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THE PREDICTION OF SETS AND EXPERIMENTAL DATA
CONCERNING SPAWNING AND SETTING OF
OSTREA VIRGINICA
and
THE PREDICTION OF OYSTER SETS AND NOTES ON TEN
UNIDENTIFIED BIVALVE LARVAE OF MALPEQUE BAY

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1939

THE PREDICTION OF SETS AND EXPERIMENTAL DATA

CONCERNING SPAWNING AND SETTING OF

OSTREA VIRGINICA.

Report for summer of 1938

by

Margaret Miller.

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PART I.

Larvae

A. EXPLANATION OF THE METHODS OF EXAMINATION OF PLANKTON TOWS.

A number 18 mesh plankton net was invariably used for the collection of larval samples.

Standard samples for the comparative estimation of the distribution of oyster larvae were prepared in the following manner.

(1) The product of a 10-minute motor boat or dory tow was strained through number 5 netting to eliminate the copepods and the larger plankton. The filtrate was allowed to settle and the excess sea water pipetted off to a standard height of 2 cm. in the jar, leaving a residue of 81 c.c. 4c.c. of formaldehyde were added to fix the larvae in a 5% solution of formalin. The jar was vigorously shaken to distribute the larvae evenly. 1 cc of the contents constituted a standard sample. Error in counts may be attributed to variation in the speed of the boats, variation in the thickness of the glass on the bottom of the jar, and to larvae clinging to strained out copepods and to the sides of the jar.

(2) 75 gallons of sea water, or 300 strokes of lift pump passed through a plankton net from a specific place at a specific depth, constituted a pump sample. Standardization was accomplished by condensing the whole sample through settlement and decanting. If oyster larvae were numerous, the average number in 2 or 3 cc. was multiplied by the total number of cc. in the sample. If oyster larvae were scarce, the whole condensed sample was examined. Error in counts may be attributed to variations in the length and force of the stroke of the lift pump and the clinging of the larvae to the sides of the jar.

1cc. of a standard sample of a 10-minute boat tow equalled approximately 32% of the total count of a 75-gallon pump sample.

Boat tows were taken at specific intervals from June 15 to August 18 at Bentinck cove, Grand river and Bedeque bay by Fishery Inspector H. V. Carr, and at Trout river, Foxley river and Conway Narrows by Fishery Inspector L. J. Murphy. Boat tows were taken at 2001 and at the stage previous to July 7, at which time pump samples were started and continued to August 20th.

B. PREDICTIONS.

Location. Predictions were made for the following localities: Landing stage at Biological station, Station 2001, Trout river (William's cove), Brown's creek, Schooner creek, Shipyard creek, West of Grand river bridge, Nebraska creek, Bentinck cove (Inman bed, Clark's creek, Carr's bed, and Beaton's creek), Waiter's creek, Barbara Weit river, Curtain island, Conway narrows (Smith's area), Foxley river (McDonald's creek), Bedeque bay (Dunk river, Wilmot bridge and Bedeque wharf).

Each locality will be dealt with in turn giving, where data are available, temperature graphs, salinity, gonad indications, size frequency analyses, brood numbers and date of calculated spatfall. The stations are indicated on the accompanying map (figure 1) and a summary of the data will be found in table I.

Predictions. (1) Landing stage of Biological station.

Gonad indications. Examination of 10 adult oysters on June 13, showed maturity of the majority of the eggs and sperms with indication of very little spawning having taken place previous to that date.

<u>Male</u>		<u>Female</u>
1. active	4 active	1 mature
2. active	5 active	2 mature
3 active	6 active	3 fairly mature
7 active		

On June 28, 7 oysters from Totten bed showed the following conditions.

<u>Male</u>		<u>Female</u>
1. $\frac{1}{2}$ spent	3. $\frac{3}{4}$ spent	1. nearly spent
2. $\frac{3}{4}$ spent	4. $\frac{1}{2}$ spent	2. nearly spent
5. nearly spent		

The first major spawning had thus taken place between the dates of June 13th and 28th.

Temperature indications. A graph of the temperatures at the end of the landing stage in degrees Centigrade may be found in figure 2. June 1, 10 and 14 show rises above the spawning threshold. On June 1 the eggs and sperms were immature, the bottom temperature too far below the 20° line and the duration of the surface rise too short to be significant as a spawning date. On June 10 there is a probable spawning indication. The water temperature from June 14 to July 1, and from July 7 to August 24, presents at all times conditions favourable for spawning.

