MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No. 83

Experiments on the effect of salinity on the growth of oysters of Malpeque bay.

By

J. W. B. Cox.

BIOLOGICAL BOARD OF CANADA

MANUSCRIPT REPORTS OF THE BIOLOGICAL STATIONS

No.
83

Title

Experiments on the effect of salinity on the growth of oysters of Malpeque bay.

Author

J. W. B. Cox

1931

EXPERIMENTS ON THE EFFECT OF SALINITY ON THE GROWTH OF OYSTERS OF MALPEQUE BAY

By J. W. B. Cox

1931

The work was carried on in wooden tanks. The tanks, built the previous summer, are on the shore within the tide range. One large tank is divided into six compartments with false bottoms of wood, the actual bottom of the tank being the sand of the shore. Four of these compartments were used in the work and will be referred to as Tanks 1, 2, 3, and 4. The tanks were open to the weather on top.

An attempt was made to run each tank at definite salinities, but, due to the heavy rains, evaporation and seepage of fresh water up through the sand bottom of the tanks, considerable fluctuations in salinity were experienced in each tank but the results are at least comparable.

Tank No. 1 was to be run at the same salinity as Bideford river which is usually between 28 and 29 per mille. Due to seepage and heavy rains this degree of salinity could not be feached. The highest salinity reached in tank No. 1 was 28.3 per mille and the lowest was 24.5 per mille; the average was between 24.5 per mille and 27 per mille.

In tank No. 2 the highest salinity reached was 21.5 per mille, the lowest 15.7 per mille and the majority of the time the salinity was between 18 and 21 per mille. It was attempted to keep this tank as near as possible to 20 per mille.

In tank No. 3 the highest salinity was found to be 12.8 per mille, the lowest 10.3 per mille. This tank showed the least variation in salinity of any of the tanks.

It was attempted to run tank No. 4 at 5 per mille. Due to heavy leakage this tank was exceptionally difficult to control and shows the greatest variation of any of the tanks. The highest salinity experienced was 10.0 per mille (lasting but a few hours), the lowest being 4.1 per mille. For the majority of the time, however, the salinity ranged between 4 per mille and 7 per mille.

It must be kept in mind that the season was exceptionally wet, making the control of salinity a difficult task.

The tanks were filled on July 16, each tank receiving about 2' 4" of water. At first water was added every two days to keep the tanks full, but due to the cold temperature of the fresh water this kept the tamperature below that desired. Since temperature is the most important factor in the spawning of oysters it was considered advisable to replenish water only once weekly. For this reason a weekly variation in depth is found. This fact also made the salinity more difficult to control.

No attempt was made to control the temperature of the water. They simply fluctuated back and forth according to the weather conditions. Daily records of both maximum and minimum temperatures were noted. For instance on Aug. 1, when fresh water was added, tank No. 1 showed a difference of 8.5°F. between maximum and minimum readings, tank No. 2 a difference of 9° F., tank No. 3 a difference of 10.5°F., and tank No. 4 a difference lf 16°F.

On July 16, forty oysters were placed in tanks Nos. 1, 2, 3, and 4. These oysters were taken from England's bed in Smelt creek (Bideford river). The temperature of the water on removal was 18.1° C. and the salinity 28.5 per mille. The temperatures of the tanks were 64.5° F., 62° F., 61°F. and 60.5°F. respectively. The salinities were 26.7, 16.3, 11.2 and 9.1 per mille. The oysters were about half spawned when placed in the tanks. That is they had already spawned and ejected half their spawn. This fact was determined by opening about forty oysters and observing the condition of the gonad.

On July 20, the temperature of the tanks reached a height that was favourable for spawning. Tank No. 1, 69°F., tank No. 2, 69°F., tank No. 3, 69°F, and tank No. 4, 69.5°F. Although much more favourable temperatures were reached in the course of the next seven days no spawning was observed.

On July 28, ten small oysters from England's bed were added to each tank. This was done to increase the number of males (the percentage of males being greater among small oysters) and the presence of sperms in the water induces the female oyster to spawn.

On the same date the oysters were brought within a close proximity of one another so that they would stimulate each other the quicker. The thermometers were placed so that at no time of day they would be influenced by the direct heat of the sun.

A favourable temperature continued until August 3, but no spawning was observed.

