertical series of shells like those used in 1937 (Medcof 1937) was found. These have objectionable features, the chief being lack of uniformity. Several trials with different types of collectors to detect differences in intensity of spatfall during four-hour intervals, day and night, though very laborious proved to be fruitless. It was hoped that the effects of tidal currents, light intensities and possibly wind action would be illustrated.

Table IV. Summary of Hydrographic Observations on the Miramichi in 1943.

Locality	Date	Time	Tide	Weather	Depth	Temp.	Salinity p.p.m.
<u>UPPER SECTION</u>							
Schooner Point Area No. 5	June 16	10:15 a.m.	$\frac{1}{2}$ F	Cloudy fresh W	Sur. 12'(E)	---- ----	11.6 15.8
Shelldrake Island Area No. 4	June 16	10:30 a.m.	$\frac{1}{2}$ F	"	Sur. 8' 14'	12.3 ---- 10.4	7.9 16.1 18.2
Point du Quart Area No. 13	Aug. 13	3:30 p.m.	HR	Cloudy mod. SW	Sur. 5' 10'(E)	19.2 ---- 18.3	17.9 21.3 21.5
<u>MIDDLE SECTION</u>							
Oak Point Area No. 15	Aug. 15	9:50 a.m.	LF	Raining Fresh SE	Sur. 8'(E)	18.7 18.7	18.7 18.6
Baie du Vin (2 miles west of area No. 24)	Sept. 11	11:00 a.m.	HF	Bright fresh SW	Sur.	19.3	20.0
<u>LOWER SECTION</u>							
Egg Island (near area No. 35)	Aug. 16	p.m.	LF	Bright calm	Sur. 10'	21.8 19.7	21.2 21.6
Birch Point (near area No. 35)	Aug. 17	11:15 a.m.	HF	Showers fresh S	Sur. 17'(E)	19.3 19.2	19.1 20.5
Quoi c'est ca Area No. 35	Sept. 10	11:30 a.m.	LR	Cloudy light SW	Sur.	18.7	20.8
<u>NAPAN RIVER</u>							
At bridge $\frac{3}{4}$ mile above area No. 8	Aug. 13	9:34 a.m.	LF	Clear calm	Sur. 10'(E)	17.7 17.7	---- 6.9
At area No. 8	Aug. 13	11:00 a.m.	LS	Clear mod. SW	Sur. 8'(E)	18.3 18.3	8.8 8.6
At area No. 8	Aug. 13	5:20 p.m.	HS	"	Sur. 6' 12'(E)	---- ----	14.0 15.4 15.8
At area No. 5	Aug. 13	12:00 noon	LR	"	Sur. 15'(E) 8'	18.7 18.7 ----	11.1 16.2 12.5

Table IV. (Continued)

Locality	Date	Time	Tide	Weather	Depth	Temp.	Salinity p.p.m.
<u>BLACK RIVER</u>							
At area No. 22	Sept. 9	11:00 a.m.	HF	Bright mod.SW	Sur. 12'	20.4 20.2	17.9 18.4
At area No. 20	Sept. 9	10:15 a.m.	HR	"	Sur. 6' 12'	---- ---- ----	17.9 18.6 18.7
<u>BAIE DU VIN RIVER</u>							
At area No. 24	Sept. 9	3:10 p.m.	LF	Bright fresh SW	Sur. 8' 15'	19.8 ---- ----	20.7 20.7 23.9
Near area No. 25	Sept. 9	4:00 p.m.	LF	"	Sur. 6' 12'	21.3 ---- 21.4	18.4 19.9 19.5
<u>EEL RIVER</u>							
At area No. 49	Sept. 10	6:45 p.m.	LF	Bright calm	Sur. 3' 7'	20.0 ---- 19.8	20.0 20.4 21.6

Partly through force of circumstance the leases already granted in this area seem to be used more as private fishing grounds than as areas for practising oyster culture. The greatest obstacle to the proper development of oyster culture is the lack of any arrangement for obtaining seed stock. The writer is of the opinion that Quoi c'est ca (Area No. 35) could be best used for this purpose. There is already a good stock of small oysters there but under natural conditions its value to the industry is slight compared with what could reasonably be expected if it were properly used as seed stock on well-chosen leases.

The local fishery officer and some of the fishermen are opposed to the idea of such a program.

The whole problem is dealt with in greater detail in the next section of this report.

Conclusions

The Miramichi is one of the most important oyster producing areas in the Maritimes.

The fishery is entirely dependent on natural production for there has been no serious attempt at oyster culture anywhere in the area.

The oysters are generally "fresh".

Their quality is generally below that of Malpeque bay and the Shippigan area but the stocks from the lower section compare favourably.

There is good reason to believe that production of better quality stock could be greatly increased by establishing a suitable program of oyster culture. There is already some opposition to such an undertaking.

SECTION II

The Seed Problem of Miramichi Oyster Culturists

The chief problem of lessees of oyster ground in the Miramichi area is the shortage of small oysters for stocking purposes. No program of spat collection has been developed and there are no local tide flats where oysters are found in sufficient numbers to encourage picking as practised in many places. As a result lessees have asked permission to take oysters for stocking purposes from deep beds in the upper section and from Quoi c'est ca. In order to judge the wisdom of granting such a request and for general information a study of growth based on annual rings on the shells of oysters was made for seven representative areas. Measurements of the longitudinal diameters of the rings appear in Tables V to XI and some of these results are summarized in Figure 2. The results for Shelldrake island when plotted out give a curve resembling that for the Lower Newcastle bed (figure 2). The Bay du Vin curve is like that for the McKnight bed. The MacDougall bed curve also resembles the McKnight bed but flattens out earlier and the market size is not reached until after the seventh year. Because of their bearing on the seed problem of lessees three of these seven areas were carefully studied.

Lower Newcastle or Loggie Bed (Area #2) - figure 1

There are considerable numbers of oysters on this bed but they are nearly all small in spite of the fact that the ground has not been fished commercially for the past several years. There are large numbers of 1942 spat present. The meats of the oysters are very fresh, the shells thin but firm and many are blunt on the margins - what the English call "dumpy". The growth rate is fairly high at first but falls off after about the fifth year and on the average, market size, if achieved at all, is not reached before the ninth or tenth year (figure 2). Many dead shells are found along with the oysters taken and the sizes of these indicate that many oysters grow old and die before they attain a length of $3\frac{1}{2}$ inches. Slow growth in this area is attributed to low salinities (table IV). This characteristic makes the area suitable for the production of seed stock only.

Quoi c'est ca (Area #35)

This is a bar of stone and gravel bottom about 100 yards wide and a mile long, partly covered with eel grass. For abundance of oysters this ground can be compared with the bars at Malagash, N.S. The sample of 167 oysters measured on August 16 (table III) came from an area only 18 inches square which corresponds to a population density of about 75 oysters per square foot. Many 1942 spat are present and enormous numbers of earlier year-classes. There are very few oysters above market size but according to estimates of the local fishermen the commercial production of the area approximates 100 barrels a year

Which is about 23% of the total production of the lower section (table I). The writer is of the opinion that this estimate is too high.

The meats of these oysters are very fat, the shells hard (specific gravity 2.84), and symmetrical, but often "dumpy". The average time required to reach marketable size appears to be ten years (figure 2). Salinities over this area are high enough to favour much more rapid growth (table IV). It is probable that low temperatures of the outer Miramichi bay waters to which these oysters are exposed at every rising tide are responsible for the low growth rate.

Because natural seed production is so successful and growth rate so slow it would be wise to use the area solely for seed production. It is quite possible that with proper management Quoi c'est ca could supply all the seed stock needed on the Miramichi and several other areas besides, at a very low cost. This would require careful study and experimentation.

Fishermen who visit this area gather the oysters by hand at low tide. They are opposed to any change in the present status of this ground as a public fishing area.

Jenkins Bed (area #45).

This area is a public bed but may be regarded as typical of the grounds to which lessees wish to transfer seed stock from areas like the Lower Newcastle bed and Quoi c'est ca. It has a good population of oysters and although it is fished regularly every autumn a high proportion of the stock is at or near market size (table XI). The shells are symmetrical and strong with no signs of "dumpiness". The meats are fat but not quite so fat as those at Quoi c'est ca. The time required to reach marketable size seems to be seven years (figure 2).

The temperatures in this shallow area are probably higher than those at Quoi c'est ca and the salinities about the same, that is, much higher than on the Newcastle bed. This combination of favourable conditions probably explains the higher growth rate.

Conclusions

The growth rates throughout the Miramichi system are low probably because of prevailing low salinities.

From available information the transfer of oysters from up-river grounds like the Lower Newcastle bed, to areas like the Jenkins would undoubtedly be a sound method of increasing production. The quality of the oysters would be improved, the maturation time reduced, and the percentage survival increased.

With slight reservations the same may be said of transfers from Quoi c'est ca. The quality of the meats of these oysters would probably drop slightly but the maturation time would be reduced by two or three years. This would increase the yield, benefit the lessees greatly and relieve the present congestion of the oyster population on Quoi c'est ca.

In neither of these cases would the public fishery suffer seriously if the natural production of these grounds were set aside solely for use as seed stock. Their value as such to the industry would depend, of course, on the extent and efficiency of their use but there is not the least doubt that it could be many times greater than it is at present. Even greater use could be made of Quoi c'est ca if a suitable scheme of artificial seed collection could be worked out for it.

Until a policy is developed for the use of these areas as seed producers, the chances for the development of an oyster farming program in the area seem to be very poor. There is likely to be local opposition to such changes as would be involved by this development but this should be regarded in proper perspective.

Table V. Diameter of annual rings measured longitudinally in mm. of 28 oysters from the MacDougall bed, Black River, N.B., collected September 9, 1943.

Ring Number or Age in Years	1	2	3	4	5	6	7	8	9
6		23							
3		18							
5		20							
9		24	49	55					
-		26	48	57	62				
-		19	43	52	61				
-		27	40	48	58				
6		32	53	64	73	84			
8		25	49	66	75	80			
9		27	43	64	72	74	77		
-		18	50	75	102	115	122		
-		34	50	58	66	74	81		
-		13	36	50	66	84	92		
-		20	45	61	71	76	81		
6		27	52	66	72	78	81		
-		25	42	57	68	82	84		
8		19	38	53	64	66	68		
5		23	38	55	70	76	79		
9		27	54	69	81	90	97	103	
4		21	46	56	69	84	93	96	
5		20	48	68	83	98	112	117	
4		19	38	51	69	81	92	95	
4		20	41	56	69	81	90	93	
-		27	51	63	70	76	80	82	
5		27	58	77	93	100	106	111	
5		19	38	54	59	66	82	91	95
5		25	46	66	72	78	85	93	95
6		26	48	65	71	83	92	99	107
Age-frequency distribution	0	3	0	1	3	2	9	7	3
Corresponding year of settlement	1943	1942	1941	1940	1939	1938	1937	1936	1935

Table VI. Diameter of annual rings measured longitudinally in mm. of 25 oysters from McKnight's Point Bed, Black River, N. B., collected September 9, 1943.

Ring Number or Age in Years	1	2	3	4	5	6	7	8	9
	6	13							
	6	21							
	7	18							
	5	16							
	5	19							
	5	27							
	7	25							
	6	24	43	60	68				
	15	31	44	60	67				
	16	35	56	73	87				
	15	30	42	51	62	69			
	--	25	49	61	71	77			
	9	30	55	66	83	94			
	--	22	47	67	77	85			
	17	29	53	66	74	84			
	7	23	54	59	69	77	79		
	12	37	52	63	74	84	91		
	5	28	47	65	80	93	97		
	4	27	54	69	83	89	96		
	--	23	51	77	94	100	107		
	11	30	51	73	95	102	107		
	--	28	58	68	77	86	95	104	
	17	38	56	65	78	88	99	104	
	7	28	55	76	90	102	116	131	150
	6	19	42	50	58	66	73	77	81
Age-frequency distribution	0	7	0	0	3	5	6	2	2
Corresponding year of settlement	1943	1942	1941	1940	1939	1938	1937	1936	1935

Table VII. Diameter of Annual rings measured longitudinally in mm. of 27 oysters collected September 9, 1943, from the bed at the mouth of Baie du Vin River (Area #24).

	<u>Ring Number or Age in Years</u>								
	1	2	3	4	5	6	7	8	9
10									
5		18							
7		19							
4		17							
6		19							
6		15							
6		22							
7		27							
8		28							
6		19	31	42					
18		30	40	47					
4		26	44	57					
17		30	49	62					
10		21	41	58	67				
6		26	41	55	69				
7		20	35	57	68	77			
5		28	39	47	60	70			
--		29	47	64	77	82			
--		35	58	72	78	85			
9		30	48	73	86	91			
--		30	52	67	76	84			
--		33	58	80	98	105			
4		24	38	54	63	74	84		
--		29	52	72	79	89	98		
4		15	42	58	66	81	93		
6		38	53	69	84	97	113		
5		37	64	96	99	110	115	118	
Age-frequency distribution	1	8	0	4	2	7	4	1	
Corresponding year of settlement	1943	1942	1941	1940	1939	1938	1937	1936	

Table VIII. Diameter of annual rings measured longitudinally in mm. of 60 oysters from Lower Newcastle Bed (Loggie bed) collected November 12, 1942.

<u>Ring Number or Age in Years</u>									
1	2	3	4	5	6	7	8	9	
3									
5									
3									
2									
2									
2									
3									
2									
3									
3	16	34							
3	17	41	54	60	67				
4	19	31	42	57	71				
6	16	20	41	50	56				
4	18	32	44	58	68				
6	20	35	49	61	75				
7	20	34	47	52	59				
5	26	50	60	71	73				
7	27	39	59	75	85				
4	23	48	57	67	75				
8	25	35	54	66	78	84			
3	20	35	43	54	63	70			
5	19	36	54	68	79	89			
--	13	32	45	60	68	74			
6	22	36	58	70	77	89			
4	11	29	52	64	81	88			
4	14	31	47	55	64	68			
5	16	30	46	67	75	82			
4	13	20	32	47	54	60			
5	15	38	49	55	59	65			
10	24	40	53	65	71	74			
4	12	28	38	52	57	65			
4	19	36	51	63	72	80			
--	25	41	54	61	67	73			
5	16	27	40	53	57	59			
4	22	39	55	61	69	73			
6	25	33	49	60	65	72			
4	16	39	53	65	75	81			
10	26	43	60	68	77	84			
4	17	49	57	70	79	83	88		
4	17	35	49	60	76	83	91		
8	23	32	48	58	67	71	75		
4	19	30	42	55	66	69	73		
5	15	33	51	71	80	87	93		
3	14	28	46	57	62	72	77		
9	14	27	46	53	61	71	77		

Continued on next page

Table VIII (Continued)

		<u>Ring Number or Age in Years</u>										
		1	2	3	4	5	6	7	8	9	10	11
	3	14	32	48	71	81	91	96				
	4	16	32	46	58	67	74	80	87			
	3	15	33	53	71	86	95	105	108			
	3	24	41	52	71	76	88	95	100			
	9	22	34	47	53	61	69	77	82			
	5	18	29	42	49	57	61	64	70			
	4	13	22	35	47	55	59	66	73			
	3	14	28	38	46	54	58	60	63			
	4	17	28	42	55	63	75	82	90			
	4	18	34	43	58	74	79	81	87			
	4	14	33	53	62	74	81	88	95	98		
	5	17	28	36	55	62	72	80	87	95	101	
Age-frequency												
Distribution	10	1	1	0	0	9	19	9	9	2	1	
Corresponding year of settlement	1942	1941	1940	1939	1938	1937	1936	1935	1934	1933	1932	

Table IX. Diameter of annual rings measured longitudinally in mm. of 7 oysters from Shell Drake Island collected November 12, 1942.

		<u>Ring Number or Age in Years</u>										
		1	2	3	4	5	6	7	8	9	10	11
	7	16	34	49	55							
	5	11	42	55	70	73						
	6	19	36	44	53	64						
	4	27	41	56	64	84						
	5	28	50	67	82	91	96					
	3	16	34	56	69	78	86					
	6	25	44	56	68	75	82	95				

Table X. Longitudinal diameters in mm. of annual rings of 38 oysters from Quoi c'est ca collected August 17 and September 14, 1943.

		Ring Number or Age in Years													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
<u>August 17, 1943</u>		3	17												
	4	18													
	4	18													
	3	7													
	5	18													
	4	17													
	7	24													
	3	24													
	4	16													
	4	20	40	58	74										
	3	25	38	52	58										
	4	17	37	49	58										
	4	27	43	50	57										
	4	22	37	55	70										
	3	16	38	56	66										
	3	19	34	48	57										
	3	24	40	57	60										
	3	26	47	60	73	79									
	5	18	43	59	69	76									
	2	20	45	65	69	73									
	4	26	43	54	62	69	73								
	4	19	42	59	96	87	92								
	5	21	41	49	67	74	82								
	4	16	36	52	60	72	80								
	5	18	37	53	64	73	75	81							
	3	28	49	60	78	83	92	83	81						
	3	20	38	52	66	74	82	85	81						
	3	16	39	57	66	78	84	89							
	4	22	47	58	69	84	88	100	105	103	81				
<u>September 14, 1943</u>		4	24	33	50	61	64								
	5	28	37	51	64	68	74	81							
	3	19	38	47	66	67	71	81							
	--	15	30	50	67	74	79	87	91						
	--	16	41	51	62	64	67	73	78	79					
	--	19	38	48	60	75	77	84	90	94					
	4	16	32	47	53	65	73	80	84	88	90				
	3	12	28	42	55	61	67	73	78	80	86	90			
	5	19	30	51	65	73	72	80	84	102	101	100	102	105	
Frequency distribution		0	9	0	0	8	4	5	5	1	3	1	1	0	1
Frequency distribution of years		1943	1942	1941	1940	1939	1938	1937	1936	1935	1934	1933	1932	1931	1930

Table XI. Diameters of annual rings measured longitudinally in mm. of
51 Jenkins' bed Oysters collected in September and December, 1943.

	Ring Number or Age in Years								
	1	2	3	4	5	6	7	8	9
<u>September 10, 1943</u>									
2		12	34	43					
3		17	34	49	58				
--		13	25	48	61				
4		29	53	61	70				
--		15	31	49	57				
--		20	42	63	68				
--		25	45	68	77	81			
4		27	46	59	72	80			
--		27	47	62	70	75	76		
5		23	43	63	70	77	83		
3		29	51	75	85	96	101		
3		21	48	70	83	95	105		
--		11	28	46	50	57	64		
--		28	49	64	76	84	92	94	
6		34	58	71	77	85	92	96	
--		21	40	52	61	65	71	76	
3		21	48	63	71	77	80	87	
--		18	42	63	70	82	91	94	
--		24	48	63	71	80	87	93	
4		27	46	66	70	78	84	92	
<u>December</u>									
9									
4									
3		14							
7		28							
5		25							
6		30	42	48					
5		36	61	75	84				
--		34	52	70	84				
--		11	43	58	84	95			
5		23	39	59	69	79			
10		30	35	55	92	102			
6		24	46	64	84	92			
4		16	36	47	57	68			
3		12	26	54	71	88			
--		20	50	70	81	101			
4		22	47	65	70	78	88		
--		18	44	64	78	92	108		
--		28	51	70	78	88	94		
--		38	49	63	71	79	89		
6		28	50	67	82	96	104		
7		29	55	64	75	86	96		
6		20	45	67	80	87	97		
--		32	56	73	80	85	94	100	
5		21	47	62	72	87	98	107	
4		28	51	70	78	85	92	97	
--		18	35	53	65	77	85	96	
--		26	55	68	72	82	84	89	
5		27	40	62	74	86	94	103	
5		26	59	83	89	99	105	110	
--		--	40	62	78	94	102	106	
--		14	28	43	60	74	82	88	100

SECTION III.