Size-Frequency Analyses. Straight-hinge oyster larvae were first recognized in the water on June 21. They had then reached the height of about 100. Size-frequency tables were first prepared on June 30 when easily identified umbo oysters were present. Graphs representing the size-frequencies of the larval population at stated intervals throughout the summer, with the existent hydrographic conditions, are given in black in figure 3. Having obtained the height

measurements of the modal group and the average surface temperature during its pre-existing larval period, the remaining number of free swimming days of that group and at that temperature, were estimated from the growth curves compiled by Dr. J. C. Medcof in 1936-37.

Dates of Predictions. Prediction dates are given in the summary of predictions in table I. A mussel set was expected between oyster broods 1 and 2. Thus the putting out of oyster culch was not encouraged until just before July 14th.

(2) Station 2001. Gonad indications and hydrographic conditions at station 2001 were assumed in the calculation of prediction dates to be similar to those at the stage. The average temperature at 2001 however, must have surpassed that of the deeper adjoining waters, for oyster broods were in advance about one day of those at the stage.

The size-frequency distribution analyses are found in figure 3, coloured red, and the actual prediction dates in table I. The frequency of the modal group under examination referred to in column 6, table 1, is compared with the figure 90, or the total frequency of oyster larvae at the stage at its maximum point. This figure was taken from a lcc. standard sample prepared from a tow containing the greatest number of larvae at the time predictions for the first major set were being made. Later in the progress of the same set and later in the season, upon two occasions, probably under more favourable hydrographic conditions for taking samples, the station standard sample exceeded the figure taken as its own maximal frequency. The original figure was, however, retained in the comparison of larval frequencies with other tow stations.

(3) Trout river (William's cove). No adult oysters from Trout river were at any time examined for gonad maturity. Temperature graphs are presented for Trout river in figure 4. By comparing the temperatures for each locality with the temperature at the stage on corresponding days, a mean temperature difference between that locality and the stage was obtained. When in the prediction of sets the temperature on a particular date was necessary, and was not available from the records of that tow station it was thus estimated from the stage observations by using this mean temperature difference. Trout river was calculated to have a M. T. D. of -0.5°C or 0.5° lower than the stage. A report of frequency height measurements for each locality is given in table II, and the prediction dates deduced from this data in table I.

(4) Brown's creek (Dave Strongman's Area). One tow only was collected at Brown's creek, eliminating the possibility of temperature graphs and making the temperature indications on which the predictions were based on approximation only. M. T. D. -2.5°C . This low comparison with stage temperatures is paralleled by the longer larval period found here -29 to 30 days.

(5) Schooner creek. The M. T. D. = -2.4°C . Similar conditions to the neighboring water of Brown's creek are observed here with the larval period extending from 23 to 29 days.

(6) Shipyard creek. The only tow from Shipyard creek examined showed too few larvae to make a definite prediction of sets. Some settlement was indicated on July 16. M. T. D. $\circ 0$ or the same as the stage (figure 6).

(7) West of Grand river bridge. M. T. D. $\circ -0.5^{\circ}\text{C}$. or the same as was found for Nebraska creek in Grand river (figure 6). The low number of larvae made the prediction probably unreliable.

(8) Nebraska creek. Temperatures are found on figure 6 with a M. T. D. of -0.5°C . The first major set was predicted for July 14 or the same as the stage.

(9) Bentinck cove (Inman bed). Tows from points both east and west of Inman bed were examined. The hydrographic conditions and brood ages at the two localities were similar but at west of Inman bed there was a lower number of larvae, so predictions are tabulated on the basis of east of Inman bed. The M. T. D. $\circ -1.2^{\circ}\text{C}$. which accounts somewhat for the scarcity of larvae in the water up to July 19, preventing the prediction of sets. See figure 5 for temperature data. The occasional occurrence of older umbo stages at an earlier date which corresponded with the age group at the stage, suggests the proximity of shallower waters where limited amounts of spawning took place. Larvae at Inman bed increased in frequency as the season advanced and on July 19 it is interesting to note that both the modal groups and the total larval content exceeded those of the stage at any time during the summer. Broods at Inman bed were not so clearly defined as at other stations. The prediction made on July 19 was for the occurrence of spatfall starting July 20 and continuing in a constant number until July 24.

(10) Clark's creek. The tows examined possessed too few larvae for satisfactory predictions. Temperature records were identical with Inman bed and indicated similar larval conditions.

