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SPAWNING OF OYSTERS AND SETTLEMENT OF SPAT,
BIDEFORD RIVER, 1931.

by

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BIOLOGICAL BOARD OF CANADA

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This report brings together records of spawning and settlement and growth of spat in Bideford river in 1931. The data, which have long been on hand, are especially interesting at this time in connection with J. C. Medcof's work on the spawning and spat fall in Bideford river with special reference to the length of the larval period, the growth of the larvae and the accurate prediction of sets. While these data do not suffice for an accurate determination of the length of the larval period they do provide corroborative evidence.

The data consist of records of spawning in oysters examined by Mrs. Needler, in observations of spawning by the writer in connection with the direction of spat collection operations, in measurements of spat on experimental shell bags placed in the water at various dates and in records of the total settlement of spat on the bags.

The observations of spawning were estimations of the proportion of spawning which had been completed by the oysters under examination. It is obvious that examinations of this sort cannot give any accurate figure for the proportion of eggs which have been shed. The estimates are particularly subject to personal error and although such terms as " $\frac{1}{2}$ spent", " $\frac{1}{4}$ spent", etc. are used these are only arbitrary designations with relative rather than absolute significance. It may be safely believed that oysters called " $\frac{1}{2}$ spent" have done more spawning than those called " $\frac{1}{4}$ spent" but it is extremely doubtful whether the fractions are at all close to the proportion of spawning which has taken place. A number of factors may increase the difficulty of estimating the proportion. The oysters may commence spawning before all are ready, so that the initial appearance before any spawning varies considerably. Even when ready to spawn oysters vary considerably in the quantity of eggs. These and other factors added to the inherent difficulty of estimating the proportion of eggs shed even if all oysters were alike, render the observations of very vague significance. They have, however, some value. They indicate when some spawning takes place, approximately when it starts and approximately when the oysters are largely spawned out. It seems probable to the writer that examinations of this kind are less reliable in the early than in the late stages of spawning. It seems more probable that a large amount of spawning will go unnoticed in the early part of the season. This is borne out by the observations in 1931 and by later experience, and is of significance in using examination of oysters as an indication of when to put out materials for spat collection. Without observations on the larvae and depending on examination of the oysters and on temperatures alone, there is considerable danger of missing an important early "set".

The data and observations follow.

Spawning. Observations by A. B. Needler, principally the examination of gonads, may be summarized as follows:

Grant's bed, May 29. Spawn forming in some.

Grant's bed, June 9. A few nearing maturity but little or no spawn evident in most.

Grant's bed, June 16. Oysters mostly with little spawn. Immature eggs present. Some oysters sickly in appearance.

Grant's bed, June 29. Drilled oysters all with enough sexual products to show sex.

July 2. A great many oysters in shallow water below the station building were observed spawning vigorously.

Grant's creek	Spent or almost spent	0	fem.	12	males	
July 2	$\frac{1}{2}$ spent.	2	"	3	"	
	$\frac{1}{4}$ spent.	4	"	5	"	2 her
	$\frac{1}{8}$ spent	0	"	5	"	
	Just starting.	1	"	0	"	
	Immature.	2.				
At laboratory, July 13.	Shallow water.					
	Spent or almost.	8	"	11	"	??
	$\frac{1}{2}$ spent.	8	"	6	"	
	$\frac{1}{4}$ spent.	8	"	1	"	
	$\frac{1}{8}$ spent or ripe.	None.				
Fred England point, July 16						
	Spent or almost	0	"	0	"	
	$\frac{1}{2}$ spent.	3	"	1	"	
	$\frac{1}{4}$ spent.	6	"	7	"	
	$\frac{1}{8}$ spent.	5	"	2	"	
	Barely spawning.	0	"	1	"	
Grant's bed.	Spent or almost	2	"	3	"	
July 16	$\frac{1}{2}$ spent.	12	"	1	"	
	$\frac{1}{4}$ spent.	12	"	13	"	
	$\frac{1}{8}$ spent.	5	"	6	"	
	Barely spawning.	1	"	0	"	
Grant's bed.	Spent or almost	10	"	10	"	12?
July 23	$\frac{1}{2}$ spent.	2	"	1	"	
	$\frac{1}{4}$ spent.	3	"	3	"	
	$\frac{1}{8}$ spent.	0	"	1	"	
	Ripe or just starting.	None				
Grant's bed.	Spent or almost.	7	"	5	"	35 ?
Aug. 7	$\frac{1}{2}$ spent.	0	"	1	2	
	None $\frac{1}{8}$ spent or less.					