Neguac Observations

During the summer of 1943 Mr. Daniel LeBlanc a lessee at Lower Neguac applied for a permit to gather small oysters from the beaches in Neguac bay. Supervisor Collette of Newcastle, N.B., requested an examination and report of the leased ground in order that he might better judge the wisdom of issuing the permit. The writer made an examination on August 20th and reported his findings to Mr. Collette in a letter dated August 23rd.

As regards quality, the Neguac stocks rated high. The meats were fat, the shells well-shaped and strong with a high specific gravity (2.48)

Young oysters of the 1942 and 1943 sets were abundant and several other age classes were well represented in the populations indicating a regularity of spatfall. There was no survival of the 1941 set.

Two water samples, at the surface and at the 7' level were taken August 20, 1943 over the lease. Both had a salinity of 27‰ which would indicate more favourable conditions for development of good oysters than are to be found in other parts of the Miramichi estuary. The bay is shallow and must have high summer water temperatures because it supports a heavy population of quahaugs which require higher spawning temperatures than oysters.

In mid-September Dr. Kerswill visited Neguac bay in connection with his study of bar clams and on September 15th gathered a random sample of oysters from half-tide level on a beach mid-way between Neguac and Lower Neguac. These he turned over to the writer. Annual ring studies have yielded data on age-frequency distribution and growth rate which are summarized in Table XII.

From these it appears that oysters growing on the flats reach marketable size in about 6½ years. Presumably less time would be required on submerged beds. This rate of growth is relatively high and compares favourably with that at Tracadie, N.B.

According to Inspector Breau there is only a small oyster fishery in the district but there are great numbers of oysters on tide flats which might be planted to advantage on leased areas in deep water.

Altogether Neguac bay seems to offer favourable prospects for an expansion in the public fishery and the development of oyster farming. Because of the high quality of the stock and the speed of their growth all possible assistance and encouragement should be given to those who are enterprising enough to take out leases in the bay.

Table XII. Diameter of annual rings measured longitudinally in mm. of 42 oysters collected September 15, 1943, near Neguac, N.B., on the beach at half-tide.

Ring Number or Age in Years	1	2	3	4	5
	3				
	5				
	5				
	5				
	14				
	6	27			
	14	37			
	8	31			
	8	24			
	8	26			
	11	26			
	12	38			
	10	31			
	8	24			
	10	31			
	3	19			
	9	23			
	9	38			
	8	35			
	--	36			
	--	38			
	7	31			
	10	34			
	6	33			
	13	31			
	11	35			
	8	27			
	9	23			
	6	21	38	53	
	7	23	42	50	
	16	33	41	49	
	15	33	51	64	
	7	28	45	61	
	6	31	46	52	63
	10	25	43	58	64
	9	27	40	50	57
	--	32	48	58	71
	--	38	55	66	78
	--	32	48	62	70
	--	31	44	60	75
	--	36	59	74	80
	8	35	53	67	83
Age-frequency Distribution	5	23	0	5	9
Corresponding year of settlement	1943	1942	1941	1940	1939

SECTION IV

The Prospects for Oyster Production at Tracadie, N. B.

History

In 1942 a commercial fishery of oysters opened up for the first time at Tracadie, N.B., and 336 barrels were taken from Tracadie Lagoon. In 1943 the catch up to the end of October was 300 barrels. As a result of the 1942 fishery a flurry of interest in oyster culture developed and several leases were granted in 1943 by the New Brunswick Department of Lands and Mines. Because of this interest some preliminary investigations were made.

Hydrographic conditions

The lagoon was found to have extensive areas of firm bottom covered by sufficient water to make oyster culture a safe venture. Salinities were favourable (25‰ at Windmill point on August 12th, 1942, and 26‰ at the Old wharf on June 15th, 1943). The shallowness of the lagoon and the smallness of its outlet probably ensure high water temperatures during the summer.

Native Oyster Population

On August 20th, 1943, the writer in company with Inspector James Losier, Tracadie, N.B., explored the principle fishing area. This is in the middle of the lagoon opposite the old gut through the bar that separates the lagoon from the Gulf of St. Lawrence. Nowhere were the oysters abundant enough to produce what might be termed beds. They were all large, old oysters, mostly attached to mussel shells. A typical sample of 48 contained only oysters 6, 7, 8 and 9 years old. Judged from annual rings the frequency distribution in the four year-classes was 9, 10, 22, and 7, respectively. Measurements of the greatest diameters of annual rings (Table XIII) show that the market size (length 3½") is reached in six years (fig. 2) - a comparatively short time. The shells were well shaped, firm and heavy (specific gravity 2.33).

The meats were well flavoured and very fat. The index of condition of a sample of the native stock taken October 13, 1943, from the public fishing area was 163 - an unusually high value. Thus it appears that Tracadie lagoon is capable of producing large quantities of oysters of the very highest quality in less time than is required in most districts.

At the same time natural reproduction is quite inadequate to the maintenance of a commercial fishery. The last spatfall of which there are any survivors seems to have been in 1938 (Table XIII). Judging from this the prospects are that the small fishery which has developed during the past two years will come to an end very soon because the four existing year-classes are being intensively exploited. The most promising means of maintaining production is through the importation of seed stock from outside areas.

Figure 2. Growth curves, developed from the study of annual rings on oyster shells.

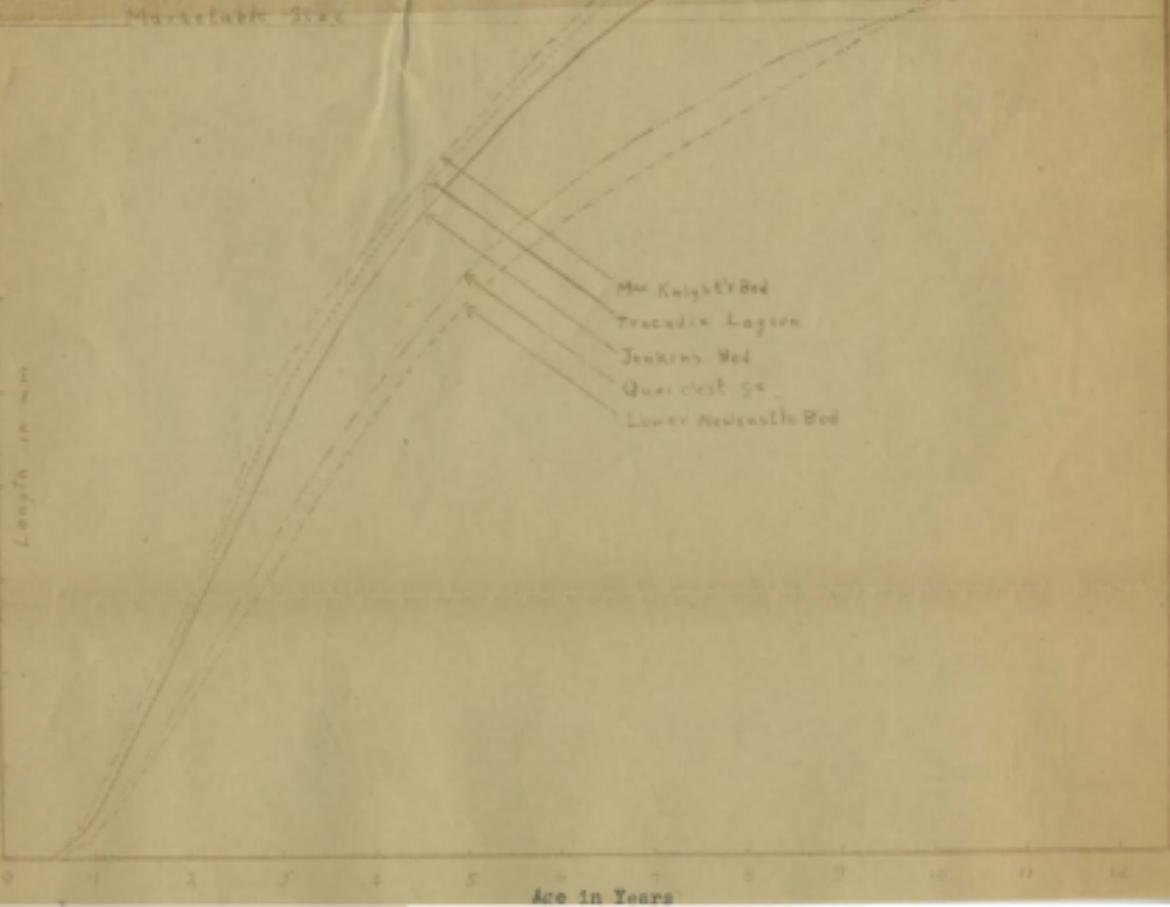


Table XIII. Showing the diameters of annual rings measured longitudinally in mm. of 25 native Tracadie Lagoon oysters collected October 13, 1943, and the ages and lengths in mm. of 21 native Tracadie Lagoon oysters collected August 20, 1943.

	Ring Number or Age in Years								
	1	2	3	4	5	6	7	8	9
<u>October 13</u>	--	19	45	58	65	83			
4		22	46	57	72	94			
5		28	47	68	83	92			
7		39	57	70	75	87			
5		22	49	63	71	80			
5		33	49	62	67	73			
2		20	39	58	68	76			
5		29	50	71	80	89			
4		30	50	70	81	90			
5		36	55	63	74	84	95		
--		27	50	63	75	85	91		
--		22	50	72	81	93	98		
4		30	54	62	71	77	82	86	
5		17	41	58	78	86	97	106	
2		23	56	73	81	88	97	101	
3		19	43	60	68	77	88	98	
8		30	57	62	72	80	86	100	
6		20	53	65	80	93	105	114	
--		32	57	76	85	94	103	112	
8		22	42	59	71	86	96	108	
6		24	45	64	74	80	88	96	
5		29	54	57	63	72	84	89	
--		21	45	64	82	96	100	106	
6		26	46	64	76	85	92	98	109
6		21	54	70	81	94	103	113	127
<u>August 20</u>	--	--	--	--	--	87			
--	--	--	9-	--	--	--	94		
--	--	--	--	--	--	--	76		
--	--	--	--	--	--	--	78		
--	--	--	--	--	--	--	69		
--	--	--	--	--	--	--	--	99	
--	--	--	--	--	--	--	--	113	
--	--	--	--	--	--	--	--	143	
--	--	--	--	--	--	--	--	101	
--	--	--	--	--	--	--	--	92	
--	--	--	--	--	--	--	--	117	
--	--	--	--	--	--	--	--	92	
--	--	--	--	--	--	--	--	109	
--	--	--	--	--	--	--	--	117	
--	--	--	--	--	--	--	--	121	
--	--	--	--	--	--	--	--	121	
--	--	--	--	--	--	--	--	--	102
--	--	--	--	--	--	--	--	--	118
--	--	--	--	--	--	--	--	--	142
--	--	--	--	--	--	--	--	--	118
--	--	--	--	--	--	--	--	--	138

Age-frequency distribution of combined samples Total 46 10 7 22 7

Corresponding year of Settlement 1938 1937 1936 1935

The Shippigan-Tracadie Transfer

On August 12, 1942, a bushel-and-a-half of small oysters taken from various beaches near Shippigan, N.B., were scattered at Windmill point, on the area in which Mr. W.J.Hammond of Six Roads, N.B., was at that time interested in leasing. On October 13, 1943, Mr. Hammond fished a sample of these and shipped them to the writer at Ellerslie, P.E.I. The index of condition of legal-sized oysters from this sample was 179 - the highest value ever recorded.

Almost all the oysters showed two very clear recent annuli on the shells. The first was interpreted as separating the Shippigan and Tracadie growth and the second as separating the 1942 and 1943 season's growth at Tracadie. Several measurements recorded in Table (XIV) were made to illustrate the effects of the transfer. A comparison of the observations on introduced and on native oysters (Tables XIII and XIV and figure 2) shows them to be in very close agreement, as regards growth rate.

A more complete study should be made of this interesting area with trial rearings of seed from different sources and all possible assistance given to those who are enterprising enough to attempt oyster culture there.

Table XIV. Showing the 1943 growth in length judged from shell annuli, of oysters from the Shippigan-Tracadie transfer of 1942.

Length at end of 1942. mm.	Length Oct. 13 1943. mm.	Increase in 1943. mm.	Length at end of 1942, mm.	Length Oct. 13 1943, mm.	Increase in 1943. mm.
49	66	17	75	89	14
46	62	16	67	78	11
55	71	16	76	83	7
46	60	14	86	92	6
54	69	15	81	94	13
48	63	15	81	87	6
54	70	16	77	98	21
57	69	12	67	77	10
58	73	15	76	88	12
57	68	11	83	95	12
85	93	8	87	97	10
96	105	9			
89	102	13			
78	81	5			
64	78	14			
94	100	6			
65	74	9			
68	87	19			
47	71	24			
63	83	20			

SECTION V.

Shediac Bay Observations

Studies of Native Population

No observations were made on native oyster stocks in Shediac bay from December, 1941, until October 22, 1943, when a random sample of 110 was fished from the Poirier bed at the sampling station formerly used (Medcof 1941). The oysters were taken back to Ellerslie and studied. Data on their age-frequency distribution and growth rate, based on annual ring studies, appear in Table XV. Comparisons of these results with those of 1940 and 1941 (Medcof 1940 and 1941) indicate that the composition of the population has changed considerably, probably because of intensive fishing in 1942 and 1943. For the same reason the oysters were scarce as compared with 1940 and 1941. It took three-quarters of an hour to gather the sample of 110 oysters with ordinary tongs.

Table XV shows that the 1936 year-class which dominated the 1940 sample has practically disappeared and the relatively less numerous 1938 year-class now constitutes over 70% of the total population. There has been virtually no production of oysters of the 1940, 1941, and 1942 year-classes but the 1943 year-class now forms about 15% of the population. In other words the conditions observed formerly have altered superficially but not essentially and there is no reason to alter any of the conclusions drawn from earlier studies.

When plotted out, the annual ring data do not give as smooth a curve as might be expected from such a large sample. This peculiarity can be partly attributed to the fact that the great bulk of the population was composed of a single year-class. As a result the differences in average growth produced by good years and bad years are not liable to be smoothed out in the plotting as is the case in dealing with samples showing normal age-frequency distribution. The curve shows that the mean length of oysters in millimetres is 4, 21, 47, 61, 70, 80, and 87 millimetres at the end of the 1st, 2nd -----6th and 7th years respectively, and that marketable size is reached in $7\frac{1}{2}$ years. By Canadian standards this rate of growth for "natural" oysters of this quality would be considered low, but not abnormally low, as claimed by some who have attempted to explain the low oyster productivity of the bay solely on the basis of slow growth.

Studies on Introduced Stocks.

It was concluded from earlier observations (Medcof 1940, 1941) that local spat production in Shediac bay was not sufficient to maintain a continuous production of oysters at a reasonable level and that the introduction of seed oysters from other areas would have to be resorted to. The first trials of this were made in 1941.

Spat collected by the Department of Fisheries at Buctouche, N.B., in 1940 were reared in wire-bottomed 4' x 6' floating trays held over the Poirier bed. The mean length of these spat increased from 4 to 31 mm. in the interval July 4th to September 19th. This rate exceeds that of "native" stock growing on the bottom just described and, judged by Prince Edward Island standards for tray rearing, would be considered satisfactory for that season of the year.

That same year on July 16th a small lot of Gillis cove, N.S., spat was planted on the "Horseback" bar which runs southwest from Indian island in Shediac bay and on the Poirier bed at the sampling station. Subsequently, these plants were sampled but there was some difficulty in recovery due partly to the sparceness of planting. The limited number of observations that were made indicated that growth in both areas was satisfactory but that there was a considerable mortality on the bar. From what is now known of seasonal growth it is plain that the results of both these rearing tests would have been more valuable if the plantings had been made earlier in the year.

The writer co-operated in a tray-rearing experiment designed by Dr. Kerswill and set up on May 26th, 1943, in the lagoon at the mouth of the Scoudouc river just south of the highway bridge at Shediac. Two 4' x 6' trays were moored in the middle of the lagoon and two at the west side and stocked with spat of the 1942 set. One tray in each place contained 2000 Gillis cove spat and the other 3000 Malagash spat. The oysters were not measured at the time the experiment was set up but on October 22nd, 1943, when samples were removed the 1942 and 1943 growth were clearly distinguishable by growth rings. Measurements were made of the longitudinal diameters of the 1942 annuli and of the total lengths of the spat in the samples. A summary of the results appears in the following table.

	Malagash Stocks			Orangedale stock		
	Tray No.	No. in sample		Tray No.	No. in sample	
Mean length of the 1942 growth ring	1 & 3	11.8 mm.	99	2 & 4	21.3 mm	100
Mean length of spat October 22, 1943	1	32.9 mm.	253	2	43.1 mm.	207 A
	3	----	---	4	39.9 mm.	253 B

Judging from the results obtained in the 1942 and 1943 growth experiments at Allerslie using 2' x 4' floating trays each stocked with 100 spat the growth at Shediac was about 20% low but would still be considered satisfactory.

Table XV. Diameters of annual rings measured longitudinally in mm. of 111 oysters from the Poirier bed, Shediac bay, N.B., October 22nd 1943.