(11) Carr's bed. Hydrographic conditions at Carr's bed agree with Inman bed and Clark's creek at Bentinck cove.

(12) Beaton's creek. M. T. D. $\circ -1.2^{\circ}\text{C}$. It is suggested by the similarity of temperature records in the whole Bentinck cove area (figure 5) that conditions and thus the predictions would be the same, with a representation more probable of the small first sets in the creeks.

(13) Waite's creek. The only tow obtained from Waite's creek examined on July 6 yielded no oyster larvae. The temperature at this tow station was 3.2°C . lower than at the stage. It might be assumed from this fact that a later sample would have proved more typical.

(14) Conway Narrows. Figure 4 indicates a rapid response of temperature to change of atmospheric conditions and a M. T. D. of -0.7°C . Tows of July 6 and 14 were unsuitable for accurate prediction, while on July 29 an immediate set was indicated which would extend in diminished numbers over a period of one week with very few younger larvae to develop after that.

(15) Foxley river (McDonald's creek). Adult oysters examined on June 21 showed mature eggs and sperms in the following proportions.

Female.

Male.

1. mature, slightly spent.
2. some spawning.
3. $\frac{1}{4}$ spent.
4. slight spawning.

1. mature, active, no spawning
2. not very active.
3. some spawning.
4. very little spawning.

A certain amount of spawning could thus have taken place previous to June 21. The temperatures are represented in figure 4 with a M. T. D. of -1.2°C . Mode set occurred on July 15-16 and 9.

(16) Barbara Weit river. Adult oysters examined on June 22 showed the following conditions:

Female

Male

1. $\frac{1}{4}$ spent.

1. $\frac{2}{3}$ spent.
2. $\frac{1}{4}$ spent.

3. $\frac{1}{4}$ spent.
4. some spawning.

Spawning had thus taken place previous to June 23. M. T. D. $\approx -0.1^{\circ}\text{C}$. which is very little lower than at the stage (figure 6).

(17) Curtain island. No hydrographic data were available from Curtain island making the prediction for July 18 an assumption only. Larvae occurred in 10% of the stage frequency.

(18, 19, 20) Dunk river, Wilmot bridge and Wharf at McDonald's point.) Sets at these three localities were very nearly identical although there were slight variations in temperature.

McDonald's point wharf, M.T.D. $\approx -1.0^{\circ}\text{C}$.

Dunk river, M. T. D. = -0.3°C .

Wilmot bridge, M.T.D. = -0.1°C .

Although these temperatures are shown to be only slightly lower than at the stage, the adult oysters indicated only very slight spawning before July 11. July 7 tows showed no oyster larvae whatsoever and very few bivalves of any kind.

July 11 adult oyster examination.

Female.

Male.

1. mature, no spawning.
2. no spawning.
3. some spawning.

1. mature, no spawning.
2. no spawning.
3. some spawning.
4. little spawning.

On July 19 the oysters were about half spawned.

Female.

1. $\frac{3}{4}$ spent.
2. $\frac{3}{4}$ spent.
3. $\frac{1}{4}$ spent.

Male.

1. $\frac{3}{4}$ spent.
2. $\frac{1}{2}$ spent.

No set was predicted before July 30 and the major set occurred on August 4.

Summary. It may be noted from this account of conditions and predictions at the various localities that all the tow stations showed lower temperature averages than at the stage, with the exception of station 2001 where advance brood maturity indicated higher temperatures.

No oyster larvae were present in the tows of the North shore stations after August 11.

PART II.

Spat.

A. EXPERIMENTAL COLLECTORS.

The experimental spat collectors used at first were cardboard rectangles of a consistent 84 square cm. size, cut from the flat pieces placed between egg crate fillers and dipped in cement. They were supported by wooden clamps on a rigid steel rod which was hung from the floor of the stage with the lower end sunk into the mud. An elastic band held the clamp together at its free end. At half tide the top collector was 12 inches out of the water. Four other collectors were placed at intervals of 18 inches down the steel rod reaching a depth of 60 inches or about 6 inches from the bottom.

At station 2001 the same collectors were used but their support consisted of clothes pins soldered to a number 9 wire, weighed down with a stone and attached to the yard arm of a stationary pole.

At the peak of the first set it was found that although these cardboard squares caught *Mytilus*, *Mya* and *Teredo* in abundance, oyster larvae did not attach themselves to the unprotected surfaces, in numbers proportionate to those settling on the commercial collectors. Squares of commercial collectors were therefore cut and attached to the clamps in such a way that there were two vertical sides and a horizontal surface between them. This protected horizontal surface presented the area which was examined.