Grant's bed, August 12 and 31. All spent or nearly so.

Observations by the writer, added to the above, indicate the course of spawning as follows. Some spawning occurred about June 20 in shallow water especially in the creeks, but apparently affected deeper oysters little or none. The next active spawning came on July 2 to 6 approximately, leaving the oysters in the creeks and in shallow water near the station

over half spent but leaving much spawn in the oysters in deeper water. Some spawning probably occurred in the very warm spell about July 11 and by July 23 the oysters even in deep water (near the head of the river) were pretty well spent. After that date the small remaining spawn was released.

Temperatures. Temperatures observed in 1931 at Station 2001 (mouth of Paugh's creek or Paugh's bed), at Station 2002 (Pulpit bed in lower part of Departmental reserve) and at Station 2003 (Bideford river just below station) are given in a report "Hydrography of the Malpeque bay area. II. Data for the open water of 1930, 1931 and 1932" presented by the writer in 1935. They are summarized here from the point of view of spawning and for easy comparison with the other data.

The temperature remained well below the spawning level (about 20 deg. Cent.) until about June 20. On that date a temperature above 20 degrees was recorded at the surface at Station 2001 but not at the other two. Spawning temperatures may have occurred immediately before and after this date, especially in shallow water and in the creeks.

The temperature then dropped again, falling below 15 degrees on June 29. It then increased rapidly reaching about 23 degrees at the surface at 2001 on July 3 and the bottom water passing 20 degrees on the following day. On July 2 oysters were observed spawning vigorously in shallow water near the laboratory and a general spawning burst is highly probable at this time, apparently with sufficiently high temperature in deep water for the first time.

After July 4, temperatures fell slightly again but not below 20 degrees. From July 8 to 10 they again rose slightly and from July 10 to 11 very rapidly to a peak of over 27 degrees at 2001, the highest reading of the summer.

Temperatures fell again in the following days, passing below 20 degrees at Station 2001 on July 17 to 20. They then rose again to over 21 degrees on July 21 and remained very high for the rest of the month.

Throughout August the temperature remained about 20 degrees or above with many minor variations the most pronounced of which was a dip to about 20 degrees in the first five days of the month followed by a rise to over 23 degrees on the sixth.

The above variations are based on temperatures at 2001. At 2003 the figures indicate similar variations but are not so complete. At Station 2002, the most seaward of the three, the same variations are shown but with less range. Thus in early July the readings show a more general rise to the peak on July 11 with the minor peak about July 2 - 3 not so evident.

To summarize: The above data indicate probable spawning bursts, due to temperatures rising through the 20 degree level or to sudden rises above this level, at the following times.

About June 20. The first passing of 20 degrees in shallow water but apparently not in deep water.

About July 2. A rise from below 15 degrees to above 20. Affecting deep as well as shallow water by July 4.

About July 11. A sudden increase from above 20 degrees to the peak temperature of the year.

About July 21. An increase from below 20 degrees to over 21 degrees followed by a continued rise.

About August 5. A minor increase from about 20 degrees to over 23 degrees.

Settlement of spat. Observations on the settlement of spat include rough notes of the presence or absence of newly settled spat on culch examined by the writer and records of the number of spat obtained on experimental bags of shells placed along the shore almost daily at Grant's point (mouth of Faugh's creek) and at the laboratory, and measurements made August 12 to August 14 of spat on the latter. The total number on the experimental bags was the average of two bags counted in October when all surviving spat were large enough to be obvious. The measurements were of all the spat on sample shells taken in each case from a number of places in the bag.

On the basis of a probable spawning burst in shallow water about June 20 and an observed spawning burst on July 2 the placing of bulky culch (broadcast shells) was commenced at the beginning of July. Wire bags of shells (which can be handled quickly were not placed in the water until July 14 - 15 at Faugh's creek and July 20 farther down the inlet at Shipyard point and Claude Williams' shore. All of the culch placed along the shore or on shallow beds received a heavy set, the heaviest being on the bags along the shore at Faugh's creek.

Examinations of shells showed no set before July 15. Shells examined then and on the eighteenth showed that a very heavy set occurred in Faugh's creek on July 15 and 16 but fewer at the laboratory. This is reflected in table III. A few spat were still settling on the 18th, more now at the laboratory. Examination of shells on the 20th showed no spat which had settled on that day, but examinations on the 24th showed a few which had settled in the past two or three days, especially in Faugh's creek. Examinations on the 27th showed another heavy set on that day and immediately previously, much heavier at the laboratory than at Faugh's creek. This was the heaviest set at the laboratory as was that of July 15 and 16 at the creek. After that observations were very scanty but, combined with table III, they show that some settlement occurred as late as August 22.