Ring Number or Age in Years							
1	2	3	4	5	6	7	8
3							
5							
3							
4							
2							
2							
3							
3							
2							
2							
2							
2							
2							
2							
3							
3							
2							
8	28	50	64	77			
3	24	40	51	58			
6	27	42	58	68			
11	30	50	65	79			
--	33	59	70	77			
--	22	40	49	56			
--	31	56	62	68			
6	30	50	63	69			
--	21	39	53	66			
--	22	40	56	64	78		
--	26	43	62	79	95		
10	30	54	68	78	81		
--	34	53	64	79	82		
--	22	41	58	64	75		
--	36	58	66	76	89		
3	23	46	66	80	91		
8	34	55	64	70	82		
5	26	37	55	62	70		
--	23	49	61	73	81		
5	19	47	59	58	64		
--	37	54	59	71	80		
--	26	52	75	82	95		
5	32	47	55	60	69		
--	13	41	47	58	69		
7	37	60	70	74	77		
6	25	43	60	70	81		
--	20	45	57	72	76		
7	34	53	65	72	83		
--	34	47	58	70	77		

Continued on next page

Table XV. (Continued)

		Ring Number or Age in Years					
1	2	3	4	5	6	7	8
3	26	51	71	86	120		
--	24	38	55	59	67		
13	40	55	67	74	78		
5	35	60	73	94	107		
--	22	38	49	63	70		
2	25	38	57	75	85		
5	38	55	76	88	99		
5	27	45	62	71	76		
5	24	43	65	77	90		
--	28	47	59	70	77		
--	26	50	62	68	72		
--	27	40	46	51	56		
4	20	35	48	54	64		
5	23	37	47	57	70		
--	34	49	57	79	86		
--	32	41	56	67	69		
7	18	49	59	66	74		
5	26	61	79	87	99		
7	38	53	66	70	78		
7	32	49	58	68	74		
--	28	49	67	78	90		
6	21	37	47	59	63		
--	18	41	56	72	85		
--	27	50	78	96	106		
--	33	56	62	69	78		
12	36	56	66	76	81		
10	20	45	57	68	80		
--	35	51	71	75	82		
4	32	48	56	63	68		
--	20	52	68	78	84		
5	33	50	59	67	77		
--	27	54	62	68	77		
--	25	44	53	64	72		
--	27	48	60	69	82		
4	24	38	50	57	65		
6	14	46	76	85	99		
--	37	52	66	78	85		
4	14	31	51	65	75		
3	27	47	53	62	69		
4	24	40	57	68	76		
5	33	51	66	78	88		
5	25	55	64	71	83		
4	19	45	61	74	81		
5	32	53	68	75	90		
5	30	43	57	65	74		
4	38	61	69	78	79		
2	16	42	51	56	64		
--	34	52	69	79	90		

Table XV (Continued)

	Ring Number or Age in Years							
	1	2	3	4	5	6	7	8
--	31	49	64	71	79			
--	35	56	67	75	82			
3	20	28	47	60	65			
--	21	42	54	70	78			
--	22	45	55	77	83			
5	28	49	65	83	97			
--	21	49	63	73	85			
6	43	63	72	80	86			
3	17	33	54	78	87			
7	30	42	57	71	79			
--	44	61	70	85	95			
--	16	41	61	74	78			
--	39	68	74	81	85		88	
--	--	45	68	85	98		109	
4	32	48	67	74	82		83	84
6	23	51	71	82	91		100	108
Age-frequency distribution	18	0	0	0	9	80	2	2
Corresponding year of settlement	1943	1942	1941	1940	1939	1938	1936	1935

SECTION VI

Completion of 1942 Growth Experiment

On November 13 and 14, 1942, several lots of oysters involved in the growth experiment of that year (Medcof 1942) were placed in the channel of the river for wintering. Lots 2A, 3A and 4A were taken from the beach and lowered on an open platform with nothing to obstruct water circulation. Lot 10 was left in exactly the same position it occupied throughout the open water season. The wire screen of the bottom of the tray containing lots 12, 13, and 15 was boarded over so that there was little chance for circulation and placed upside-down on the bottom beside the tray containing lot 10.

On May 4, 1943, all these were recovered and remeasured. The results have been entered in table VIII of the 1942 report. They involve 437 measurements which show indisputably that no growth took place in the period November 13, 1942 to May 4, 1943, under the three conditions of water circulation over the oysters.

SECTION VII

The 1943 Growth Experiment

Experience gained from the 1942 growth tests and the results of the analysis of the Needler-Clark data (Wedcof 1942) were of assistance in designing the 1943 experiments described below.

Part I. Tray Growth in Different Parts of Bideford River

Numbered floating trays measuring 2' x 4' with $\frac{1}{4}$ " mesh wire screen bottoms were moored at various positions in Bideford river. Each was stocked with 100 oysters from a large group of 1942 spst selected for uniformity of size and shape and then mixed randomly.

The trays were disposed as follows:

- #33 Three-quarters of a mile above the biological station in the channel of Smelt creek where there is a foot of water at low tide.
- #32 In the little cove on the south side of Smelt creek immediately west of the station warehouse where the water is 4' deep at low tide.
- # 4 Opposite Forbes' house and the station land where the water is 3' deep at low tide.
- #34 At the end of the bar at Shipyard point in 8' of water at low tide.
- #37 Over the Totten bed in 5' of water at low tide.
- #35 In the channel in Claude Williams' creek 300' west of the outlet in 2' of water at low tide.
- #36 Over the Cooper bed where the water is 8' deep at low tide.

Results and Conclusions from Part I. Measurements made on the tray stocks at various times are summarized in Table XVI. The data show that growth was best approximately the same at the warehouse and at Forbes' area. The length and weight increases for the season were 200 to 210% and 3500 to 3600% respectively. The Shipyard point oysters were better shaped than the lots further up the river and the figures show that although their length increase was somewhat less than that maximum their gain in weight was just as good. Greater disturbance resulting from more exposure to wind and sea probably accounts for this peculiarity.

Compared with the areas just mentioned, growth was progressively poorer far up Smelt creek, in Claude Williams' creek and over the Totten bed. This finding is in accord with the results of the Needler-Clark experiment of 1935.

The Cooper bed tray was lost during a storm shortly after the July 7 measurements were made. Up to that date growth was even poorer than on the Totten bed.

Table XVIII indicates that the shell specific gravity was highest (i.e. the shells were hardest) in areas where shell shape and growth were best.

Taken together the results show that there is an intermediate region in the river where growing conditions are most favourable. This is a useful piece of information from the oyster culturist's point of view.

Part II. Growth at Different Distances from Shore

A. In Floating Trays. At the Forbes area trays like those used in Part I of this study were similarly stocked and moored by hatlars from both ends so their distance from shore could not change. These were placed at different distances below high water mark. Some were exposed during part of the tidal cycle. The length of their exposure has been calculated from July records of the tide gauge set up at the landing stage of the biological station and from soundings made at the trays on September 1. The experimental set-up is described in the following table.

Tray No.	Position	Depth Relationships
1	High on the beach	Exposed 44% of the time.
2	Below 1	Exposed 35% of the time.
3	Below 2	Exposed only at low "spring" tides - less than 1% of the total time.
4	Just below low water mark of low "spring" tides	Never exposed. Water 2 to 3 feet deep at normal low tide.
6	Over the edge of the channel	Water 8 to 9 feet deep at normal low tide.

The results of measurements on these oysters appear in Table XVI and show that growth improves with distance from shore out to the mooring place of tray 4. In the deeper water beyond this it appears to fall off slightly.

The practical significance of the fact that growing conditions for tray spat are best at moderate depths is obvious.

E. On the Bottom.

(1) Using spat

Four plots measuring 4' x 4' were staked off at different distances from high water mark. Each was stocked with 100 spat with no protection from the seas such as was provided in the 1942 tests.

Besides these there were three plots set up off shore from the Forbes area in water that was 6 to 7 feet deep at normal low tide. Two of these were 10' x 10' plots stocked with 2000 spat and the third a shallow 2' x 4' mud-filled tray (like those used in 1942) resting on the bottom near tray #6 of Section A of Part II of this experiment and stocked with 100 spat.

The experimental set-up is described in the following table.

Plot or Tray Number	Position and Bottom characteristics	Depth Relationships
19A	The farthest out of the four plots: soft mud	Never exposed: 3-3½' of water at low tide.
19B	Closer to shore than 19A: sticky but firm sand-mud	Never exposed: 2-2½' of water at low tide.
19C	Closer to shore: firm sand.	Covered by 1' of water at normal low tide but exposed at low "spring" tides.
19D	Just above 19C: firm sand.	Just above normal low water mark: exposed 35% of the time.
16	10' x 10' plot: on hard shell bottom: further out than 19A but opposite it on the Forbes area.	In water 6-7' deep at low tide.
18	10' x 10' plot: soft mud bottom: position same as 16	"
17	Shallow tray: position same as 16 and 18 but further east and off the oyster bed close to tray #6.	"

Table XVI. Summary of results of 1948 growth experiment. Lengths are given in millimetres and weights in grams.

Tray or Lot No.	Date and Mean Size			Season's Increase												
	Length	Weight	No. Measured	mm.	g.	mm.	g.									
1	16.1	0.358	100	July 9			16.0	0.50	10	11.4	0.714	7				
				(1) 18.4	0.360	99										
2	15.7	0.315	100	July 9			18.5	1.89	94	14.0	2.81		6.5	52	1.9	690
				18.3	0.452	99										
3A	14.3	0.232	98	July 9			18.5	0.800	100	11.8	1.89	71	7.5	52	1.27	470
				18.4	0.489	98										
3	15.0	0.361	99	July 9			20.8	5.87	71	41.8	11.8	90	26.8	180	13.8	3100
				21.8	1.04	98										
4	15.0	0.274	101	July 9			24.4	8.58	38	42.8	10.0	32	28.8	210	9.7	2000
				21.8	0.830	97										
5.1	13.0	0.78	5	July 10			Lost									
				20.8	1.87	3										
5.2	17.0	0.5 #	100	July 16			17.0	10.2	100	Lost						
				----	2.40	100										
5.3	18.4	0.6 #	100	July 16			42.8	5.27	73	Lost						
				----	2.27	104										
5.4	17.0	0.4 #	98	July 16			26.0	2.52	121	Lost						
				20.8	2.08	100										
5.5	16.0	0.4 #	98	July 16			28.7	4.97	99							
				20.8	1.70	107										

Table XVI (Continued)

Tray or Lot No.	Date and Mean Size			Date and Mean Size			Date and Mean Size			Date and Mean Size			Season's Increase			
	Length	Weight	No. Measured	Length	Weight	No. Measured	Length	Weight	No. Measured	Length	Weight	No. Measured	mm.	%	Weight gms.	%
6	14.4	May 22 0.200	98	22.4 22.5	July 9 0.523 1.01	98	40.1	Sept. 2 7.12	77	42.0	Nov. 5 11.6	78	28.6	200	11.2	2500
7	17.2	May 24 0.486	100	32.7	July 8 0.80	99	44.1	Sept. 2 6.63	89	46.0	Nov. 8 12.1	87	29.6	170	12.6	1700
8	17.5	May 24 0.482	100	36.2	July 12 1.28	100	43.8	Sept. 7 8.12	98	44.1	Nov. 8 10.7	96	28.6	150	10.2	2100
9	17.8	May 24 0.544	100	37.2	July 12 1.44	98	42.2	Sept. 7 8.12	95	43.1	Nov. 8 12.0	88	25.2	140	9.5	1700
10	17.0	May 25 0.542	101	34.4 35.2	July 12 1.14 1.14	87 96	39.0	Sept. 7 6.15	98	39.8	Nov. 8 8.20	96	28.8	120	7.82	1400
12	16.8	May 22 0.420	101	31.4 30.2	July 12 0.886 0.922	28 20	22.6	Sept. 7 4.63	84	Lost						
13	15.2	May 22 0.277	102	31.7	July 12 0.688	71	28.2	Sept. 7 67.2	82	201.8	Nov. 9 9.87	86	14.8	100	2.22	1000
14	17.0	May 25 0.426	99	35.2	July 12 1.26	94	41.8	Sept. 2 6.22	94	47.0	Nov. 5 14.5	94	29.0	120	14.0	1000
16	17.8	May 25 -----5	100	Recovered none												
17	17.1	May 25 0.470	100	30.2 31.2	July 12 0.826 0.881	32 100	29.0	Sept. 5 2.00	12	31.0	Nov. 9 2.77	12	12.0	80	2.22	800

Table XVI (Continued)

Tray or Lot No.	Date and Mean Size			Season's Increase												
	Length	Weight	No. Measured	ML.	S	ML.	S									
18	17.3		100	Recovered none			Sept. 8									
19A	15.8		96				26.3	2.00	3	Lost						
17B	12.4		109	21.4		98				26.7		27	12.3	170	6.01	1100
20	16.1		108	27.6		41				28.5		42	21.4	120	7.28	1200
21	16.8		99				27.2		84	40.2		98	21.4	110	6.84	1200
22	14.8		97	22.0		94	42.0		25	44.5		96	22.7	200	12.5	4000
23	48.8		61	57.2		52	60.4		24	59.7		56	10.8	42		
24	47.8		55	54.6		52	60.9		42	61.2		53	12.6	27		
25	65.2		26	60.5		28	60.2		22	60.0		26	4.5	8.8	18.5	22
26	61.8		49	61.9		48	58.5		47	Lost			7.9	8.5	7.5	12
27	64.9		26	62.0		61	60.2		60	59.5		58	4.6	5.4	15.0	12
28	65.5		100	62.5		64	57.3		42	56.0		41	10.5	12	23.1	22

Table XVI (Continued)

Tray or Lot No.	Date and Mean Size			Season's Increase												
	Length	Weight	No. Measured	Length mm.	gms.	Weight gms.	%									
29	25.5	25.7	100	31.1	27.4	48	33.5	100.0	45	35.0	110.0	43	9.5	11	25.0	30
30	25.0	25.5	48	30.0	26.4	50	32.0	28.0	45	33.5	100.0	48	8.7	12	28.0	34
31	17.7	0.503	99	22.7	1.09	79	23.5	8.17	77	25.0	12.4	73	29.3	170	11.9	1000
32	17.4	0.45 *	98	24.7	1.32	99	25.0	9.33	100	26.4	17.0	98	34.0	300	14.7	1000
33	17.0	0.40 *	100	23.0	0.909	99	23.1	7.19	97	24.0	15.0	92	27.0	190	14.0	1000
34	17.5	0.46 *	100	23.0	1.40	92	23.0	9.00	93	25.0	18.0	97	29.0	190	14.0	1000
35	18.4	0.54	97	23.0	1.81	98	23.0	8.73	95	23.0	17.0	90	23.0	180	17.0	1000
36	18.0	-----	99	21.0	1.64	97	lost									
37	18.0	0.50	101	23.0	1.16	93	23.0	7.90	77	lost			**	180		1000
38	18.0	0.54	100	23.0	----	98	21.0	7.00	97	20.7	12.0	90	28.1	180	12.0	1100
39	18.1	0.76	99	21.0	----	98	23.0	8.00	97	23.0	110.7	93	30.0	180	14.0	1000

(1) In the July samplings it was found that several of the original spots had been lost during heavy weather. Some had sifted through the screen and others had worked through cracks before the food in the cages had swollen enough to plug them. For this reason most of approximately the same size selected from commercial trays were added to a number of the depleted lots. In every case where this was done a second line was started in the table. The first set of values entered in the second line show the average length and weight for the complete sample - old and new combined. The number of spot added in each case is equal to the difference between the numbers in the column "Number Measured".

* These values are approximations obtained by interpolation from weights of other lots listed in this table and equal the values that might be anticipated for rest of corresponding samplings.

** These values were obtained by extrapolation of the growth curve for lot 37 parallel to the curves for corresponding lots that were not lost before the final measurements in November.

Storms in early June swept away most of the stock in plots 19C and 19D and during the course of the summer either lobsters or starfish destroyed many of the spat in 19A. The spat in 19B survived in greater numbers. In spite of repeated efforts with oyster tongs and a hand dredge it was impossible to recover sufficient numbers of living spat from plots 16 and 18 to get reliable estimates of growth. Many empty shells came up and it is suspected that starfish killed most of the experimental animals. The spat in the mud tray fared much better. The results are summarized in Table XVI.

The scanty data obtained from the mud tray and from plots 19A and 19B indicate that growth improves towards low water mark and was in all cases less than on floating trays. This supports last year's conclusions which were better supported by observations.

Nothing can be said about the growth of spat on mud and shell bottom in deep water but some ideas of what may be expected may be derived from the study of the adults grown on these two types of bottom. See next section.

(11) Using Adults

Five lots of adult oysters, each with a groove ground into the lower valve for certain identification, were set out to see how growth varied in different places on the bottom and for comparison a sixth lot was held in a 2' x 4' compartment of a floating tray. The set-up is described by the table below.

Lot Number	Description of lot: Position and bottom characteristics	Depth Relationships
25	98 oysters: on shell bottom off Forbes area : 10' x 10' plot	6-6½' of water at low tide.
27	96 oysters on mud bottom close to lot #25: 10' x 10' plot	"
26	49 oysters on shallow mud-filled tray 2' x 4': close to trays 17 and 6 and resting on the bottom.	"
28	50 oysters on firm sand-mud bottom close to shore at Forbes area	Covered by 1-2' of water at normal low tide and by 6" at low "spring" tide.
29	50 oysters closer to shore than #28 but near #28: firm sand-mud	Just below normal LWM but exposed at low "spring" tides
30	48 oysters in a floating tray moored near plots 25 and 27, and tray 4 of Part I of this experiment.	Water here 6-7' deep at normal low tide.

Table XVI shows that the season's growth on the bottom just below low tide level (lot 29) was almost twice that in deep water (lots 25 and 27).

Growth on the mud-filled tray was better than directly on the bottom but not nearly so good as on the bottom near shore.

Growth on shell bottom was better than on mud bottom. The difference is more pronounced if the growths in weight are compared rather than length-growth. The reason for this is that the oysters on shell bottom grew symmetrically whereas those on mud bottom tended to be long and thin-lipped. Table XVIII shows that there was little difference in the fatness of the two lots. They were fatter than natives in the same depth of water but much thinner than oysters grown on the bottom nearer shore or in the floating tray.

The growth of lot 30 on the floating tray was greatest of all but it had only a slight advantage over lot 29, at low water mark on the beach. As regards shell symmetry and fatness of meats there was little to choose between the two (table XVIII).

This may be partly because the oysters in lots 28 and 29 were always placed carefully on the beach. The hinge was pressed slightly into the bottom which gave the "nose" a slight tilt above the bottom. Care was taken to give the oysters in the mud tray (lot 28) the same tilt. No such treatment was possible in the case of lots 25 and 27.

The results show that conditions favouring active growth also favour fattening and in a general way adults and spat react in the same way to differences in environment. Both these findings have practical significance.

The fact that growth and fattening are better in shallow than in deep water may yet prove useful in our areas. The Europeans find it worth their while to plant all their oysters by hand in shallow water just as the Chinese plant each rice plant separately.

Part III. Growth in Fixed and Floating Trays

A. On the Tide Flat. A 2' x 4' wire-bottomed tray (2A) was fixed to supporting posts on the tide flat at the same distance from shore as No. 22 and No. 3. The posts were of such a length that the tray suffered the same exposure as did tray No. 2. The oysters on it were tossed about by wave action and sometimes subject to severe drying in warm weather at low tide even though they were protected by the wooden tray cover. Table XVI shows that they did not grow as well as those in tray No. 2 which probably suffered less severe drying.

B. In Deep Water. Three trays were set up close together on the Forbes area for the study of growth in fixed and free-floating trays in deeper water. They were as follows:

Tray Number	Description	Depth Relationships
6	Moored at one end.	Floating at the surface.
8	Suspended by ropes from fixed supports	3-3½' below the surface at normal low tide.
7	Weighted and suspended by ropes below a free-floating log raft.	3' below the surface at all times.

Table XVI shows that lot 7 grew better than lot 8 suggesting that the vibration of the tray produced by wave action assisted growth.

It also appears that lot 6 grew better than lot 7. This difference is harder to interpret because the two trays differed both in depth and in the extent of vibration. Tray 6 always moved about more freely than 7.

Part IV. Growth at Different Depths in Fixed Trays

Trays 8, 9, and 10 were fixed at levels 3½', 2' and 6" above the bottom, respectively, at the Forbes area where the water is 7' deep at normal low tide, close to tray 6. Table XVI shows that growth improved progressively towards the surface being best in tray 6. This result is not in complete agreement with that of 1942 which indicated that growth was best at mid-depths.

It is quite clear that there is no great advantage to be gained by submerging trays below the surface.

Part V. Effect of Crowding Tray Spat

A 4' x 12' tray (#5) was sub-divided into six 2' x 4' compartments by wooden partitions and stocked as follows:

Compartment Number	Number of Spat
5.1	5
5.2	100
5.3	500
5.4	2,000
5.5	4,000
5.6 (contained 48 adult oysters labelled lot 30)	

Unfortunately lot 5.1 was lost after July 16 and a heavy storm shortly after September 6 carried away the cover of the trays and confused the different lots. However, measurements made on and up to that date show that crowding greatly reduced growth. Not only was there less growth in the crowded sections but the shape of the spat was definitely inferior to that in less crowded. For this reason weights show the crowding effect better than length measurements. The greatest reduction in growth appeared early in the series when the crowding was increased from 100 to 500. Growth was practically halved by this change in density.