Tables III and IV give the spatfall at the stage and at 2001 as discerned from the experimental collectors. Indication is made of any deviation from the habitual daily examination and count and of the change from rectangle squares to the commercial collector blocks. A week's comparison of the relative efficiency of vertical and horizontal surfaces for the collection of spat is recorded with 2001 data. The superiority of the horizontal surfaces is noted on each day and on June 28 in particular. August 1 proves an exception when the vertical collector count was 3 and the horizontal 0. The success of the commercial blocks in comparison with the cardboard rectangles may be read in the greater numbers of spat which settled after the change was made even though the heaviest set of the season was then over.

B. COMMERCIAL COLLECTORS.

Counts were made of representative portions of commercial collectors from various localities on various dates, record of which is found in table V. No comparative examination of the distribution of sets at various points in one inlet have been made.

A good set in all areas has been indicated while some floats had settlement too high to prove beneficial to good growth. The consistent high temperatures which occurred this summer have given the larvae all favourable chances of good and steady growth with little retardation through cold weather conditions.

These same high temperatures may also be responsible for keeping the larvae in the upper regions of the water and in contact with the collectors, instead of inactive near the bottom. This assumption is strengthened by an observation related by Mr. H. B. Forbes. "Although the set of 1937 was small in comparison with that recorded for this season, the natural set on the bottom and on oyster beds was exceedingly good".

Comparisons made between cement-coated egg crate fillers and tar-coated egg crate fillers showed a spat collection of 6,976 on cemented fillers against 840 on the tar-coated.

Unless otherwise indicated, collector samples were taken from both top and bottom collectors of each bundle and from the following section of the collector. Horizontal: 3 rd. from the left side and fourth down from the top or up from the bottom. Vertical: 3 rd. from the right hand side and 3 rd. down from the top of the upper collector and 3 rd. up from the bottom of the lower collector.

PART III.

Observations on Bivalves other than Oysters.

A. OCCURRENCE AT TOW STATIONS OF LARVAE OF MYTILUS, MYA, TEREDO AND VENUS.

The information obtained on these organisms from the notes made at the time of examination of tows for oyster larvae is presented in table VI. Stat on 2001 appears to be more advanced in age groups of all four bivalves and the stage a day or so later. On August 1 at Foxley river there were observed larvae strange to the tows of this season. They were then in the umbo stage and 208u in length and 188u in height, about the same size as the mussel larvae of that stage but of different shape and of a pale pinkish yellow colour. They were also noticed at 2001 and Inman bed at the same time. At the stage around August 10 they constituted approximately 75% of the bivalve population. No unknown bivalves settled out on the collectors at any time which corresponded in size to these molluscs.

B. SETTLEMENT OF ORGANISMS OTHER THAN OYSTERS.

On experimental collectors. Record was kept from the experimental collectors at the stage of Mytilus, Mya and Teredo. There also appeared about July 6, a bivalve which has not as yet been identified, but which settle in such large proportions that a record was kept in the possibility that it would be of interest after identification. The recorded observations are given in table VII.

The largest mussel set of the season was in process on June 22 when counts were first begun. Succeeding and smaller sets occurred on June 25, 26, 29 and July 14. The eight mussels found at 60 inches on July 20 were all past the newly settled stage with well defined dissoconch shell. From July 22 to August 18, when examinations were stopped for the season, no mussels were found on the collectors although straight hinge and umbo stages appeared in the tows from August 1 and forward in about 20% of the major brood.

Settlement of clams occurred on June 22, 23, 30, July 6, 14 and 19 with diminution of numbers from July 19 to 26. Straight-hinged larvae were observed on August 6, and later, the umbo stages. On July 18 at 2001 it was noted that there were 18 mya at 48 inches, top of the collector in comparison with 8 at the stage, total count.

Teredo settled in large numbers, with a maximum of 12 per square cm., on the experimental collectors practically all in the hollows of the cement and in the shadow of the wooden clamp. From June 22 to July 26 there seemed to be a continual set with the peak on July 12-13. From June 22 to August 18 no settled Teredo are recorded but straight-hinged and umbo stages represented 75% of the bivalve population in the pump samples.

Venus were first observed on July 14 as part of the collector population. Very few attached themselves during the summer, although a similarly shaped but smaller-sized bivalve appeared in greater numbers and at the same time. Some of those recorded as quahaugs may thus belong to this group. ~~XXXX~~ It is possible that they may be Callocardia.