The "small" spat of tables I and II included all below 0.5 mm. and consequently do not indicate necessarily a set on the date of examination. They are, however, very interesting in that they occur even on the first bags put out and in considerable numbers. Thus bags put out at the laboratory on July 14 to 20 obtained about 19 times as many spat (counted in October)

as those put out within a week of examination in August, but when examined they had 6.5% "small" spat which must have settled in that week. Thus they show a higher proportion of "small" spat than the total sets suggest, bearing mind, of course, that no allowance is made for mortality. In view of the fact that table III indicates that there is a considerable deterioration in the efficiency of cultch (highest total sets on bags put out just before heavy sets) the data suggest a heavy mortality of spat as the only explanation in view. They do indicate, too, that, although the efficiency decreased, it was in 1931 still considerable after many days in the water. This is corroborated by the occurrence of heavy sets on shells which were put out on shallow beds in the first week of July but on which no set could be found until the 15th.

To summarize, there was certainly a very heavy set on July 15 and 16 especially at Paugh's creek, and just before July 27 especially at the laboratory. Other peaks are not so plainly evident from the records. Some sets continued until late in August.

Discussion. The above data are limited but have value, especially when considered with data of other years. Some points of interest are summarized below.

1. Length of larval period. While not accurate or entirely conclusive by themselves the 1931 data are in accord with a larval period of about 25 days. There are two cases supporting this period.

Spawning apparently occurred about June 20 when temperatures suitably high were preceded and succeeded by such lower levels. Observations of oysters indicated limited spawning then. There was undoubtedly a very heavy set, especially in Paugh's creek, on July 15, and 16.

Between June 29 and July 3 there was a rapid increase in temperature from below 15 degrees to over 23 degrees. Surface temperatures rose first. Active spawning was observed near the laboratory on July 2 and examinations of oysters that day showed that considerable spawning had occurred both there and in Grant's creek, although later observations indicated that less had occurred in deeper water. A heavy set occurred on July 27 and immediately before, especially near the laboratory. The occurrence of some set on July 24 - 25 days after temperatures below 15 degrees - indicates that for some larvae at least the period is less than 25 days, but only slightly so. The heaviest set occurred near the laboratory 25 days after active spawning was seen there.

These two instances are clear. Other instances may be suspected, such as the apparent increase in set August 3 and 4. (table III) related with the temperature peak of July 11. The data corroborate the findings of Mr. Medcof in later years of a larval period of about 25 days.

2. Variations in different parts of the inlet. The data indicate that there was heavy spawning in the creeks about June 20 which did not extend to deeper water. The sets in table III are in general later at the laboratory with the largest set about July 27 instead of 15 to 16. The figures for Shipyard

No. of bag.	1	2	3	4	5	6	7	8	9	10	11
Fat out. July	14th	16th	17th	18th	20th	21st	22nd	23rd.	24th	25th	27th
Examined. August	13th	13th	13th	13th	13th	12th	13th	13th.	13th	13th	12th
Total No. of spat.	2955	4376	5380	5161	3417	4064	4827	3971	5277	6657	4329
No. in sample.	509	352	538	354	479	201	360	293	310	216	269
Numbers of each length, calculated from sample.											
Small (6 mm.)	46	233	490	394	227	81	603	490	463	1908	448
1 mm.	221	12	230	131	220	424	442	150	867	307	592
2	395	111	470	234	596	1030	857	490	1122	1384	1040
3	511	271	750	599	518	648	791	845	952	1503	860
4	401	541	650	482	440	566	657	887	1054	733	768
5	424	959	710	628	476	222	496	422	459	492	448
6	290	959	650	715	291	303	308	326	170	215	96
7	290	640	670	686	298	141	214	232	85	31	16
8	203	406	410	528	206	283	188	68	51	62	
9	87	98	230	467	78	121	147	82			
10	64	25	140	190	54		80		17		16
11	12	37		88		40	13				
12	12	37		29							

No. of bag.	12	13	14	15	17	18
Fat out. July	28th	29th	30th	31st Aug.	3rd	4th.
Examined August	12th	12th	12th	12th	12th	12th
Total No. of spat.	1499	2984	1147	764	623	538
No. in sample	307	1515	165	47	20	22
Number of each length, calculated from sample						
Small (6 mm.)	152	458	245	579	468	440
1 mm.	123	286	166	177	156	98
2	338	917	406			
3	431	687	287			
4	286	458	49			
5	162	76				
6	15					

Total number of spat on bags determined by counting after removal in October. It does not, therefore, include those which died small.