For a stricter test of crowding effects this part of the experiment should be repeated.

Part VI. The Effect of Eel Grass on Growth

A. In Trays. Tray 22 was moored in the same depth of water and only a few yards from tray 3 of Part II but directly over a small bed of eel grass. In this position at low tide the screen bottom of the tray often touched the eel grass but seldom if ever rested on the bottom. The grass blades were about one foot long at the end of the season.

Table XVI shows that growth in tray 22 was better than in tray 3 but not quite so good as in tray 4 in slightly deeper water.

B. On the Bottom. Three plots all at the same depth and stocked with 100 spat each were laid out on the bottom at the Forbes area just below low water mark to study the effect of eel grass which at this point was long and heavy. At the first of the season the grass was short but by the end thinning was necessary several times on plot 20 to prevent the growth from becoming as dense as on plot 21. The plots were as follows:

- 19B on clear firm sand-mud.
- 20 in a sparse bed of eel grass and near its edge.
- 21 in the centre of a small dense growth of eel grass.

Table XVI shows that growth in these three plots was progressively less in the order listed. The shape of the spat grown in the eel grass was less symmetrical than on the clear bottom.

Clearly, eel grass inhibits growth of oysters on the bottom but not to the same extent it does the growth of quahaugs (Kerswill 1941). This difference in growth is doubtless caused by differences in water circulation. Why the quahaugs and oysters should respond to such different degrees is not immediately clear.

Even though the growth of oysters in trays in shallow water is favoured by choosing mooring sites over beds of eel grass the plant promises to become more and more of a hindrance to oyster culturists because it reduces the growth rate of oysters on the bottom and leads to poorly shaped shells. A more elaborate study of the plant should be undertaken.

Part VII. Effect of Direct Sunlight on Growth

In 1939 certain observations were made on shells proportions of tray oysters grown in light and darkness (Medcof 1939) and similarities were observed between oysters grown on the bottom in shallow water and those in the lighted compartments of trays. In 1943 a further test was made to see how oysters growing on the beach in the intertidal zone would react if protected from direct sunlight.

Two of the concrete blocks 2' x 2' x 2" with oysters set in them and exposed on the beach in 1942 (Medcof 1942) were used in this test. They were placed close together just below tray 2 where they were exposed 30% of the time. What had been lot 4A of 1942 became lot 24 in the 1943 tests and what had been lot 3A of 1942 became lot 23 of the 1943 tests. It was protected from sunlight by a wooden cover 4' x 4' supported 10" above the concrete by wooden posts. Both these lots were reared below low water mark in 1942 and may be considered comparable even though lot 4A was in slightly deeper water and a little further from shore than lot 3A. If the comparability of the lots were debated it can be argued that the effects of the 1942 treatment would tend, if anything, to reduce the apparent differential effect of the 1943 treatment rather than add to it because the light in shallower water where lot 3A was held was probably stronger than in the deeper water at 4A.

Measurements of the two lots in 1943 are summarized in Table XVI and subsidiary observations in Table XVII. Both are discussed below. Protection from light had the following effects:

1. Growth in length was increased by over 50%.
2. The shells produced had a low specific gravity.
3. The shells had a smaller cavity relative to the total volume of the oyster and to the total volume of the shells themselves.
4. "Fluting" of the shell margin, a characteristic of oysters grown in the intertidal zone, was greatly reduced.
5. The meats did not fill the shell cavity so completely so there was more shell liquor present.
6. There was little or no effect on fatness judged from the two recorded values of the index of condition. This result is different from that observed in the 1939 with tray oysters and may not be representative of the two lots in this case.
7. The set of spat on the shells was greatly increased especially on the upper valves.
8. Epiphytic growth was greatly reduced.

It might be possible to take practical advantage of some of the effects of protection from light. For example: (1) in areas such as Shippigan where spat collection is difficult, sets might be obtained by exposing shells in shadows cast by wharves or by boats and barges at their moorings; (2) there is good reason to believe that if spat could be maintained in the bottom at low water mark and protected from direct sunlight they would grow just as well as or better than they do on floating trays (compare the growth of lots 23 and 24 and the pairs 28 and 30 and 19B and 4).

The second possibility should be more completely explored.

Part VIII. Growth in a Slat Bottomed Tray

The industry needs a cheaper tray for rearing spat than that with the wire cloth bottom now in use. A trial rearing of 100 spat in a 2' x 4' tray was made with a wooden bottom composed of wooden slats $\frac{3}{4}$ " square separated by cracks $\frac{1}{8}$ " wide. This tray floated very high because of the great amount of wood in its construction. It was moored beside tray 6.

Table XVI shows that in spite of the small openings for water circulation in the tray there was considerable growth. It compared favourably with tray 6.

In spite of careful painting with the tar-copper oleate mixture the slats were badly eaten by Teredo and some had to be replaced in the course of the season. This difficulty would rule out the use of slatted trays at least until a better preservative than tar-copper oleate is found. The result is not completely discouraging because it shows that good growth can be obtained in trays at this density of crowding with small openings in the bottom. The search for a cheaper tray should be continued.

Part IX. Growth of Spat on Platforms

From time to time attempts have been made in Australia, in Japan and in the United States to grow oysters on platforms raised off the bottom, but possible advantages of this system have never been carefully explored in our areas. In 1943 two platforms measuring 4' x 4' each stocked with 100 spat were suspended from a fixed support three feet off the bottom at a point off the Forbes area where the water is 7' deep at low tide. One (lot 12) was made of flat boards and the other (lot 13) was of wire cloth of $\frac{1}{4}$ " mesh supported by a wooden frame.

Table XVI shows that growth on the wire was about one and one-half times that on the wooden platform but still much less than in tray 6 close by.

Throughout the season but especially in late summer a heavy epiphytic growth covered the oysters and the platforms and must have seriously reduced water circulation over them. No such growth was found in tray 8 which was fixed at the same depth as the platforms but protected from light by its wooden cover.

From this test it is concluded that uncovered platforms are not adaptable to Bidford river conditions.

Table XVII. Summary of observations made November 2nd, 1948, on oysters in the intertidal zone exposed to and protected from light.

Lot No.	Treatment	Season's inc. in length mm.	Specific gravity of shells	Shell capacity Shell volume %	Shell capacity [#] Total volume	"Fluting" of shell margin	Index of Condition	Shell liquor Shell capacity cc. ³	Spitfall on shells of ten oysters	Epibiotic growths
23	Protected by wooden cover 52 oysters	20.8	2.84	64	45	3 clear cases but none extreme: 3 cases with suggestions of "fluting"	110	18	Heavy catch: up to 50 spat on upper valves fewer (up to 40) on lower valves	Few algae growths: several mussel attached.
24	Exposed to direct sunlight 55 oysters	13.6	2.88	89	48	18 clear cases: 8 of these extreme with points of "flutes" projecting 2-3 mm. beyond general margins of the shells	105	17	Relatively light set av. of 1 and at most 3 on upper valves: av. of about 20 on lower valves	Heavy growth of sea lettuce and other algae; no mussels.

[#] Shell capacity is the volume of the space between the valves in cc.

Part X. Growth in a cage of the Needler-Clark Type

One of the original wire cages used in the 1935 Needler-Clark growth experiment (Medcof 1942) was discovered at the biological station in the spring of 1943. It was stocked with 100 spat (lot 14) and suspended from a fixed support at the same depth as the wooden platforms. Table XVI shows that growth in the cage was only slightly less than in floating tray 6 which was moored above it, and much better than in the fixed submerged trays at the same depth.

Because it shows the approximate equality of growth in the cage and floating tray this observation is of particular interest. It thereby provides a basis of comparison for the 1935 growth experiment with those carried out before and since in floating trays.

Part XI. Comparison of Growing Conditions in 1935, 1942, and 1943.

Because growth is of such importance to the industry it is worth while to compare its extent from year to year in the hope of getting a better understanding of the factors regulating it. Strictly speaking there are so far only three years' data reported that permit such a comparison, for Bideford river. These are for 1935, 1942 (both reported last year Medcof 1942) and 1943.

In 1942 two mud-filled trays, #16 and #17 stocked with adult oysters were held in deep water on the Forbes area. These showed a total seasonal growth of 13% and 12% respectively. They were in all respects comparable to lot 26 of 1943 which showed an increase of something less than 8%.

In 1942 a series of adult oysters (lot 15) was held in a floating tray over the Forbes area in almost exactly the same spot as lot 30 in 1943. The seasonal growths for these two lots were respectively 20% and 12%.

These two comparisons show very clearly that 1942 was a better growing year than 1943.

In 1935 the "small stock" used by Needler and Clark was of a size comparable to that used in spat rearing tests in 1943. Furthermore a cage (#14136) of small stock was held just below low tide level from a fixed support at the boat mooring which that year was close to the Forbes area where lot 14 was held in a similar cage in 1943 at a similar depth. The growth increases for these two lots were 158% and 180% respectively.

It was shown in reporting Part X of the 1943 experiment that growth in such cages (lot 14) is not very different from that in floating trays in the same position. It is therefore reasonable to compare the growth of small stock in cage #14132 in Claude Williams' creek in 1935 with that in tray 35 moored in the same part of the same inlet in 1943. The records show that the increases for these two were 155% and 180% respectively.

The two comparisons suggest that 1943 was a better year for growth than 1935. This statement cannot be made without some reservation, however, because unlike the tests in 1942 and 1943 the 1935 experiment was probably not set up until a small amount of growth had already taken place.

It is quite clear from the foregoing discussion that there are important year-to-year differences in growing conditions for oysters. No attempt is made here to explain these but it is worth while to have supplied an experimental demonstration of this fact which has been vaguely felt by the industry. It would seem worth while for the biological station to include as part of its regular programme, a measurement of the growth of oysters of a given size class each year. By this device a body of data would be accumulated that would not only be useful to the industry but might also lead eventually to a recognition of factors controlling growth.

Part XII. Comparison of conditions in Bentinck Cove and Bideford River

Two trays of the sort used in Part I were stocked with Bideford river spat and moored in Bentinck cove at points which in regard to position in the inlet seemed comparable to the Forbes and warehouse areas in Bideford river where growth was best.

Number 38 (cf. Bideford tray #32) was in the mouth of Carr's creek southeast of the government wharf, close to a group of commercial trays. The water there was approximately 3' deep at low tide.

Number 39 was (cf. Bideford tray #4) halfway between the mouth and the forks of the creek that opens to the northwest of the government wharf. Here the water was about 4' deep at low tide.

Results. Table XVI shows that growth was slightly better in tray #39 than in #38 but that in neither case was it as good as in the corresponding part of Bideford river. The suggestion is that Bentinck cove provides poorer conditions for growth than Bideford river.

Part XIII. Subsidiary Observations on Oysters in the Growth Experiment

In early November determinations of the index of condition and shell specific gravity were made on several lots of oysters involved in the growth experiment. Some of these data have already been referred to. They are summarized in Table XVIII.

Table XVIII. Subsidiary Observations

Lot Number	Index of Condition	Lot Number	Specific Gravity of Shells
23	110	6	2.31
24	105	9	2.16
25	92	32	2.23
27	95	33	2.28
28	117	34	2.29
29	125	35	2.19
30	125	39	2.24
Natives from shell bottom on Forbes area: deep water		86	

Summary Discussion of Growth Experiment

The several conclusions from the tests involved in this experiment appear above but it is worth emphasizing the more important results by drawing them together here at the end.

1. The best places to moor trays are in the intermediate parts of the inlets and at intermediate depths away from the channels.
2. On the bottom, growth is best at and near low water mark but survival in this zone is poor because of wave action. If spat could be maintained in this zone and given protection from sunlight they should grow just as well or better than they do in floating trays.
3. The presence of eel grass may promote growth of tray spat in shallow water areas but is a definite handicap to growth of oysters on the bottom.
4. The common tray that floats at the surface is expensive because it has a wire-cloth bottom but it is still the most satisfactory device known for spat rearing in our areas. There is no advantage to be gained by suspending the tray below the surface from either fixed or free-floating supports. Platforms of the regular sort are quite unsatisfactory.
5. In this part of the river the areas that permit the best growth also produced the fattest and best shaped oysters.
6. Differences in growth from year to year and from inlet to inlet have been demonstrated but have not been explained.

The implications of 2, 4, and 7 are such as to warrant further exploration.

SECTION VIII

Rate of Air Drying of Oysters

In gathering data for the growth experiment it was not always possible to make weighings and do volume measurements immediately after the samples were brought into the laboratory. It was assumed that the unavoidable and sometimes extended exposure to air would result in drying and low values for the weights of certain samples and that these losses should be allowed for in analysing the results. An experiment was carried out to find out what corrections should be applied to weighings.

No attempt was made to study the effect that drying had on the volume determinations.

Three samples of oysters and one sample of empty shells were washed with a brush in fresh water in the same way the experimental lots were treated and then shaken to remove excess water so that they were left wet but not dripping. After this they were weighed, laid out singly on the laboratory table and reweighed at intervals for several days. In the course of handling small fragments of shells were sometimes broken off but these were carefully preserved and reweighed with the oysters to which they belonged at each determination.

The samples were as follows: (1) Empty shells of ten adult Cooper bed oysters fished and opened October 7. The shells were left in tap water over night having been washed before opening. (2) Ten adult oysters with an average length of 104 mm. fished October 7 from the Wharf bed and left in the warehouse until the morning of October 8 when they were washed. (3) Twelve small oysters (two-year-olds) with an average length of 83 mm. taken from a tray at 9:30 a.m., October 8. (4) Twenty small spat of the 1942 set with an average length of 37 mm. taken from a tray at 9:30 a.m. October 8.

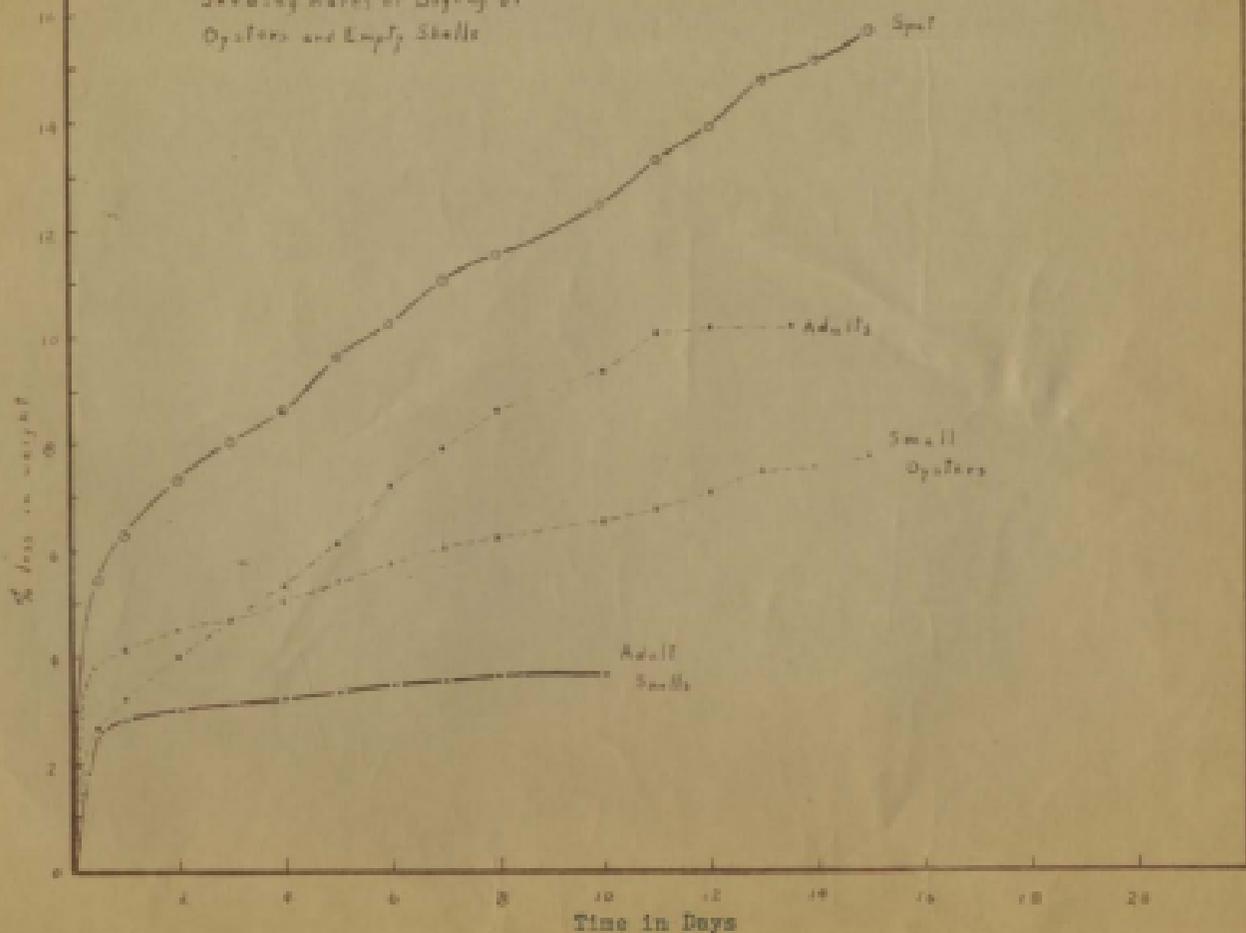
In the course of the experiment some records of air temperature and relative humidity were made using a wet and dry bulb hygrometer. These appear below.

Date	Time	Room Temp. °F.	Relative humidity %
Oct. 8	8:55 a.m.	64	51
	10:20 "	66	57
	2:15 p.m.	70	48
	9:20 "	70	48
11	9:35 a.m.	50	57*

* approximately.

Figure (3)

Showing Rates of Dying of
Oysters and Empty Shells



The conditions as indicated by the five determinations listed may be considered as representative of those obtaining throughout the experiment and show no variations which might have had a radical influence on the course of drying.

The results of the weighings and certain computations from them appear in Table XIX. In Figure 3 the percentage loss in weight in relation to drying time is represented graphically.

In general, all four samples behaved similarly. There was a rapid loss during the first ten or twelve hours, the rate of loss being roughly inversely proportional to the size of the oyster. The smaller oysters have a greater surface area per unit volume than the larger. It may be assumed that changes during the first stage are caused largely by evaporation from the whole outer surface of the shells.

After twelve hours there was practically no loss in the weight of the empty shells but with the oysters it was different. In this second stage, drying went on at a lower but more or less constant rate, still inversely proportional to the size of the oyster. It seems likely that at this stage evaporation is restricted to the margins of the valves and that the water is supplied by seepage of the oyster's shell liquor to the shell margin.

There is a lack of conformity in the behaviour in the three lots of oysters during this stage. The rate for the adults is higher than would be expected from the results obtained with small oysters and spat. The difference may be partly explained by the fact that the adult oysters were fished a day earlier than the rest, that they were less regular in form and that they were probably in poorer condition. It is generally considered that such oysters are unable to keep their shells tightly closed. Had Cooper bed cup oysters been used rather than stock from the Wharf bed the results might have been in better agreement.

This sort of test might be extended to include winter storage problems where desiccation is an important factor.

Table XIX. Summary of data on drying of shells and oysters when exposed to air in the laboratory.