On Aug. 4, thirty oysters from Cooper bed were placed on shelves in each tank. The shelves were about six inches from the surface of the water. They were so placed that they would be subject to a sudden rise of temperature (on sunny days). That is they were more directly in the sun's heat and also the fact that the surface layers warm up the quickest. These oysters were collected on August 3, and allowed to stand out of water until the following day, then placed in the tanks as stated. The temperature at Cooper bad on removal of the oysters was 19.62 °C. at the surface and 19.32° C. at the at the bottom. The salinity was 28.4 per mille at the surface and 28.7 per mille at the bottom in the vicinity of the oysters. These oysters were chosen because they were nearer the open bay and would be affected less early by temperature and consequently contain more spawn. This was found to be the case; the oysters were only about one quarter spent. The temperature of the water in the tanks at this time was not inducive to spawninf being: tank No. 1, 65.5°F., tank No. 2, 65°F., tank No. 3, 65.5°F, tank No. 4, 66°F. From August 4 to August 6 the temperature rose rapidly.

On August 6, at 3.00 p. M. the oysters from Cooper bad placed in tank No. 3 were noted to be spawning. The temperature at the the bottom of the tank was 75°F. In the vicinity of the oysters the temperature was 77°F. In the other three tanks no spawning was noted. The temperature in these was somewhat lower than tank No. 3 (tank No. 1, 74°F, tank No. 2 74.5°F., tank No. 4, 72.5°F) From this date until August 25, favourable temperatures existed but no further spawning was observed.

On August y, cultch for attachment of the young spat was placed in each tank. Two types were used: clean oyster shells and cardboard collectors (composed of interlocking strips and similar to the partitions used in packing eggs). These cardboard collectors are covered with a mixture of cement, sand and lime.

After an interval of ten days this cultch was examined daily. On the 21st of August fifteen days after spawning, young spat were found on the oyster shells in tank No. 3. These young spat showed a shell growth of not more than twenty four hours. Although the cardboard cultch was examined closely, no spat was found attached. Indeed, the number of spat found attached to the oyster shells was very small considering the number of eggs and sperms that must have been thrown into the water by thirty oysters. One hundred and three of these spat were measured and averaged 0.52 mm. in length.

The poor setting of spat in all probability was due to the low salinity of the water - around 12 per mille. This is less than one half the salt concentration at which oysters are found in the so-called "rivers" in this district.

The cultch of all tanks was examined closely for several days following this but no more spat were found. Tanks 1, 2, and 4 showed no spat set, and since no spawning was observed it is presumed that the oysters of these tanks did not spawn.

The reason the oysters did not spawn in tanks Nos. 1, 2 and 4 is not known. Tanks Nos. 1 and 2 were nearer natural conditions than No. 3. One would hardly expect any results from tank No. 4 under such adverse conditions. It is thought that if they had been placed in the tanks before any spawning had taken place that they would spawn quite normally in tanks Nos. 1 and 2. A change of environment while the gonad is ripe seems to slow up or altogether stop spawning.

On Aug. 14, in tank No. 4, five oysters from England's bed and five fromCooper bed were found dead. Those from England's bed had been dead longer than those from Cooper since they showed greater decomposition. Only a faint putrefying odour could be noticed from the Cooper bed oyster. On August 15 two from England's bed and four from Cooper bed were dead. On Aug. 17 one from Cooper bed, on Aug. 18 three from Cooper bed and on Aug. 21 one from Cooper bed were found dead.

It was noted that the first oysters to die were the smallest ones. The oysters from Cooper bed contained more young oysters, consequently the greater death rate. The yoing small oysters having the lesser vitality succumbs to conditions that the old large oyster can withstand. The old oyster at least survives much longer.

On July 29, 104 spat averaging 1.9 mm. in length were placed in tank No. 1, 111 spat averaging 1.88 mm. in length were placed in tank No. 2, 102 spat averaging 1.99 mm. in length were placed in tank No. 3 and 104 spat averaging 2.1 mm. in length were placed in tank No. 4. These spat were obtained from Paugh's creek.

On the same date 123 spat from Paugh's creek were placed in Bideford river adjoining the Biological station (and the tanks)

The spat from Paugh's creek placed in tanks 1, 2, 3, and 4 and also those placed in Bideford river were masured on August 12, 26, Sept, 2, 9, 16, 23, and 30. The following results were obtained:-

Table 1. Lengths of spat.