Nov. 19, 20 & 21 (August 6, 7 & 8) had only "small" spat, examined on August 12 No. 22 (put out August 11) had none on August 12.

Also measurements of # 1 on September 14.

Table II. Measurements of spat on shell bags put out at Grant's point, 1931.

No. of bag	1	6	11	16	17	18	19	20	21
Put out.	July	21st	27th	August 1st	3rd	4th	5th	7th	8th
Examined.	July	14th	14th	14th	14th	14th	14th	14th	14th
Total no. of spat.	7280	3106	2682	949	1307	414	336	291	123
No. in sample	271	405	233	15	41	7	4	12	5
Numbers of each length, calculated from sample:									
Small (0 mm.)	239	354	241	506	936	355	336	291	123

1 mm.	106	285	219	317	227	59			
2	212	639	516	127	96				
3	265	762	667						
4	424	485	575						
5	636	277	253						
6	1034	77	161						
7	1007	60	46						
8	1404	100							
9	954	39							
10	424	23							
11	292								
12	106								
13	53								
14	27								
15	27								

Table III. Spat on experimental bags of shells, Bideford river, 1931. Total numbers of spat on the bags in October.

<u>Date put out.</u>	<u>Grant's point</u>	<u>At station.</u>	<u>Number</u>
July 14th	7280	2955	1
16 th	4463	4376	2
17th	4723	5380	3
18th	3697	5161	4
20th	3316	3417	5
21st	3106	4062	6
22nd	4631	4827	7
23rd	2942	3971	8
24th	4159	5277	9
25th	2642	6657	10
27th	2682	4329	11
28th	2557	1499	12
29th	556	2984	13
30th	198	1147	14
31st	346	764	15
Aug. 1st	949	324	16
3rd	1307	623	17
4th	414	535	18
6th	336	241	19
7th	291	318	20
8th	123	282	21
11th	71	164	22
14th	None put out	120	23
18th	"	113	24
20th	"	49	25
Put out July 31st. at Claude Williams' creek			3034
Put out July 31st. at Cooper bed.			1203
Put out July 31st. at Shipyard point.			2568
Put out July 31st at Ellis cove.			1362
Put out July 31st. at MacKay's point			976

point, Claude Williams' creek and Cooper bed suggest that the set was, on the whole, even later farther seaward. The later occurrence of the set farther down the inlet is an important point to be borne in mind in prediction of sets. Predictions apply only to limited areas.

3. Decrease in efficiency of cultch. Table III indicates that there was in 1931 a considerable decrease in the efficiency of cultch within a few days after placing in the water. At the laboratory the bags put out on July 25 and 26 obtained more spat, presumably from the heavy set on July 27, than did those put out a few days earlier. The big total sets occurred on bags placed in the water immediately before the heavy sets. This is in accord with the results in 1930 when variations in the total sets obtained on bags, at Claude Williams' shore especially, closely paralleled variations in the number of larvae ready to settle at the time the bags were placed in the water.

But the decrease in efficiency was not definitely shown to be so great that bags placed in the water (e.g. at laboratory July 20 to 23) a few days before heavy sets did not catch a good paying number. Bags put out as early as July 14 still obtained a considerable number of spat just before August 12 to 14. Tables I and II do not indicate a great decrease in efficiency. The change in efficiency is probably not a simple decrease but the efficiency may vary in both directions. The changes in efficiency also probably differ from place to place and season to season. More information is needed on this subject and it is not possible to explain the conflicting evidence above on the basis of the evidence which is available.

4. Spawning as shown by examination of oysters. The limitations of examination of oysters as an indication of the proportion of spawning which has taken place are discussed on page 1, and there is no need to repeat the discussion here. It is evident, however, that to get a clear picture it would be necessary to examine oysters from a great variety of situations and that even then it would be impossible to gauge the relative importance of spawning bursts accurately. In 1931 the observations did not indicate, for example, the relative importance of the June 20 spawning burst.

Summary. The data on spawning and settling of spat for 1931 in Bideford river are recorded for comparison with more complete information available for other years. The data support a larval period of about 25 days. They indicate the difference in spawning time between different depths and parts of the inlet. They present conflicting evidence on the fouling of cultch. Some of the aspects of the general problem are discussed in a very cursory manner. Time did not permit examination of the data in tables I and II in connection with growth rates.

Killarsie, P. E. I.
March, 1938.