	Shells of 10 adults			10 whole adults			12 small oysters			20 spat		
	Time	Weight gms.	% loss in weight	Time	Weight gms.	% loss in weight	Time	Weight gms.	% loss in weight	Time	Weight gms.	% loss in weight
Oct. 6	8:55 am	1277.5	----	9:58 am	1178.0	----	10:10 am	347.0	----	10:41 am	115.8	----
	9:05 "	1275.2	0.08	10:07 "	1173.5	0.33	10:22 "	348.5	0.1	10:46 "	115.3	0.43
	9:20 "	1273.5	0.31	10:21 "	1172.5	0.30	10:37 "	345.6	0.4	11:08 "	114.7	0.95
	9:42 "	1271.0	0.51	10:45 "	1170.8	0.58	11:10 "	344.0	0.9	11:32 "	113.9	1.6
	10:27 "	1267.0	0.82	11:27 "	1167.5	0.72	12:01 pm	342.0	1.4	12:30 pm	112.8	2.5
	11:25 "	1262.0	1.2	1:30 pm	1161.5	1.2	1:35 "	339.4	2.2	1:36 "	111.9	3.4
	1:35 pm	1254.5	1.8	3:30 "	1155.5	1.7	3:35 "	336.3	3.1	3:35 "	111.0	4.1
	2:30 "	1249.0	2.2	9:12 "	1148.0	2.6	9:15 "	333.9	3.9	9:17 "	109.5	5.4
	9:10 "	1244.5	2.6									
9	9:00 am	1241.5	2.8	9:02 am	1138.5	3.2	9:05 am	332.8	4.1	9:05 am	109.5	6.3
10	9:45 "	1239.0	3.0	9:47 "	1129.0	4.0	9:48 "	331.4	4.5	9:52 "	107.3	7.3
11	9:20 "	1237.5	3.1	9:23 "	1121.0	4.7	9:26 "	330.6	4.7	9:32 "	106.5	8.0
12	10:00 "	1236.0	3.2	10:02 "	1114.0	5.3	10:05 "	329.6	5.0	10:05 "	105.8	8.6
13	10:05 "	1235.0	3.3	10:05 "	1104.0	6.1	10:10 "	328.3	5.4	10:10 "	104.7	9.6
14	10:00 "	1234.0	3.4	10:08 "	1091.0	7.2	9:55 "	327.2	5.7	9:55 "	103.8	10.2
15	10:05 "	1233.0	3.5	10:05 "	1083.0	7.8	10:10 "	326.2	6.0	10:10 "	103.0	11.0
16	10:05 "	1232.0	3.6	10:05 "	1075.0	8.6	10:10 "	325.6	6.2	10:10 "	102.5	11.6
18	10:00 "	1231.5	3.6	10:00 "	1067.0	9.3	10:05 "	324.5	6.5	10:05 "	101.5	12.4

Table XIX (Continued)

Date	Shells of 10 adults			10 whole adults			18 small oysters			10 Spat		
	Time	Weight in gms.	% loss in weight	Time	Weight in gms.	% loss in weight	Time	Weight in gms.	% loss in weight	Time	Weight in gms.	% loss in weight
Oct. 19	10:10 am	1831.5	3.8	10:10 am	1058.0	10.0	10:15 am	323.6	6.7	10:15 am	100.5	13.8
20	-----	-----	---	10:05 "	1048.5	10.1	10:00 "	322.6	7.0	10:00 "	99.7	13.8
21	-----	-----	---	1:00 pm	1041.0	10.1	1:00 pm	321.4	7.4	1:00 pm	98.8	14.7
22	-----	-----	---	-----	-----	-----	10:00 am	320.8	7.5	10:00 am	98.4	15.0
23	-----	-----	---	-----	-----	-----	10:10 "	320.1	7.7	10:00 "	97.8	15.6

SECTION IX

Effects of Formalin Preservation on Index of Condition

Several times in the course of investigations it has been necessary to determine the index of condition of samples of shellfish that have been preserved in formalin. So far there is no basis for strict comparison of results for fresh and preserved animals. This year a few observations were made in an attempt to relate them. On different dates a sample of adult Cooper bed oysters and of large tray oysters was selected for condition tests. Each sample was divided into two similar lots one of which was tested in the fresh condition and the other preserved in a 5% solution of formaldehyde in tap water. After a period of preservation the second lots were tested. The results appear in the following table.

Stock	Date fished and preserved	Calculated		Expected reduction	I.C. After preservation		Reduction in I.C.	
		I.C. fresh oysters	I.C. without salts		Date	I.C.	Amt.	%
Small oysters 2-2½" long	May 5	111	79	32	Oct. 4	91	20	18
Large oysters 3½-4" long	Oct. 7	128	91	37	Nov. 17	69	59	46

The results show a marked reduction in the index as a result of preservation.

Causes of Drop in Condition

The meats in the preserved specimens were in such a highly contracted state that they were hard and rubbery and contained very little water. All the body fluids had passed into the shell cavity and were discarded with the shell liquor following the regular practice. Ordinarily the marine salts of the body fluids constitute an important part of the dry weight of the meats. Their loss in the shell liquor brought about by body contraction accounts for a good part of the drop in the index of condition.

The shells of the preserved specimens gaped slightly so there was ample opportunity during preservation for the dissolved salts contained in the body fluids and shell liquor to become greatly diluted

by the fresh water of the preservative solution. Presumably in cases where the volume of the preserving solution is great as compared with that of the oysters the amount of the salts left in the meats would be negligible. This dilution effect would also lead to a lowering of the dry weights of meats and consequently to a depression of the index of condition. This depression would probably be of less importance than that produced by the body contraction.

The water content of oyster meats related to index of condition and to the salinity of the habitat has already been studied and reported on (Medcof 1940) and it is possible to estimate the extent of the loss in condition attributable to the two factors just discussed. For Cooper bed oysters with an index of condition of 110-130, the water content is approximately 90%. The salinity of Biddeford river ranges about 28%. Using these values and the dry weights of the meats obtained in the condition tests on the fresh oysters in the present tests a new index has been calculated for the oysters had they been saltless as the preserved oysters virtually were. The calculated values are shown in the table together with the expected drop in the index - based on the expectation that all the salts were lost from the meats during preservation.

A comparison of these values with the observed reductions shows that the drop in the index was less than expected in the case of the small oysters and more in the case of the large. This disparity can be attributed in part to differences in the methods of preservation of the two lots. The small oysters were contained in a quart jar with a relatively small amount of preserving fluid while the large oysters were placed in a bucket with a large volume of fluid. The dilution of the salts was undoubtedly much greater in the second case. Accordingly, a greater drop could have been expected in the index for large than for small oysters. There are apparently other factors such as lack of uniformity in the samples of fresh and preserved oysters contributing to the differences.

The data show:

1. Formalin preservation produces a drastic reduction in the index of condition.
2. Variations in the exact manner of preservation influences the extent of this reduction.

Tester (1937) has shown that the lengths of herring shrink considerably after salting but so far as the writer is aware there are no published accounts of the effects of preservation on shellfish. If such information were available it would increase the usefulness and might alter the interpretation of data such as that published by Huntsman (1921) which relates to condition of preserved material.

Further observations should be made including a study of preservation in solutions composed of formalin of various strengths and in fresh water and in sea water with various dilutions.

SECTION X

The Blister Worm, Polydora, in Bideford River

A few years ago the writer reported the discovery of Polydora ciliata in Cape Breton and Malagash oysters (Medcof 1938 and 1939) and gave some information on the extent of infection in different areas and the detrimental effects produced. As far as is known this is the first record for Canada although it was not published.

The worms were identified by Mrs. C. J. Berkeley and specimens were sent to Mr. J. R. Lunz of the Charleston Museum, S.C., who was studying the same species in South Carolina.

Since that time Lunz (1941) and Needler (1941) have both referred to the presence of the worm in Canada but have added nothing to the information in the 1938 and 1939 reports.

During the summer of 1943 samples of oysters from the Cooper bed and from several beds in the upper part of Bideford river were examined. No blisters were found in Cooper bed stock but the up-river oysters showed several that contained small worms that were sent to Mrs. Berkeley and identified as P. ciliata.

The blisters were rather inconspicuous compared with those of Cape Breton oysters. They contained so little mud as to be almost transparent. They were small, regular in outline and scarcely raised above the general level of the shell surface. The largest observed was 12 mm. long, about 1.5 mm. wide and raised 0.5 mm above the general surface of the shell.

The percentage infection of the oyster population varied somewhat from bed to bed but averaged between 10 and 20%. Altogether 120 up-river oysters were examined. Twenty-two valves from these showed one or more recognizable blisters. One valve bore eight but the average number was one or two. In several cases both valves of the same oyster were infected.

The blisters were so inconspicuous that none of the local fishermen had noticed them. In this respect the conditions are very different from those in the Bras d'Or lakes. It has been suggested by Lunz (1941) that low salinity favours the development of Polydora. This seems to be the case so far as our areas are concerned but further study will be required before this can be confidently stated.

SECTION XI

The Chemical Composition of Shells

In a letter dated January 11th, 1944, Mr. H.F.S. Paisley, Director of Publicity for the Department of Fisheries, wrote Doctor Needler of the Fisheries Research Board requesting information on the composition of oyster and clam shells. This matter was turned over to the writer. A summary of the available literature on the subject was prepared and forwarded to Mr. Paisley. On previous occasions similar enquiries have been received from different sources and for this reason it has appeared worth while to incorporate the summary in the annual report where it will be generally available.

The three references to Shutt's work were supplied by Mr. C. H. Robinson, the Dominion Agricultural Chemist, through Mr. H. Barton, Deputy Minister of Agriculture.

Because of the great variety in the methods of analysis used by the various investigators whose reports were consulted, no attempt has been made to incorporate all the results in a single table.

European Oysters

Mohius (1880, 1883) presented results applying to Holstein oysters (*O. edulis*):

Carbonate of Lime	96 - 97%
Sulphate of Lime	1.8 - 1.3%
Phosphoric acid	0.08%
Oxide of Iron	0.03%
Magnesium and aluminum (traces)	
Organic material (Conchyolin)	Left valve (cupped) 1.01 - 1.025%
	Right valve (flat) 1.10 - 1.15 %

Cayeux (1916) after studying whole shells from *O. edulis* reported the following composition:

	<u>Composition</u>	<u>Av. Composition</u>
Calcium carbonate	0.838 - 0.048	89%
Calcium phosphate	0.011 - 0.075	4%
Organic matter	0.037 - 0.096	7%

The values shown in the column "average composition" were calculated by the writer from the data in the first columns which are quoted directly from Cayeux.

Orton and Amirthalingham (1927) reported an analysis of the chalky deposits in the shells of Q. adultis as follows:

	Based on whole shell	Based on dry solids
Calcium carbonate	78.5%	97.2%
Water	19.2%	0
Miscellaneous (Na_2O , P_2O_5 , SiO_2 , Cu, SO, S)	2.3%	2.8%

Douville (1926) reported on the analysis of the brownish marginal frill of the right valve of Q. adultis as follows:

Carbonate of Lime	88.4%
Albuminoid materials	4.8%
Nitrogen	0.8%
Insoluble material	3.1%
Water	1.3%

The work of Mabijs, Orton and Amirthalingham and Douville is of interest in showing variety in composition of shells of the same species and in different parts of the same shells. These observations are useful in interpreting the records which follow.

American Oysters and Mussels

Gutzell (1923) reports the composition for whole dried shells of Q. virginica as follows:

Aluminum	0.044%
Calcium	38.80 %
Iron	0.10 %
Magnesium	0.186%
Manganese	0.009%
Phosphoric acid	0.074%
Silica	0.575%
Organic matter	1.46 %
Water (loss to 110°C)	0.28 %
Chlorine	0.0035%
Carbon dioxide	41.96 %
Nitrogen	0.196%

From these data it may be deduced that the American oyster shell is composed of approximately 96% carbonate of lime and 1.5% organic matter and 2.5% of a miscellany of other elements.

Field (1922) reports an analysis of American mussel shell (Mytilus adultis) as follows:

Calcium oxide	51.21%
Magnesium	0.27%
Iron and Manganese oxide	0.32%

Silica	0.11%
Carbonates	37.33%
Sulphates	1.02%
Organic matter	8.05%
Water	0.58%
Phosphates	(traces)
Chlorides and sulphides	(traces)

Judging from this table the shell is composed of 88% Calcium carbonate.

Fox and Coe (1943) report the composition of adult mussel shells (Mytilus californianus) as 93% carbonate of lime, but show that in juveniles it is considerably below this.

Canadian shells

Shutt, F. T. (1924), the Dominion Chemist, reports an analysis of a sample of clam shells powdered so fine that 77% passed through a screen of 20 mesh to the inch. This powder is a by-product in the manufacture of poultry grit from shells obtained in the vicinity of Saanichton, Vancouver Island, B.C. The species of clam is not mentioned. It is probably Saxidomus.

Moisture	1.03%
Inert matter	
insoluble in acid	1.20%
Carbonate of lime	92.87%
Carbonate of	
Magnesia	1.85%
Oxide of Iron and	
Aluminum	0.40%
Phosphate of Lime	0.44%
Undetermined organic	
matter, etc.	2.21%

The chemist regards this matter as a useful amendment for soils in need of lime but considers it too coarse to produce a rapid neutralization of soil acidity.

Shutt, F. T. (1927). The chemist reports as follows on an analysis of a mixed sample of sea shells, probably taken from beach wrack, mostly of barnacles (Balanus crenatus), with some mussels (Mytilus edulis):

Carbonate of lime	88.95%
Carbonate of Magnesia	2.01%
Oxide of Iron and Alumina	0.61%
Undetermined	1.22%

He comments that this material if ground sufficiently fine would be useful as an amendment to soils in need of lime.

Shutt, F. T., (1931). The following table summarizes the report on five samples submitted to the chemist. He comments to the effect that all five samples could be used satisfactorily as poultry grit and that No. 5 would be particularly good since it contains 6.81% protein.

No.	Material	Source	Mineral matter insoluble in acid %	Oxide of iron and alumina ($\text{Fe}_2\text{O}_3 + \text{Al}_2\text{O}_3$) %	Carbonate of lime (CaCO_3) %	Carbonate of magnesia (MgCO_3) %
1	Oyster shell (whole)	Shediac, N.B.	2.14	0.52	92.50	0.91
2	Crushed oyster	Nelson, B.C. (Probably imported from Seattle, Wash)	0.92	0.76	93.50	trace
3	Scallop shell (whole)	Annapolis Royal, N.S.	0.34	0.32	98.50	0.61
4	Crushed clam shell	Annapolis Royal, N.S.	1.96	0.24	94.75	0.00
5	Dried ground egg shell	Belleville, Ontario.	0.14	----	39.62	1.97

Hunter and Harrison (1928) give the following results for percent composition of two samples of oyster shells tested:

Aluminum	0.045 %	and	0.043 %
Calcium	37.78 %	"	36.81 %
Copper		"	0.0025 %
Iron	0.11 %	"	0.09 %
Magnesium	0.183 %	"	0.189 %
Manganese	0.009 %	"	0.009 %
Potassium permanganate	0.075 %	"	0.075 %
SiO_2	0.570 %	"	0.580 %
Zinc	-----	"	0.0009 %
Organic matter lost above 110°C.	1.41 %	"	1.51 %
Water lost at 110°C.	0.27 %	"	0.28 %
Chlorine	0.0034 %	"	0.0035 %
CO_2 , average for both lots	57.19 %	"	
Nitrogen	0.196 %	"	0.196 %

Besides the chemicals chiefly considered by the workers already referred to, Clarke and Wheeler (1922), have shown that other elements occur in the shells of mollusks in small amounts. These include fluorine, strontium, iron, manganese, copper, lead, zinc, cobalt, nickel and silver. The same workers have shown that there are variations in the chemical composition of shells of a species depending on its micro-habitat and regional distribution.

Summary

There is a certain disparity in the results quoted but all agree that calcium carbonate is the chief constituent of our shells. Organic constituents, chiefly conchyolin, come next, then magnesium. When the metals occur as compounds other than carbonates they are commonest as sulphates and phosphates.

Because sea water is such a complex solution it is not surprising that the shells of marine molluscs contain varying amounts of many elements. This enhances their value in agriculture and makes them superior to pure lime.

Some information on the processing of oyster shell for commercial use in the United States has been summarized by Dumont (1925).

SECTION XII

The Relative Fatness of American and Canadian Oysters

Under the protection of the Canadian war-time embargo on the importation of American oysters several small Canadian concerns have produced limited quantities of shucked oysters. So far as the writer is aware only one of these is working with suitable equipment and there is a general lack of knowledge and experience. On the markets the Canadian product as a whole is regarded as inferior to the American. This has been attributed to the poor condition (thinness) of our oysters which also results in a low yield of meats per bushel of whole oysters and in excessive "bleeding" (loss of body fluids) and flaccidity of the meats. Another cause is said to be improper processing of the oysters such as puncturing and mangling of meats during opening, etc., which seems to be common. This detracts from the appearance of the product, causes excessive "bleeding" and makes bad matters worse, generally.

To gather more definite information on the first of these proposed explanations it is planned to compare the condition of oysters from American and Canadian waters by actual condition tests on samples obtained from various points in the United States. Through correspondence the writer has already obtained information gathered by Mr. G. R. Lunz of the Charleston Museum, Charleston, S.C., in connection with his study of the mud blister worm (Polydora) which infests oysters. Mr. Lunz has submitted these data to the writer from time to time for comment but has referred to them so briefly in his publication (Lunz 1941) as to make it worth while recording them more completely at this time. According to his report Mr. Lunz made determinations of the index of condition on 67 individual oysters following the method described by Medcof and Needler (1941). The results for 65 of these appear in Table XX. Unfortunately Mr. Lunz bought the oysters he studied in the open market or at canneries and knew only of the general district from which they came and nothing of their micro-habitats. Because South Carolina oysters are produced almost entirely on tidal flats and because the degrees of intertidal exposure is known to influence growth rate (and hence size), fattening and Polydora infestation (Lunz 1941, 1943 and Medcof 1942) careful sampling would seem to be indispensable in a study of this kind.

In preparing Table XX an attempt has been made to arrange Mr. Lunz's mass of data in a form satisfactory for study. His results except for large oysters seem scarcely to justify his blanket statement (1941, pg. 278) that infection by Polydora reduces the index of condition. Such a relationship is by no means clearly demonstrated by these figures. At the same time the data on condition are useful to us for comparison with our own. Conditions approaching those in South Carolina waters are found in the Bras d'Or lakes. Here salinities are prevailing low but are subject

to less variation than those described by Lane. Neglecting this difference and others that may have arisen from differences in the exact manner of index of condition determinations by the two workers, available information (Medcof 1933, 1943, 1941) indicates that our oysters are fatter. There may be areas in Canada where hydrographic conditions are more strictly comparable but for these no data on condition have been gathered.

An estimate of the relative fatness of American and Canadian oysters is also possible from the results of actual shucking operations. The Blue Muttie Oyster Producers Association of Millis Cove, N.S., has supplied information applying to Great Lakes oysters. The following table is based on these data which are taken from the files of the Department of Fisheries and the Annual Reports of the Department of Fisheries (Seedler and Kerwell 1942, and Kerwell 1943).

Yield of Great Lakes oyster meats in American gallons per barrel (32 Imperial bushels).

Year	Yield in gallons	
¹ 1939	1.124	* The yield was 0.88 Imperial gallons per barrel. American liquid gallon equals 0.8327 Imperial gallons. Applying this factor, the yield becomes 1.12 American gallons.
¹ 1940	1.31	
² 1942	1.17	
³ 1942	1.47	
¹ 1943	1.33	

Mean 1.27

- 1 From files of the Department of Fisheries
- 2 Annual Report of the Department of Fisheries 1941-42, 89-97 - Seedler and Kerwell.
- 3 Annual Report of the Department of Fisheries 1942-43, 108-119 - Kerwell.