Paugh's creek spat planted in:

Date	Bideford R. mm.	Tank 1 mm.	Tank 2 mm.	Tank 3 mm.	Tank 4 mm.
July 29	1.99	1.92	1.88	1.99	2.10
Aug. 12	5.52	3.40	2.96	2.55	2.15
26	7.17	4.17	3.70	3.23	3.13
Sept. 2	8.68	4.33	3.81	3.31	3.12
9	9.70	4.68	4,22	3.63	3.37
16	- --	4.92	4.27	3.74	4.10
23	10.62	4.96	4.30	3.87	4.20
30	11.51	5.09	4.54	3.88	4.46
Salinity (per mille)	26 to 29.9	24.5 to 27	18 to 21	10.3 to 12.8	4.0 to 7.0

Note. These measurements correct only to the 1/10 mm.

From these data the growth curves for this set of spat (under the different conditions), were worked out. They will be found in the adjoining graph (figure 1).

The number of dead spat was determined on each of the foregoing dates and the death rate determined.

Table 2. Percentage dead among Paugh's creek spat examined.

Date	Bideford R.	Tank 1.	Tank 2.	Tank 3	Tank 4
July 29	0	0	0	0	0
Aug. 12	0	0	0	3	5
26	20	0	3	5	42
Sept, 2	26	0	3	10	43
9	26	4	8	19	43
16	?	13	15	23	70
23	32	17	16	23	72
30	33	31	27	30	74

The high death rate in Bideford river about August 26th was due to starfish which managed to get in the basket.

As far as survival is concerned tanks 1, 2, and 3 are about the same, tank 4 showing an abnormally high death rate.

On August 14th, 98 spat averaging 1.41 mm. in length were placed in tank No. 1, 101 spat averaging 1.50 mm. in length were placed in tank No. 2, 108 spat averaging 1.41 mm. in length were placed in tank No. 3 and 102 spat averaging 1.55 mm. in length were placed in tank No. 4. These spat were obtained from the cultch bags just outside the station in Bideford river. On the same date 100 spat from the same bags were placed in a wire basket in the river.

These spat were re-measured on August 24th, August 31st, Sept. 14th, 21st, and 28th. The following results were obtained.

Table 3. Average lengths of Bideford river spat examined.

Date	In river	Tank 1	Tank 2	Tank 3	Tank 4
	mm.	mm.	mm.	mm.	mm.
Aug. 14	1.48	1.41	1.50	1.47	1.55
24	?	2.32	2.75	2.00	?
31	5.68	2.47	3.18	2,36	1.59
Sep. 14	7.63	3.33	3.35	2.63	1.88
21	8.15	3.36	3.41	3.07	1.60
28	8.58	3.56	3.50	3.10	1.86
Salinity (per mille)	26 to 29.9	24.5 to 27	18 to 21	10.3 to 12.8	4.0 to 7.0

From these data the growth curves for the Bideford river spat were deduced. Figure 2 shows the growth curves.

Likewise the % death for the different tanks will be found in the following table

Table 4. Percentage dead among Bideford river spat esamined.

Date	In river	Tank 1	Tank 2	Tank 3	Tank 4
Aug. 14	0	0	0	0	0
24	7	0	0	0	0
31	28	0	0	0	15
Sept. 14	29	8	15	6	53
21	36	10	29	23	71
28	38	23	32	33	89

The survival here is about the same as with the Paugh's creek spat, tank No. 4 showing a somewhat higher death percentage and tank No. 1 somewhat lower, the per cent dead on the whole being slightly higher than in the case of the Paugh's creek spat.

The spat which set in tank No. 3 on August 21 showed but little growth. On August 21 they measured 0.52 mm., on Aug. 29, 0.60 mm., Sept. 12, 0.65 mm. and Sept. 26, 0.68 mm.

The death rate was high compared with the Paugh's creek and Bideford river spat in tank No. 3, the per centdeath on Aug. 29 being 50.9, Sept. 5, 51.9, Sept. 12, 53.8 and Sept. 26, 68.2.

The reason for this high death rate may be that the spat, being very young, only the strongest of the spat survived the adverse salinity condition. The Paugh's creek spat and Bideford river spat being much older and having greater strength to withstand the adverse conditions show a lower per cent death rate.

On looking at figures 1 and 2, it will be seen that the growth of spat in the river far exceeded the growth of spat in the tanks. Why the spat, in tank No. 1 expecially, did not reach a growth closer to that under normal conditions in the river is not known. It is thought, however, that a combination of two factors caused this condition, namely, (1) a lack of food in all the tanks and (2) a wide variation in temperature.

Pump samples were taken twice weekly. When these were examined and compared with the pump samples from the river, they contained much less available food material for the young spat. All the pump samples could not be examined closely, since the station ran short of vial bottles in which the samples were concentrated.