It should be noted that while the Blue Muttie Association measured whole oysters by the barrel holding 32 Imperial bushels they sold the meats in American gallon cans except in 1939 when they used Imperial gallon cans.

Belton (1941) states that the average yield in New Jersey is 5 to 32 pints of meats per bushel of whole oysters but that in the fall of 1940 it reached 77 pints because of unusually favourable conditions for fattening. Gossell (1933) listed "8 quarts" as a yield per bushel for fat American oysters. This is so high as to be questionable. It seems likely that "8 pints" was intended. Grave (1912) claims a yield of 9 pints of meats per bushel of Maryland oysters.

The American bushel is the old English Winchester bushel which is equivalent only to 0.8326 Imperial bushels. Using this factor the figures just quoted have been expressed in terms of American gallons per barrel of $2\frac{1}{2}$ Imperial bushels. Nelson's values become 1.96 gallons per barrel for the average yield and 2.83 gallons for the 1940 yield. Grave's figure becomes 3.40 gallons. By comparison the normal Gillis cove yield is only 65% of that for New Jersey. The best Gillis cove yield was 77% of the average New Jersey yield but only 53% of the 1940 New Jersey yield. Compared with Maryland the Gillis cove yields are only 37%.

The results published by Loosanoff and Engel (1943) for Milford Harbour, Conn., should permit a comparison if we had comparable data.

It has been shown (Medcof and Needler 1941) that the Brax d'Or oysters are on the average much thinner than those from many of the important oyster-producing areas of the Maritimes. Allowing for differences in salinity (Medcof 1939) it can be shown from values of the index of condition that it would be reasonable to expect yields from our better areas that compare quite favourably with those for New Jersey.

The same cannot be said of the comparison with Maryland yields but the writer is not prepared to accept Grave's figures without reservation.

The above discussion indicates that compared with American stocks our oysters may not be so thin as has been generally reported.

Table XX. Index of condition of individual oysters from South Carolina from determinations of Mr. G. R. Lutz during his study of the effect of *Polydora* infestation on condition.

Small Oysters			Medium-sized Oysters			Large Oysters		
Shell capacity ml.	Index of condition	No. of infesting <i>Polydora</i>	Shell capacity ml.	Index of condition	No. of infesting <i>Polydora</i>	Shell capacity ml.	Index of condition	No. of infesting <i>Polydora</i>
14.3	143	1	18.8	69	5	28.2	60	0
12.8	105	0	17.3	142	4	24.4	72	1
10.8	109	0	18.8	23	1	32.8	40	13
9.8	71	0	17.8	56	4	27.7	58	4
9.8	82	1	18.3	110	5	27.9	72	1
4.8	#271	0				31.1	68	1
10.2	93	1				27.3	73	12
Index of Condition: General average - 108			Index of Condition: General average - 94			Index of Condition: General average - 63 Av. for infected - 57 " " un- " - 68		

15 oysters from Yonge's Island, December 3, 1940

11.4	145	2	19.6	69	1	27.2	21	0
10.7	98	0	16.2	71	0	47.8	76	0
12.2	91	1	19.3	73	0	26.3	49	3
			17.4	98	0	40.6	48	8
			17.2	76	4	40.7	37	4
			19.2	97	2	21.9	105	1
Index of Condition: General average - 111			Index of Condition: General average - 61 Av. for infected - 67 " " un- " - 78			Index of Condition: General average - 61 Av. for infected - 45 " " un- " - 77		

29 oysters taken from Edisto Island, November 29, 1940, and held in Wappoo creek until December 13, 1942.

S indicates severe infestation of the shell by the boring sponge *Cliona*.

14.7	89	5	20.9	55	2	26.5	64	6
8.6	#273	0	16.5	119	4	33.0	82	0
13.8	91	1	21.7	58	6	24.4	42	1
9.9	112	3	17.3	61	0 (S)			
6.1	172	3	19.0	78	4			
12.4	122	0	17.2	67	12 (S)			
11.6	119	0	20.5	94	1 (S)			
			21.9	81	3			
			19.2	49	4 (S)			
			18.5	64	1			
			16.8	77	1			
			18.8	75	4			
			15.9	84	6			

Continued on next page-----

Table XX (Continued)

Small Oysters			Medium-sized Oysters			Large Oysters		
Shell city ml.	Index of cond- ition	No. of infesting Polydora	Shell city ml.	Index of cond- ition	No. of infesting Polydora	Shell city ml.	Index of cond- ition	No. of infesting Polydora
.....			15.1	90	4			
			18.3	87	3			
			17.3	88	6			
			20.0	57	4			
			17.1	97	0			
			16.2	74	1			
Index of Condition:			Index of Condition:					
General average - 118			General average - 74					
Av. for infected - 121			Av. for infected - 73					
" " un " - 111			" " un- " - 78					

These values are so high as to be of questionable accuracy.

* For purposes of comparison oysters with only one blister are grouped with those having none as "uninfected" and compare with those having more than one blister which are designated "infected".

SECTION XIII

The Distribution of the Oyster Drill, *Urosalpinx*, in the Maritimes

In an effort to assemble the recorded information on the oyster drill in Canada the writer has made a thorough search of available literature. It is his belief that the following account is an almost complete if not a complete summary of the records. Doubt in this matter is largely due to failure on the part of early writers to give complete references to literature they cited. For instance, Verrill's (1873) reference to records of distribution of the species in Prince Edward Island are merely, "Ball, Dawson", Both these investigators were prolific writers so that it is impossible to say with absolute certainty that all their works pertaining to this subject were consulted in this study. Fortunately Whiteaves in 1869 published a list of marine molluscs then known to occur in eastern Canada. He was well acquainted with the literature of his day as his writings clearly show. Since he does not mention the drill, it is safe to assume that it was not recorded previous to 1869. This assumption has greatly reduced the amount of work involved in searching the literature.

Urosalpinx cinerea Say, was first observed in Canada by the geologist Sir William Dawson, almost seventy-five years ago. In an appendix to his report (1871) on the geology and mineral resources of Prince Edward Island he lists it as "*Buccinum cinereum* Say", as collected in Prince Edward Island "in the course of our excursions". He gives no information as to its abundance or local distribution on the Island.

The next record is that of Bain (1885) in what is now an obscure journal, the "Canadian Science Monthly", "devoted to the interests of Canadian naturalists and designed to encourage the popular study of the natural sciences" and used in the instruction of students of the "Canadian Postal College of the Natural Sciences". Judging from the text and style of this article it is hard to understand how it could have ever been accepted as a valid occurrence record, because there is no mention of collectors, localities or dates of collection of the various species of molluscs mentioned.

In listing these older records there is one of questionable significance which has been brought to the writer's attention by Dr. J. R. Adams of Sir George Williams College, Montreal. In the Carpenter collection of molluscs at McGill University, Montreal, there is a specimen of *Urosalpinx* which is listed as collected by Dawson from Halifax harbour. More detailed information on this record is desirable.

After 1885 there was a considerable period when no new record was published but during which there were frequent references to the two just described by writers such as Verrill (1873), Ganong (1887, 1889, 1890 and 1890b), Whiteaves (1901), and Summer, Osburn and Cole (1913).

There is some confusion as to the Whiteaves' 1901 reference to Bain's record. The date he quotes is 1873 and besides this, he attributes to it a locality - Charlottetown harbour - which was not mentioned in the original article. I have been able to find only the one paper by Bain, that published in 1885. If he had published an earlier and more complete record, one would expect that it would have been familiar to Whiteaves and Ganong and other workers of his day and that they would have referred to it. For the present, therefore, it is reasonable to assume that Whiteaves meant to refer to the 1885 paper and that he blundered either in recording the date in his manuscript or in reading the "proof" of his catalogue.

It is not clear either how he was able to assign Bain's record to Charlottetown harbour. We can only suppose, as could easily have been the case, that he had access to information additional to that given in the 1885 paper, either through personal contact or correspondence with Bain. I cannot think that Ganong would have accepted Bain's publication as a valid record without similar access to unpublished information.

The next record for the species in Canada is that of Kindle (1916) who reports it as common at the mouth of the Avon river, N.S., in the Minas basin area. Dr. A.H. Leim of the Atlantic Biological Station later reported the species (Leim 1923) from further up the Minas basin at Bass river and Tenny cape where it was abundant in the intertidal zone.

The rest of the references are more recent and come from the southern part of the Gulf of St. Lawrence. On May 30, 1939, Adams (1939) found it abundant on the bars at Malsgash, in Tatamagouche bay, N.S., and on July 18th of the same year at the mouth of the Caribou river in Caribou harbour, N.S. His discoveries prompted Ingalls to search for the species during his survey of shore mollusc resources of the Northumberland strait coast of Nova Scotia. As a result, in 1939 and in 1940 Ingalls (Ingalls and Needler, 1939, Ingalls and Needler 1940) was able to record its distribution as follows:

Caribou harbour. Abundant; present (1) at MacKenzie island; (2) at the upper end of the large cove at the northeast end of Doctor island; (3) on the mainland between Spring and Oak points; (4) at the mouth of the Caribou river; (5) in the Caribou river at its junction with Little Caribou river.

Merigomish Harbour. Not common but present (1) at the south end of Fig Island, (2) in Pine Tree gut.

Pugwash River. Not common but present: (1) at the junction of Pugwash river and Dougherty's creek; (2) at the bend of Pugwash river between Canfield creek and Dougherty's creek.

In the summer of 1939 Dr. A. W. H. Needler found egg cases of the drill attached to oyster shells at Pownal bay near Charlottetown, P.E.I. Except for a letter addressed to Dr. J. R. Adams,

dated August 21, 1939, this present report appears to be the only written account of Dr. Needler's discovery. Since 1940, Dr. Kerswill has visited the area on several occasions but he states that he has found no evidence of the drill. The inference is that the species is not very common there.

On July 29th, 1943, at Wilmot point at the mouth of the Wilmot river in Summerside harbour, P.E.I., the writer found two clusters of Urosalpinx egg cases - one of six the other of ten. Half of the cases still contained developing young, the rest were empty. Besides this, five oyster spat averaging $\frac{1}{2}$ " in diameter and one 2" oyster were found all freshly drilled. No adult drills were taken. The species must be fairly common because this material was gathered in less than one-half hour while fishing a sample of 250 oysters with a pair of ordinary oyster tongs.

Summary and Discussion

In the United States the oyster drill is widely distributed. In many districts it is the most serious of all the oyster enemies and annually robs the American oyster culturists of millions of dollars. According to our present knowledge the species is permanently established in Canada in only two general regions, the Minas Basin area and the Prince Edward Island and Nova Scotia shores of Northumberland strait. In the first of these it seems to have little industrial significance. In the second, the situation is different because in every case the colony of drills occurs in a centre of oyster production. Fortunately, as compared with the oyster populations, the drill is distributed in highly restricted loci and its depredations do not appear to be extensive. However, this does not eliminate the possibility that its range may be extended by human agencies to areas peculiarly favourable to its multiplication. In other words, we do not know if and when its capacity for destruction may be suddenly and vastly increased. At present, the potential danger may be nowhere greater than in the sewage-contaminated waters of Summerside harbour where in 1942, 2137 barrels of oysters were fished and relayed for purification in other inlets of the south shore of Prince Edward Island (Kerswill 1943). It is not impossible that small new colonies of the species have already been established in the relaying areas.

A more comprehensive search for the species should be conducted in our oyster areas and a careful study made of the local distribution and abundance of the drill wherever it occurs. Such information would show the extent of the possible danger and with the results of other studies, could form a basis for extending or altering present regulations which are required for the control of the drill. Some work of this sort has been conducted at Malagash by Dr. J. R. Adams but he has not yet presented a complete account of his studies. It is hoped that such a report will be forthcoming for it is most desirable that all available information on the species should be assembled to permit an intelligent planning of a program for further investigation.

It is anticipated that in 1944 further work on the species may be undertaken.

SECTION XIV

Studies on the Shore Snail, Nassarius Obsoleta, Say,
in Bideford River, F.E.I.
by E. I. Morrison and J. C. Medcof

Nassarius obsoleta is a small turret-shaped, black snail found chiefly on beaches in the intertidal zone. As Ganong (1890) points out the headquarters of this species are in the warm waters of the Atlantic coast south of Cape Cod. In our latitudes, it is found only in isolated colonies in places where the water is particularly warm in summer. The southern part of the Gulf of St. Lawrence is one such place. Generally it occurs with other typically southern forms such as the oyster, quahaug and slipper limpet to form a community of what is termed the "Virginian Fauna". Ganong and other writers of his time referred to the assembly of animals on the cooler parts of our coast as the "Acadian Fauna".

In Bideford river Nassarius is by far the commonest of the snails and what is presumably its veliger larva is so abundant in spring and summer plankton tows that it often makes the study of other larvae difficult. Because of the unusual abundance of the snail and because Ganong (1899) has suggested that it destroys oyster spat it was considered desirable to learn something of its life-history and habits.

Collections were made in 1937 by J. C. Medcof but these were not worked over until the fall of 1943. The 1943 collecting and practically all the work involved in the investigation was done by Miss Morrison under the direction of J. C. Medcof and this report is the result of their joint efforts.

Sampling

Random sampling of the population was carried out on the beach at the Prince Edward Island Biological Station landing stage and at the Forbes' area a quarter of a mile further down Bideford river. In sampling, an area of about two square yards was marked off and all the snails on it were gathered either by picking by hand or by screening the surface layers of sand through fly screen of $1\frac{1}{2}$ mm. mesh.

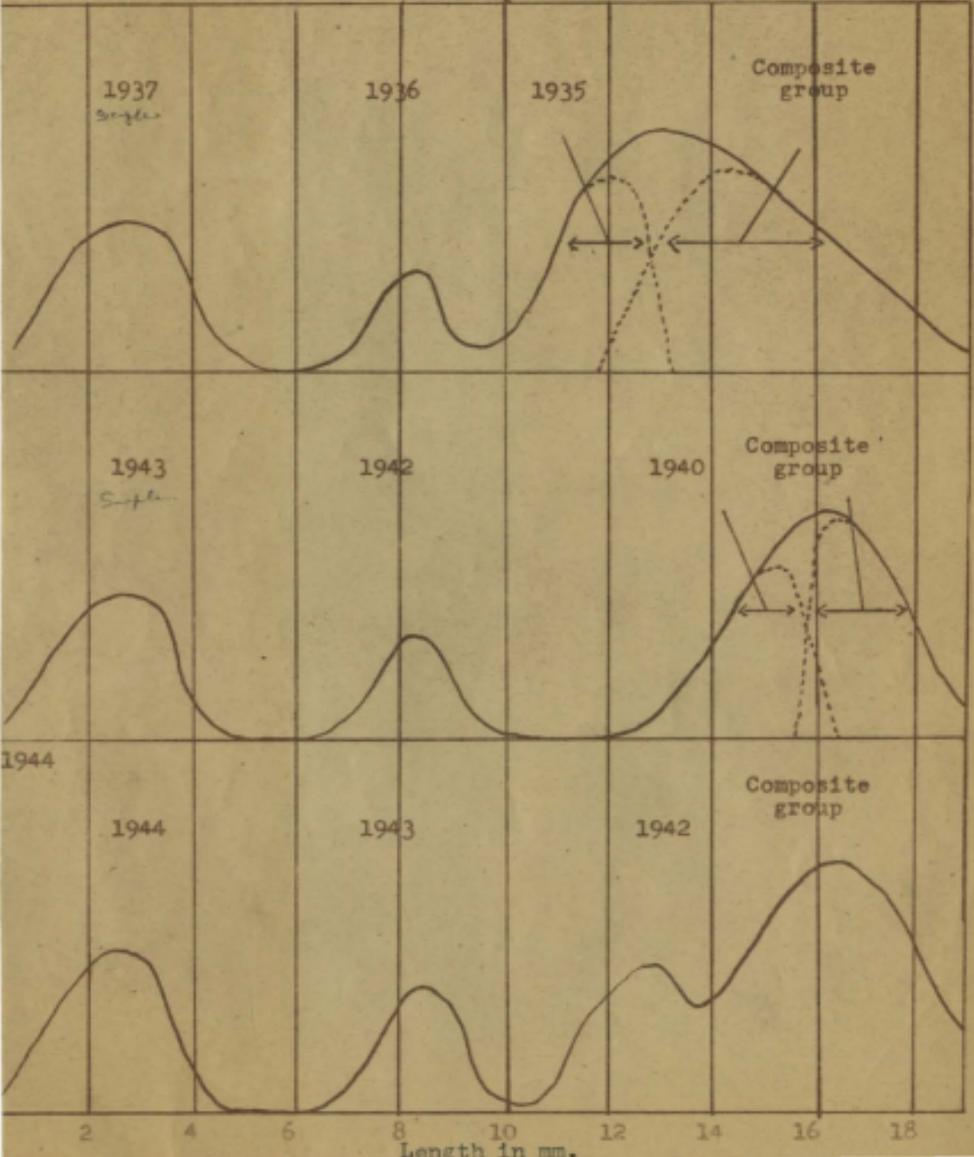
Measurements

According to Gould, (1870), the apices of Nassarius shells are generally eroded. If this erosion were extensive it might rule out the use of length measurements as an index to size. The tips of the shells of several older snails from the present collections were carefully examined. Erosion was in most cases so slight that it could be disregarded.

In a preliminary study the lengths of snails taken at the landing stage on October 1st, 1943, were measured to the nearest millimetre on a recording caliper and to the nearest 0.1 millimetre with a vernier caliper. The results showed that there is a great

Fig. (4)

Showing the mid-summer size-frequency distribution in *Nassarius* samples. Except for the first maximum representing the young of the year or 0- year class, the 1937 and 1943 curves summarize actual observations. The 1944 curve is in the nature of a prediction of what may be expected next year.



spread in the lengths of snails and in each of the size-classes. Because of this spread, there was no apparent disadvantage in using the results from the recording caliper for size-frequency distribution studies and all subsequent measurements were made only with the recording caliper. The results are summarized in Table XXI.

Deductions from Measurements

The results show that there are never more than two well-defined size-classes apparent in the population at one time.

The first conspicuous size-class is well represented - length 8-10 mm. - in the August 1937 sample but by smaller numbers in the 1943 lots. Judging from the appearance of the animals they represent the 1+ year-class although this is not certainly the case. On this assumption, Nassarius at the end of its second season reaches the length of 8-11 mm.

A peculiarity of both the 1937 and 1943 samples is that this size-class is so very inconspicuous as compared with the numerous second size-class. There are several plausible explanations for this feature: (1) the size class may never be numerous, in which case we must assume that the third size-class is composite of many different year-classes and that the snail has a long life span of several years; (2) this size-class may have been abnormally scant in these two years; (3) the sampling method may not have been adequate.

The second size-class is the most prominent in the population and seems undoubtedly to be composite of several year-classes which are absorbed by it when they reach the age of 2+ years. It is impossible by the present type of analysis to identify the several age-classes that constitute this size-class but there is considerable evidence to support the belief in its composite nature. (1) It is very numerous as compared with the first size-class. (2) It contains snails whose lengths are as great as 22 mm. which size could scarcely be attained in 2+ years, if we judge from what is known of growth rates of the 1+ age-class. (3) There are peculiar year to year differences in the modal length of this size-class and irregularities in the sequence of change in the modal length. Both of which support this conclusion.

We shall elaborate on this third bit of evidence. The modal lengths for this size-class in August, 1937, and 1943, were 13 mm. and 16 mm. respectively. A reasonable explanation of this difference is the assumption that the recruitment of snails of the 2+ year-class into the second size-class was greater in 1937 than in 1943.

In 1937 the modal length of this size-class advanced from 10 mm. to 13 mm. in the interval June to September whereas in 1943 it remained almost constant at 16 mm. throughout the season. This can be interpreted as indicating that the size-class in 1943 contained many old snails that had almost attained their ultimate size and were growing so very slowly that changes in their size was not perceptible and that

in 1937 the class contained more small young fast-growing snails.

The evidence presented in the two foregoing paragraphs is of particular interest since it indicates that conditions for reproduction in 1935 were more favourable than in 1941. The 1941 season was so unfavourable climatically that there was a general failure in oyster spat production throughout the maritime provinces (Kerswill, 1943). It may be deduced from this study that the same climatic conditions were adverse to Nassarius, another member of the "Virginian Fauna" in our latitudes.

The data in Table XXI show that the ultimate size seldom surpasses 19 mm. and that only a few snails achieve even that. The present knowledge is not sufficiently complete to permit an accurate estimate of the life span of Nassarius but it seems to be more than three years and possibly four or five.

Criticism of Sampling Methods

For several years before this study was begun it was known that in mid-summer small newly settled black snails appeared annually in great numbers on the beaches of Bideford river. The adult Nassarius were so numerous that it was assumed that these snails were their young. The examination of the Nassarius samples taken for this study showed that in 1943 the small snails were almost exclusively Bittium alternatum (Say) and that few young of Nassarius were included. Likewise only a few young of the year were taken in the 1937 samples. Consequently, almost no information has been gathered on juvenile Nassarius of the 0+ year-class. They appear to attain a length of about 6 mm. by the end of their first season.

The 1+ year-class was also poorly represented in the collections so it seems probable that the method of sampling is faulty. It may be that observations to be made in 1944 will explain these peculiarities.

Conditions Predicted for 1944.

It seems probable that the modal size of the second size-class will again remain nearly constant in 1944 for the same reasons that it was constant in 1943. Furthermore, it seems unlikely that the modal length of 10-11 mm. of what is now the 1+ year-class (what will be the 2+ year-class in 1944) will advance as far as 16 mm. by August, 1944. This means that for at least part of 1944 there will be three size-classes (besides the young of the year) apparent in the population and that it will be possible to measure the growth of the 3+ year-class. It would appear that this opportunity is one which rarely presents itself and that it arises simply because of the 1941 failure in reproduction. This being the case, if further observations on Nassarius are ever to be made, they should be carried out in 1944 when they may be expected to yield this extra information. Figure 4 summarizes the results of the foregoing discussions.

Habitat and Migrations

Juvenile snails of the 0+ year-class were not found in sampling and there is no information on their habitat preference.

During the warm-water season in Bideford river the adults were concentrated in the intertidal zone on sandy bottom although limited numbers were found in deeper water and on other types of bottom.

No definite date was recorded but some time between October 1st and November 6th, 1943, all the snails disappeared from the shore zone. On the latter date the results of dredging indicated that they had moved out into deeper water for they were found in abundance at a level corresponding to a depth of three to five feet at normal low tide. It is not known whether they burrow into the bottom and hibernate as some snails are known to do or whether they remain active all winter. No record was made of the date of their spring appearance in the intertidal zone but they were not found there in early May immediately after the ice went out. The behaviour here simulates that in New Hampshire as described by Batchelder (1915).

Reaction to Exposure

It was frequently observed when these animals are stranded in the intertidal zone at low water that they bury themselves in the sand. Sometimes the tips of their shells are exposed but more often the whole animal disappears 2-4 mm. below the surface leaving dimples in the sand that may be mistaken for clam (*Mya*) burrows.

Resistance to Continuous Exposure

Approximately 150 snails were taken into the laboratory on August 6th and left exposed to the air. At intervals samples of 10 to 20 snails were returned to salt water and the number that recovered and crawled about after an hour was counted. After four days' exposure only 50% were able to do this. After seven days' exposure only a very few were able to recover.

The animals are apparently hardy and the operculum no doubt forms a good protection from desiccation.

Reaction to Oyster Spat

On August 6th several squares of commercial spat collector with numerous one-day-old spat attached were brought into the laboratory and placed in a shallow half-litre dish of sea water together with a sample of about 20 snails. Each spat was marked by a pencil ring drawn around it. After several days the squares were examined. None of the spat had been destroyed. There is no evidence from this test to support Ganong's claim (1889) that *Nassarius* kills oyster spat.

Reproduction

What indubitably appear to be the egg cases of this species were observed in the spring and throughout the summer. No dates were recorded as to their first appearance but large masses of them were found attached to eel grass, stones, oyster shell and mussels. In counts of ten cases the number of eggs per case ranged from 60 to 132 with an average of approximately 100 per case.

So far it has not been established that the species has a free-swimming larva but this seems to be highly probable because no very minute snails have been found on the sea weeds and because there is an unusually abundant gastropod larva in the spring and summer plankton tows.

Judging from its abundance the species must be generally successful in reproduction although it seems from the results reported above that there are years when this is not true.

Further Study Planned

It is planned to take advantage of the peculiar conditions now extant and if time permits continue this study in 1944. Information will be sought on their relation to oyster spat, the time of spring appearance in the intertidal zone, differential behaviour of the several size classes, spawning, larval history, settlement, and on the growth of the several size classes.

It is possible that Canadian populations of the oyster drill, Urosalpinx, another Virginian form, may have shared the same experience in 1941 as the oyster and Nassarius. If this be true, then 1944 would be a most favourable time for a population study of the drill. An analysis in that year might be expected to yield more information than could be obtained in normal times.

SECTION XV

The Identification, Distribution and Abundance of Molluscs
in Bideford River

In the summer of 1943 a survey of molluscs in Bideford river was begun. Bottom samples from different depths down to 15 feet were taken at three stations with a bucket-shaped hand scoup lined with $1\frac{1}{2}$ mm. mesh fly screening. The scoup had a handle 18" long. The catches were sorted into what appeared to be specific groups and preserved.

It was impossible for the writer to make specific identifications of the material both from lack of experience and because the available literature is inadequate or out-dated and the synonymy most bewildering. The publication of "Johnsonia" now appearing in sections promises to remove some of these difficulties.

Samples of the sorted specimens from the dredgings, together with three lots of small bivalves collected by Miss C. M. Sullivan from her sand box collectors and several specimens collected by the writer before the dredgings were undertaken were submitted to the Museum of Comparative Zoology, Harvard College and identified by Mr. W. J. Clench and his assistant Mr. R. W. Foster. The forms recognized are listed in Table XXII with comments on some of the species. These comments have been supplied by the writer after consulting Verrill (1870) and Whiteaves (1901) and through correspondence and conversation with Mr. Clench.

Following Table XXII the species and their abundance at each of the three stations are described.

Table XXII. Species of molluscs collected from Bideford River.

<u>Pelecypods</u>	<u>Remarks</u>
<i>Cardium pinnulatum</i> Conrad	A common and wide-spread species
<i>Cumingia tellinoides</i> Conrad	
<i>Ensis directus</i> Conrad	"
<i>Gemma gemma gemma</i> Totten	"
<i>Macoma baltica</i> L.	"
<i>Modiolus demissus</i> Dill.	"
<i>Mulinex lateralis</i> Say	A Virginian form apparently the second record for Canada.
<i>Mya arenaria</i> L.	A common and wide-spread species
* <i>Mytilus edulis</i> L.	"
* <i>Ostrea virginica</i> Gmelin	A Virginian form
<i>Petricola pholadiphormis</i> Lam.	
<i>Rochefortia planulata</i> Stimpson	May be a first record
<i>Tellina tenera</i> Say	
<i>Yoldia limatula</i> Say	

Table XXII (Continued)

<u>Pelecypods</u>	<u>Remarks</u>
Venus mercenaria L.	A Virginian form
<u>Gastropods</u>	
Bittium alternatum Say	A Virginian form
Crepidula glauca Say	This is not <u>C. fornicata</u> as was formerly supposed
Crepidula plana	Both species of <u>Crepidula</u> are Virginian forms
Littorina littorea L.	
Littorina obtusata L.	
Littorina saxatilis Olivi	
Mitrella (Collumbellus, Astyris) lunata	Appears to be the second Canadian record.
Nassarius obsoleta	Virginian form
Odostomia besuturalis Say)	Only a few Canadian records both are Virginian forms
Odostomia trifida bedequensis) Bartsch	
Paludistina minuta Totten	A recently described species. This is probably the first Canadian record.
Polynices heros Say	Common and wide-spread : this is <u>Utriculus</u> of Whiteaves
Retusa pertenuis Highels	
Triphoris perversa nigrocincta C. B. Adams.	Mr. Clench considers this species one of the most interesting in the collection since this is the first time it has been reported north of Cape Cod. Appears to be second Canadian record: widespread but not often observed.
Turbonilla nivea Stimpson	Appears to be second Canadian record: widespread but not often observed.

* The species marked thus were identified by the writer and samples were not sent to Mr. Clench.

Supplement to Table XXII.

Species collected by writer at entrance to Buctouche bay, May 28, 1941.

Aeteocina (Utriculus) canaliculata Say	Common and wide-spread.
Nassarius trivittata Say	There is some doubt of the identity because the specimen was an eroded dead shell.
Modiolus modiolus L.	

Station 1. Paugh's Creek

This station was far up Paugh's creek opposite Edmond Paugh's house close to where the brook enters the creek. At this point the creek is 25 yards wide at half-tide. Samples were taken on September 21, 1943, at low tide (1) from the middle of the creek where the water was three feet deep and the bottom soft, black and clayey. (2) Nearer shore in 6" of water where the bottom is soft, reddish, clayey silt. The forms observed are listed below.

<u>Species</u>	<u>Remarks</u>
<u>Pelecypods</u>	
Gemma gemma gemma Totten	Present in great abundance all the way across the creek.
Modiolus demissus Dill.	Abundant all the way across the creek: often in burrows in sedge bank.
Mys arenaria L.	Small specimens only: found near shore and in middle of creek.
Macoma baltica L.	Found only in the middle of the creek.
Ostrea virginica Gmelin	Normal-sized specimens found in the middle of the creek.
<u>Gastropods.</u>	
Bittium alternatum	Two specimens only: close to shore
Crepidula glauca	Rare but present in the middle
Crepidula plana	" " " " " "
Littorina saxatilis	Found on beach: common
Nassarius obsoleta Say	Found all way across the creek but commonest near shore.
Odostomia trifida or besuturalis or both	Commonest in the middle
Paludestrina minuta	Commonest near shore
Polynices heros	No specimens found but pelecypod shells with <u>P. heros</u> drill holes were commonest in the middle.
Retusa pertenuis	

Station 2. Shipyard Point

Dredgings were made on September 30, 1943, at three places on the western side of the bar where the water was 1', 5' and 15' deep at low tide. Bottom sandy at 15'; sand-mud at 5'; mud-sand at 1'.

<u>Species</u>	<u>Remarks</u>
<u>Pelecypods</u>	
Cardium pinnulatum	Two dead shells: 15'. One living specimen: small: at 15'.

Pelecypoda (Continued)

<i>Ensis directus</i>	One living specimen : small, at 15'
<i>Gemma gemma</i>	A few specimens at 5'
<i>Mys arenaria</i>	Abundant at 5'
<i>Mytilus edulis</i>	Only in deep water: common
<i>Mulina lateralis</i>	Abundant at 1' : a few at 5'
<i>Ostrea virginica</i>	At all depths: abundant
<i>Petricola pholadiphormis</i>	A few shells at 15' : none living
<i>Yoldia limatula</i>	At 5' and 15' : not common

Gastropoda

<i>Bittium alternatum</i>	Only in deep samples
<i>Crepidula glauca</i>	Common at 5' and 15' : present at 1'
<i>Crepidula plana</i>	Common at 5' and 15' : present at 1'
<i>Littorina saxatilis</i>	Found at 5' and 1'
<i>Mitrella lunata</i>	Found at 5' and 1'
<i>Odostomia trifida</i> or <i>besuturalis</i> or both	At all depths but commonest at 1'
<i>Paludastrea minuta</i>	Found at 15'
<i>Polynices heros</i>	One small specimen at 15'
<i>Retusa pertenuis</i>	Common at 5'
<i>Triphoris perversa nigrocincta</i>	1 specimen at 15' : not common
<i>Turbonilla nivea</i>	1 specimen at 15'

Station 3. Landing Stage of Biological Station

On October 1, 1943, samples were taken at low tide at (1) half-tide mark (2) at 1' depth and (3) 8' depth. The bottom at these three levels is of firm sand, sand-mud with some eel grass and soft black muck respectively.

<u>Species</u>	<u>Remarks</u>
<u>Pelecypoda</u>	
<i>Cardium pinnulatum</i>	1 shell valve found at 8'
<i>Gemma gemma</i>	Common at half-tide level and 1'
<i>Macoma baltica</i>	One 15 mm. specimen and several small ones at 1'
<i>Modiolus demissus</i>	At $\frac{1}{2}$ tide and at 8'
<i>Mytilus edulis</i>	A few shells at 8'
<i>Mulina lateralis</i>	Several at 1' rare at 8'
<i>Mys arenaria</i>	At $\frac{1}{2}$ -tide and at 1'
<i>Ostrea virginica</i>	At all depths
<i>Petricola pholadiphormis</i>	One shell valve at 1'
<i>Tellina tenera</i>	At 1' and 8'
<i>Venus mercenaria</i>	Eight 1943 spat at 1'
<i>Yoldia limatula</i>	Present at 1' but commonest at 8'

<u>Species</u>	<u>Remarks</u>
<u>Gastropods</u>	
<i>Bittium alternatum</i>	Present at $\frac{1}{2}$ -tide and 1'
<i>Crepidula plana</i>	Present at $\frac{1}{2}$ -tide; common at 8'
<i>Crepidula glauca</i>	" " " " " "
<i>Littorina littorea</i>	In $\frac{1}{2}$ -tide and 8' samples
<i>Littorina saxatilis</i>	Common at $\frac{1}{2}$ -tide: a few at 1'
<i>Mitrella lunata</i>	One dead shell at 8' and 1'
<i>Nassarius obsoleta</i>	In all samples : commonest at $\frac{1}{2}$ -tide
<i>Retusa pertenuis</i>	In all samples : common at 1' and 8'
<i>Turbonilla nivea</i>	In $\frac{1}{2}$ -tide and 8' samples

The work has advanced far enough to permit a few generalizations of the broadest sort.

The molluscan fauna of Biddeford river is clearly of the "Virginian" type described by Ganong (1890). This fact is emphasized by new discoveries like that of *Tringorhis perversa nigroincta* in our area.

The small size of many of the forms that belong to the warm water fauna has had two effects. Their discovery in Canada has been delayed and, once discovered, new information on their distribution has accumulated very slowly.

There are already bits of evidence that suggest a stratification of species both with depth and with position in the river system. Further collecting should clarify these relationships.

Besides the general value these observations have to malacologists they will have more immediate uses. All the information concerning bivalves will be of direct importance to Miss C. M. Sullivan who is now studying the development and working out the specific identity of various bivalve larvae occurring in our waters.

A collection of identified material is being kept at the station to aid in checking identification of specimens obtained by the staff or brought in by the public.

Part of the collecting and much of the work of sorting and preservation was done by Miss E. I. Morrison who was employed as technician at the P.E.I. Biological Station in 1943. It is planned to continue the work in 1944.

SECTION XVI

Observations on Adult Tray-Reared Enmore Oysters

Tray rearing of oysters to the adult stage has been suggested as one method of overcoming the disadvantages of soft bottoms which make oyster culture impossible in some areas. In November there was a chance to examine disease-resistant oysters, tray-reared from Bide-river spat of the 1940 set in Enmore river during 1941, 1942, and 1943. A random sample of the stock was brought to the laboratory on November 5, 1943. The following average values were derived from observations made on two groups of five typical specimens.

Total volume	67 ml.
Shell volume	35 ml.
Shell weight	78 gm.
Index of Condition	111
<u>Shell Capacity</u> Shell Volume	94%
<u>Shell Volume</u> Total Volume	49%
Specific Gravity of Shells	2.26

Besides the above observations linear measurements in mm. of length, width and thickness were recorded for the same ten oysters and the ratios/width and thickness to length were calculated. The results appear below.

Length	Width	Thickness	<u>Width</u> Length %	<u>Thickness</u> Length %
104	68	26	65	25
103	75	26	73	25
107	73	29	68	27
105	69	26	66	25
102	74	25	73	24
104	68	25	26	25
105	72	28	28	27
105	76	72	34	32
100	68	68	26	26
103	69	67	25	24
	Mean		69%	26.0%

A comparison of these values with those reported for other stocks at the same season (see section of this report entitled "Shell Proportions" and Medcof 1939 and 1940.) leads to the following conclusions:

1. Compared with most "Fancy-Shape" grade oysters, the present stock is rather thin and narrow.
2. The uniformity in size and in the proportions of length and thickness to length is most remarkable.
3. The shell specific gravity is of intermediate value.
4. The size of the cavity within the shells is very large relative to the total volume of the shell and oysters.
5. These oysters seem to be more efficient than bottom-reared stocks because their shell weight per unit of meat contained (shell capacity) is very low. A barrel should hold more of these by count than of the more irregular bottom-reared oysters and should, therefore, command a higher price.

SECTION XVII

Shell Erosion and Anaerobic Respiration in Oysters

In an earlier report (Medcof 1942) a description was given of a fine etching of the inner face of oyster shells that appeared during winter storage. It resembled that observed by Dugal (1939) in air-stored quahaugs which was shown to result from anaerobic respiration.

In the writer's opinion either June or September would be a better time for such a study in oysters because then there is an active secretion of glassy pearly shell on which the etchings might be expected to show up more conspicuously than they do on the "hard flat" surface (Medcof 1942) that is characteristic of winter shells. It is regrettable, therefore, that in 1943 there was no opportunity for the study until November when the oysters had already gone into hibernation. The observations fall into two groups.

- I. Records were kept of the appearance of shells of oysters used in condition tests between November 6th and 11th. These are summarized in Table XXIII. The notation is the same as that used in the earlier report (Medcof 1942).
- II. Successive samples were drawn from a lot of 125 oysters fished at 11:30 a.m. on November 11 from the bed at the end of the landing stage, opened, and the shells washed immediately in fresh water, air-dried on the laboratory table and examined for etching. The records from this test appear in Table XXIV. During this test the number of upper and lower valves showing etching were separately recorded. Etched lower valves outnumbered upper by almost exactly 3 to 1.

Conclusions

A study of tables XXIII and XXIV suggests the following conclusions.

1. There is no clear relationship between the extent of etching of shells and the length of the period of air storage. Apparently oysters and quahaugs behave differently when stored in air.
2. Usually slightly more than half the oysters and valves in November oysters showed etching.
3. There is little variation in the extent of etching in oysters taken from different beds.
4. Etching is much commoner and more conspicuous in lower than in upper valves.
5. It would be worth while repeating these observations some time in June or September to see if there is any difference in the reactions of hibernating oysters and those that are actively secreting shells.

Table XXIII. Results Group I. The proportion in various lots of valves and oysters that were etched.