The pH of the tanks was taken biweekly. Tanks 1 and 2 showed no very great changes in pH. Tank 1 varied between pH 7.9 and 8.2; the majority of the time it stood at 7.9. Tank 2 varied between pH 7,9 and 8.3; the greater part of the time being between 8.0 and 8.1. Tank 3 showed the greatest variation, being between pH 7.9 and 9.0. This pH may be attributed to an abundant plant growth at that time. The same occurred in Tank4 but the pH only reached 8.9. A 24-hour test of pH was made but showed nothing unusual, the pH rising at night and falling in the morning. The pH in tank 3 held steady at 7.9 during the 24 hours. This would seem to be caused by a lack of plant growth.

The pH does not seem to affect the growth of the spat - that is, within the limits experienced.

In figure 1 the direct effect of a lack of salinity on the growth of the spat will be seen. As the salinity becomes less the spat growth is less. This was also the case with the large oysters, those in tank No. 4 showing practically no growth. Tank No. 4 seems to show a sudden growth at the end of the experiment but this is thought to be due to the high death rate. The smaller spat dying off leavering the larger ones and driving the average up.

In figure 2 tank No. 2 at first showed a greater growth than tank No. 1 but later fell off and tank No. 1 finished the larger spat.

Conclusions

It may be concluded from this work that a lack of salinity does not stimulate the growth of oysters and their spat but retards it. In creeks and rivers in this district, where the salinity is lower than the open bay, the oysters grow fast. This fast growth then would not be due to the lower salinity but to the higher temperatures which exist there.

What the optimum salinity for maximum growth is not known. Further work of this type could be done to determine this point.

Thurlow C. Nelso in his report, February 1, 1921, from the New Jersey Agricultural Experiment Station's Bulletin 351, states: "The range of water density within which profitable oyster culture may be carried on is from 1.008 to 1.024. Experiments conducted at this station have shown that at densities below 1.008 the oyster closes and refuses to feed."

This statement is borne out by my findings in so far as they were carried out. That is, at 5 per mille oysters did not grow at all and the death rate of spat at 5 per mille was 89.2%, while at 12 per mille both oysters and spat grew.

Besides carrying on this experimental work the writer determined the salinity of water samples and did the routine work of making graphs of both salinites and temperatures. Other work done by the writer was the concentration of plankton and pump samples.

This work was all carried out under the direction of Dr. A. W. H. Needler, director of the station.

Oct. 14th, 1931.

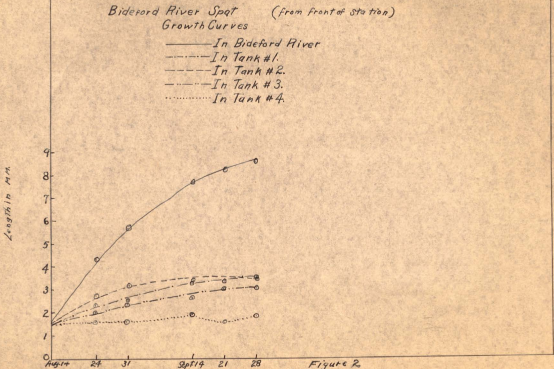
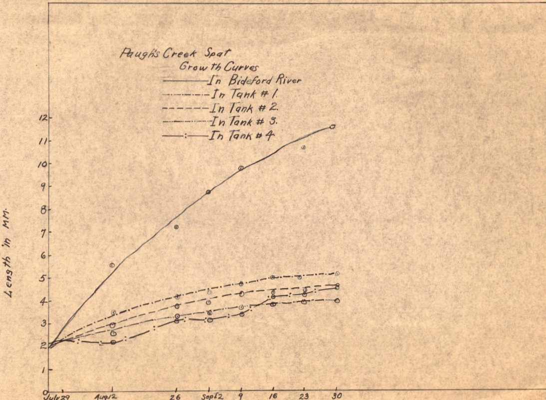

Bideford River Spat (from front of station)
Growth Curves
In Bideford River
In Tank #1.
In Tank #2.
In Tank #3.
In Tank #4.
Length in MM.
0
1
2
3
4
5
6
7
8
9
Aug. 14
24
31
Sept. 14
21
28

Figure 2.



Paugh's Creek Spat
Growth Curves
In Bideford River
In Tank # 1.
In Tank # 2.
In Tank # 3.
In Tank # 4
Length in MM.
0
1
2
3
4
5
6
7
8
9
10
11
12
July 29
Aug 12
26
Sept 2
9
16
23
30

Figure 1.