Date	Description of Sample	Period of air-storage hours	Proportion showing etching	
			Oysters	Valves
Nov. 6	Sample from Lot #28 of growth test fished 9:30 am opened 8:30 p.m.	11	7/10	8/20
9	Sample from Lot #28 fished Nov. 6 and air stored	72	5/10	8/20
6	Sample from Lot #29 of growth test fished 9:30 am opened 9:50 am	0.3	6/10	8/20
9	Sample from Lot #29	72	7/10	10/20
10	Sand bed oysters fished 11:00 am opened 2:30 pm	3.5	7/10	10/20
10	Ellis cove bed oysters fished 10:30 am opened 2:50 pm	4.8	8/10	10/20
11	Native oysters from bed on Forbes area fished Nov. 10	24	8/10	11/20

Table XXIV. Results Group II. The proportion of oysters and valves in samples drawn at different times from a lot of stage bed oysters fished 11:30 am Nov. 11th and air-stored in the laboratory.

Period of air-storage Hours	Proportion showing erosion	
	Oysters	Shells
0 (opened immediately)	2/25	12/50
1.5	17/25	24/50
3	13/25	18/50
4	14/25	21/50
5	8/12	9/24
22	7/12	10/24

SECTION XVIII

Specific Gravity of Oyster Shells

During the year several determinations of shell specific gravity besides those recorded elsewhere in this report were made and it is thought worth while recording them here. Like the rest, these determinations were all made on fresh shells that "were wet but not dripping". Some were made by the overflow method and others by weighings in air and water. To provide a strict basis for the comparison of these two types of results the specific gravity of two lots of six shells from Malagash, N.S., were measured by the two methods with the following results:

Lot No.	<u>Specific Gravity as Determined</u>	
	By overflow method	By method of weighing in water and air.
1	2.40	2.39
2	2.21	2.23

Lot 2 contained shells of two oysters that were badly attached by the boring sponge and this accounts for its lower specific gravity.

The agreement between the estimates of specific gravity of the two lots by the two methods are so good that it is justifiable to list the following results without specifying the method by which the determination was made.

Table XXV. Specific Gravity of Oyster Shells from Various Sources.

Stock	Shells Specific Gravity
<u>Bideford River</u>	
1. Adults $3\frac{1}{2}$ - $4\frac{1}{2}$ " long) from mud bottom just above warehouse in 5' of water	2.08
2. Adults from same area but on sand bottom nearer shore, water $2\frac{1}{2}$ ' deep	2.29
3. Floating tray No. 6 stock ($1\frac{1}{2}$ " long) at Forbes area	2.31
4. Fixed submerged tray No. 15 stock (2 - 3 " long) Forbes area	2.30
5. Claude Williams' creek tray stock ($1\frac{1}{2}$ " long)	2.24
Bentinck cove tray stock ($1\frac{1}{2}$ " long)	2.24
Beaton & Simmons deep water lease off Curtain Island (adults)	2.44
Enmore tray reared (adults)	2.26
Tracadie, N.B., adults	2.33
Quoi c'est ça (Miramichi river) adults	2.24
Negusc Beach stock ($2\frac{1}{2}$ - 3 " long)	2.48
Malagash, N.S.	2.40

SECTION XIX

On Shell Proportions and Shell-Liquor Content of Oysters

It has often been stated that poor low-quality oysters have more shell liquor than fat ones. Two lots of 25 market-sized oysters, one of first grade Cooper bed stock reared from "collector spat" and the other of sub-standard quality poor stock from the Forbes bed were fished November 19 and subjected to various measurements in lots of five each.

Before cutting out the meats an oyster knife was inserted between the valves of each oyster in turn far enough to pry them apart slightly without cutting into body tissues. This allowed the shell liquor to drain into a vessel for measurement. The volume of the meats was estimated to the nearest ml. by measurement in a 200 ml. graduate.

The results are summarized in Table XXVI. A comparison of the records indicate:

1. Poor quality oysters contain more shell liquor and less meat (86% by volume) per unit of shell capacity than high quality stock (31%).
(a)
2. Their shells have (a) lower specific gravity; (b) a greater shell capacity per unit of shell volume; (c) a greater shell capacity per unit of total volume of the oyster.
3. The above records are in good agreement with those reported earlier (Medcof 1938, 1940 and 1941).

Table XXVI. Shell properties of Cooper bed and Forbes bed oysters measured in lots of 5 each

Total Vol.	Shell Vol.	Shell Weight	Shell Specific Gravity	Shell Capacity ml.	Vol. of shell Liquor ml.	Vol. of Meats of gn.	Weight of Meats of gn.	Specific gravity meats	Sh.Cap. Volume %	Sh.Cap. Total vol. %	
<u>Cooper Bed Oysters May. 19</u>											
303.5	204.9	493.1	2.42	99.6	5.7	90	93.9	1.04	49	33	
298.4	186.7	468.9	2.38	101.7	6.0	91	94.2	1.04	50	34	
277.8	181.9	429.3	2.36	98.0	5.2	87	88.0	1.06	53	35	
308.8	203.8	478.3	2.34	102.0	7.6	90	88.7	1.06	51	34	
282.0	187.3	424.6	2.28	96.7	3.3	90	94.7	1.06	52	34	
Mean Value per oyster	58.8	89.0	91.7	2.36	12.8	1.1	17.9	18.3	1.05	51	34
<u>Forbes Bed Oysters May. 19</u>											
278.7	177.1	378.3	2.13	101.6	10.8	85	80.2	1.06	50	36	
309.4	184.0	394.7	2.14	122.4	12.4	106	110.8	1.09	66	40	
278.8	168.2	361.8	2.15	107.3	16.4	80	88.7	1.04	64	39	
271.4	168.0	358.5	2.12	103.4	9.0	82	98.8	1.05	61	36	
279.4	180.8	398.7	2.18	98.9	10.0	84	80.0	1.05	53	36	
Mean Value per oyster	56.5	85.2	75.6	2.14	21.3	2.3	18.3	19.1	1.05	61	36

SECTION XX

The Autumn Fatness of Malpeque Oysters 1939-1943

This fall several fishermen reported that upriver oysters were fatter and that downriver oysters were poorer than usual. To judge the truth of this report condition tests were made on samples of oysters from the Cooper bed, the Sand bed, Ellis cove bed, Beston and Simmons deep-water lease off Curtain Island and Brenton Clark's lease in Bentinck cove. The index values together with those for earlier years which have appeared in the writer's successive annual manuscript reports to the Fisheries Research Board since 1938, are set forth in table XXVII. A comparison of these supports the following conclusions:

1. The Cooper bed stock exhibits a remarkable uniformity throughout the years.
2. The two records for the Sand bed show no important difference in fatness in the autumns of 1942 and 1943.
3. Ellis cove oysters were fatter than they were in 1941.
4. The Beston and Simmons and Clark oysters were poor for bay oysters and the single earlier record (Medcof 1939) suggests that 1939 was a better year for fattening of bay oysters than 1944.
5. There seems to be some justification for the report, referred to above concerning the fatness of oysters in 1944, but the differences are not consistent throughout the Malpeque area.

Table XXVII. Autumn values for index of condition of Malpeque oysters 1939-1943.

Area	1939	1940	1941	1942	1943			
Cooper bed	Nov. 16	124	Oct. 23	128	Oct. 16	117	May 19	122
							July 9	111
Higher part	Dec. 13	114	Nov. 21	117	Nov. 16	114	Nov. 8	126
							Oct. 7	128
							Nov. 29	119
Sand bed Bideford river					Oct. 8	100		
					Nov. 9	96	Nov. 10	93
Ellis Cove Bideford River			Nov. 6	62			Nov. 10	93
Beston & Simmons lease in deep water off Curtain Island	Dec. 1	122					Nov. 15	106
							Nov. 15	105
Brenton Clark's lease in Bentinck Cove							Nov. 15	105

SECTION XXI

Size-Frequency Distribution in an stable natural population of oysters

On July 29 random samples of oysters were fished with oyster tongs from a dory at MacDonald's point in the Wilmot river and at Coles' wharf in the Dunk river in Summerside harbour, P.E.I., at points that had not been disturbed since last year by the fishermen. The individual lengths of the oysters were measured and the results are summarized in the accompanying table. Data similar to these have been gathered for stocks at Shediac, Tracadie, Shippigan and some parts of the Miramichi which are all considered abnormal and have been presented either in this or earlier reports.

The size composition of these may be considered typical of natural stocks that have maintained if not increased their numbers in spite of public fishing. It is seen to differ somewhat in the two samples but in both it lacks the erratically unequal distribution that characterizes the four populations referred to above which are considered unstable. The present observations, therefore, since they apply to what is known to be a stable population, lend support to the earlier conclusion that artificial culture methods should be resorted to if areas with unstable populations are to be used most efficiently.

Table XXVIII. Size-frequency distribution of oysters in random samples taken during the survey of the Summerside harbour area.

Length in mm.	Dunk River	Wilmot River	Length in mm.	Dunk River	Wilmot River
	Frequencies			Frequencies	
0 - 5	1	3	65 - 70	5	14
5 - 10	7	24	70 - 75	3	14
10 - 15	15	14	75 - 80	5	22
15 - 20	14	10	80 - 85	5	22
20 - 25	11	7	85 - 90	11	19
25 - 30	4	6	90 - 95	4	22
30 - 35	3	4	95 - 100	5	10
35 - 40	1	3	100 - 110	9	21
40 - 45	0	1	110 - 120	8	20
45 - 50	1	6	120 - 130	9	7
50 - 55	2	2	130 & above	<u>12</u>	<u>3</u>
55 - 60	3	8	Totals	138	269
60 - 65	9	7			

SECTION XXII

Spawning of Oysters on the Half-Shell

On June 28 a live oyster whose right valve had been carefully removed so as to avoid damage to all tissues except the adductor muscle which was severed at its insertion in the shell, was being examined in a shallow dish of sea water in the laboratory. Its heart was beating regularly, its ciliary currents were strong and in general it seemed to be behaving normally. Approximately half an hour after it was opened it began to spawn - it was a male - and continued spawning for a quarter of an hour. Then other oysters brought in at the same time but left entire in a similar vessel of sea water began spawning a few minutes later. All three proved to be males.

Several studies of spawning activity are reported in the literature (Galtsoff 1938 a & b, Nelson 1922) but as far as the writer is aware no advantage has been taken of the fact that the process can be studied after removal of the valve.

Section XXIII

Factors Regulating Spatfall

It was proposed to study factors regulating spatfall in Bideford river in 1943 using the same type of collectors as those employed in the Bras d'Or lakes (Medcof 1939 & 1940). The Bras d'Or collectors proved unsatisfactory as Miller (1940) also found. No. satisfactory substitute for the vertical series of shells like those used in 1937 (Medcof 1937) was found. These have objectionable features, the chief being lack of uniformity. Several trials with different types of collectors to detect differences in intensity of spatfall during four-hour intervals, day and night, though very laborious, proved to be fruitless. It was hoped that the effects of tidal currents, light intensities and possibly wind action would be illustrated.

REFERENCES

- Adams, J. R. Investigations at Malagash, N.S., 1939. Summary Report, Appendix No. 33 to Ann. Rep. Atl. Biol. Stn. for 1939.
- Bain, F. The shells of Prince Edward Island. Canadian Science Monthly (Publication of Acadian Science Club) 3(3):33-35, March, 1885.
- Batchelder, C. H. Migration of Ilyanassa obsoleta, Littorina littorea & L. rudis. Nautilus 29:43-47, 1915.
- Cayeux, T. Etude systematique des organismes. Mem. pour servir a l'explication de la carte geologique detaillee de la France, 1916.
- Clarke, F. W. and W. C. Wheeler. The inorganic constituents of marine invertebrates. U.S. Geol. Surv. Prof. Paper #124:1-22, 1922.
- Dawson, J. W. (assisted by B. J. Harrington) Report on the geological structure and mineral resources of Prince Edward Island, 1871. John Lovell, Montreal.
- Dumont, W. H. Shucking oysters - one of New Jersey's growing industries. N. J. Agri. Exp. Sta. Bull. 418, 1925.
- Douville, H. Le test des Ostreides du groupe de l'Ostrea scaberrima (genre Pycnodonta F & de W) et le test des Rudistes. C. R. Acad. Sci. Paris 203 (22): 1113-1117, 1936.
- Field, J. A. Biology and economic value of the sea mussel, Mytilus edulis. Bull. U. S. Bur. Fish. 38:128-259, 1922.
- Fisheries Statistics. Can. Dept. Trade Comm. Fish. Stat. 1925-41.
- Fox, D. L. and W. R. Coe. Biology of the California sea-mussel (Mytilus californianus) II. Nutrition, metabolism, growth and calcium deposition. J. Exp. Zool. 93(3):205-249, 1943.
- Galtsoff, P. S. Physiology of reproduction of Ostrea virginica. I Spawning reactions of the female and male. Biol. Bull. 74:461-486, 1938.
- Galtsoff, P. S. Physiology of reproduction of Ostrea virginica: II Stimulation of spawning in the female oyster. Biol. Bull. 75:286-307, 1938.
- Ganong, W. F. The marine mollusca of New Brunswick. Bull. Nat. Hist. Soc. N.B. 6:17-61, 1887.

- Ganong, W. F. The economic mollusca of Acadia. Bull. Nat. Hist. Soc. N.B., 8:1-116, 1889.
- Ganong, W. F. Zoological Notes. Bull. Nat. Hist. Soc. N.B., 9:46-59, 1890(a).
- Ganong, W. F. Southern invertebrates on the shores of Acadia. Trans. Roy. Soc. Can. 8(4):167-185, 1890(b). N.S. Inst. Sci. Halifax.
- Gould, A. A. Report on the invertebrata of Massachusetts. Write & Patter, Boston, 1870.
- Grave, C. A manual of oyster culture in Maryland. Rep. of Shellfish Comm. of Maryland. 4:279-349, 1912. Baltimore.
- Gutsell, J. S. The World's oyster industry. "Marine Products of Commerce" by Tressler, pp. 504-532. J. J. Little and Ives Co., New York, 1923.
- Hunter, A. C. and C. W. Harrison. Bacteriology and chemistry of oysters with special reference to regulatory control of production, handling and shipment. U.S. Dept. Agric. Tech. Bull. 64:1-76, 1928.
- Huntsman, A. G. The effect of light on growth in the mussel. Trans. Roy. Soc. Can. 15:23-28, 1921.
- Ingalls, R. A. and A. W. H. Needler. Preliminary report on shore mollusc resources of the Northumberland strait coast of Nova Scotia. MSS Rep. Biol. Stns. Fish. Res. Bd. Can. #161:1-16, 1939.
- Ingalls, R. A. and A. W. H. Needler. A report on shore mollusc resources of the Northumberland strait coast of Nova Scotia. MSS. Rep. Biol. Stns. Fish. Res. Bd. Can. #333, 1940.
- Kerswill, C. J. Some environmental factors limiting growth and distribution of the quahaug, Yanus mercenaria L. MSS. Rep. Biol. Stns. Fish. Res. Bd. Can. #187, 1941.
- Kerswill, C. J. and A. W. H. Needler. Report on oyster culture work under the Department of Fisheries for the year 1941-42. Ann. Rep. Dept. Fish. 12, Appendix 5: 89-97, 1942.
- Kerswill, C. J. Report on oyster culture work under the Department of Fisheries for the year 1942-43. Ann. Rep. Dept. Fish. 13, Appendix 4:103-112, 1943.
- Kerswill, C. J. The spat failure in 1941. Fish. Res. Bd. Can. Oyster Farming Circ. #16, 1943(a).

- Kindle, E. M. and E. J. Whittaker. Bathymetric check list of the marine invertebrates of eastern Canada with an index to Whiteaves' catalogue. Contrib. Can. Biol. 1917:229-294.
- Leim, A. H. The fauna of Minas channel, Minas Basin and the Shubenacadie river. Orig. MSS Atl. Biol. Stn. #278, 1923.
- Leosanoff, V. L. and J. B. Engle. Polydora in oysters suspended in water. Biol. Bull. 85(1):69-78, 1943.
- Luns, G. R. Polydora, a pest in South Carolina oysters. J. Elisha Mitchell Sci. Soc. 57(2):273-283, 1941.
- Luns, G. R. The yield of certain oyster lands in South Carolina. Amer. Mid. Nat. 30(3):806-808, 1943.
- Medcof, J. C. Report of oyster studies at the P.E.I. Biological Station June to September, 1937. MSS. Rep. Biol. Stns. Biol. Bd. Can. #160, 1937.
- Medcof, J. C. Oyster investigations in the Bras d'Or lakes. MSS. Rep. Biol. Stns. Fish. Res. Bd. Can., #159, 1936.
- Medcof, J. C. Oyster investigations in the Bras d'Or lakes and studies on the condition factor of oysters. MSS Rep. Biol. Stns. Fish. Res. Bd. Can. #162, 1939.
- Medcof, J. C. Oyster investigations in 1940. MSS. Rep. Biol. Stns. Fish. Res. Bd. Can. #184, 1940.
- Medcof, J. C. Oyster investigations in 1941. MSS. Rep. Biol. Stns. Fish. Res. Bd. Can. #239, 1941.
- Medcof, J. C. Report on 1942 investigations. MSS Rep. Biol. Stns. Fish. Res. Bd. Can. #331, 1942.
- Medcof, J. C. and A. W. H. Needler. The influence of temperature and salinity on the condition of oysters (Crassostrea virginica). J. Fish. Res. Bd. Can. 6(3): 253-257, 1941 (a).
- Miller, M. Prediction of oyster sets and notes on the rearing of bivalves under laboratory conditions. MSS Rep. Biol. Stns. Fish. Res. Bd. Can. #203, 1940.
- Mobius, K. The oyster and oyster culture (1880). U.S. Comm. of Fish & Fisheries, Part VIII, pp.683-1040, 1883.
- Needler, A. W. H. Oyster farming in Eastern Canada. Bull. Fish. Res. Bd. Can. 60:1-83, 1941.

- Nelson, T. C. Ann. Rep. for 1921, Dept. Biol. N. J. Agri. Col. Exp. Stn. 34:287-299, 1922.
- Nelson, T. C. Oysters. Ann. Rep. 1940-41, N. J. Agri. Exp. Stn. Rutgers Univ. New Brunswick, N. J. pp. 108-110, 1941.
- Orton, J. H. and C. Amirthalingam. Notes on shell deposition in oysters with a note on chemical composition of "chalky" deposits in shells of O. edulis. J. Mar. Biol. Assoc. 14(4):935-954, 1927.
- Shutt, F. T. Powdered clam shell. Rep. Dom. Chemist for year ending March 31, 1923, p.9, 1924.
- Shutt, F. T. Broken sea shells. Rep. Dom. Chemist for year ending March 31, 1926, p. 45, 1927.
- Shutt, F. T. Analysis of poultry grits. Rep. Dom. Chemist for year ending March 31, 1930, p.85, 1931.
- Sumner, F. B., R. C. Osburn and L. J. Cole. A biological survey of the waters of Woods Hole and vicinity, (1911). Bull. U.S. Bur. Fish #31, 1913.
- Tester, A. L. Population of herring (Clupea pallasii) in coastal waters of British Columbia. J. Biol. Bd. Can. 3(2):108-144, 1937.
- Verrill, A. E. Report upon the invertebrate animals of Vineyard Sound and the adjacent waters, etc. Rep. U.S. Fish. Comm. 1871-73, pp. 295-778, 1873.
- Whiteaves, J. F. Catalogue of the marine invertebrata of Eastern Canada. Geological Survey of Canada, Ottawa, 1901, pp. 1-271.