Molluscs other than oysters seemed to settle quite often in groups, perhaps 10 in a clump and once 40 Mytilus were found congested in about 1 square cm. surface. Besides this clumping on open smooth surfaces, holes in the cement seem to attract congregations of bivalves, although eddies or tidal currents are probably in this case responsible for sweeping them into these depressions.

On Commercial Collectors. Notes on occurrence of bivalves other than oysters are recorded, where observations were made, with the data on commercial collectors used in experiments on vertical distribution, current, and fouling.

PART IV.

Experimental Data.

A. VERTICAL DISTRIBUTION OF LARVAE.

This entailed an investigation of possible factors influencing the position of oyster larvae in the water. The experiment consisted mainly of a series of 75-gallon pump samples taken at the end of the landing stage at three depths, 6 inches below the surface, half the depth at that time, and 6 inches from the bottom. Samples were taken every three hours for 27 hours. The data are given in table VIII.

Any inferences which could be made from the data cannot be considered conclusive for two reasons. The samples were taken at exactly the time when the larvae were normally settling out of the water regardless of hydrographic conditions and, secondly, the experiment would have to be repeated many times in order to attribute any one of the many variations to any particular influence. To supplement this experiment a study of the periodic larval samples was made and the observations relative to the subject included here.

DISCUSSION.

Light. By comparing the relative numbers of larvae found at the surface, centre and bottom from table VIII, it may be noted that the larvae in the middle of the day when the light is strongest are at a maximum at the central depth, during the morning and early evening at a maximum at the surface, and at night it varies. At 9 p.m. on July 14 a marked decrease in the actual numbers continues until 3 p.m. July 15th, with the exception of surface at 3 a.m. Settlement of larvae is probably responsible for the decrease and it may be argued that the increase at 3 p.m. cannot be attributed to a phototropism but that it is due to the appearance of newly developed umbo larvae.

Temperature. The same larval distribution results may just as logically be correlated with an optimum temperature requirement for larvae. The sudden and single increase in surface distribution at 3 a.m. cannot be explained by either of these factors. From an examination, however, of the percentage of larvae in the water under the various hydrographic conditions of the summer, no correlation could be noticed between temperature and frequency. The suggestion which has been made concerning the increased activity of larvae as the temperature rises is disputed in figure 2 by the fact that the two tows with most larvae were collected on days recording temperatures below 20°C. On these two days, to supplement the next paragraph, it is to be noted that there was only a slight N.E. wind.

Wind. In the morning of July 14 a fresh southwest wind arose and continued until morning, making a third factor to which disappearance of larvae may be attributed. That wind has an effect upon distribution is emphasized by counts made at the stage before, immediately after, and two days after a southwest

Date	Stage	Surface	At 4 ft.	larvae per/gallon
July 8	-----Stage	131	1120	75
July 11	-----Stage	3	27	" " "
July 12	-----Stage	208	1370	" " "

At 2001 this phenomena may again be noted, except that no sample was taken on July 12 as check.

Date	Station	Surface	At 4 ft.	larvae per 75 gal.
July 7	-----2001	197	810	" " " "
July 11	-----2001	22	40	" " " "

Again the inference is weakened by the same possibility of the July 8 set and the growth of young larvae to the unmeasurable stage. Examination of figure 2 shows the disappearance of larvae upon the occurrence of "fresh" southwest winds" on July 8, 14, 16, 28, and 29. The prevailing blows this summer have been southwesterly. At dates where the larval counts are high the hydrographic records show "moderate winds". The problem is presented as to where the larvae go during these adverse conditions, only to return when the conditions are moderated.

Pump samples taken 6 inches from the bottom show no increase in counts at times of adverse conditions of wind or temperature. Investigations should be carried out on the distribution of larvae and ages of larvae on the actual mud bottom.

Tide. Comparisons of neap, spring, and average tides revealed no variations in larval distribution which could not be as well attributed to other influences.

B. VERTICAL DISTRIBUTION OF SETS.

(1) Parallel with the three-hourly pump samples taken on July 14-15 record was kept of the spat fall during those periods. A slight correlation between the two may be noted but nothing conclusive could be found. It should be noted that in this experiment the cardboard squares were being used for the collection of spat. The inefficiency of these exposed surfaces, as it was later proved, for the holding of spat makes it impossible to consider these results representative of the conditions at that time.

(2) On July 13 a series of commercial collectors were hung vertically with about 6 inches between them, at station 2003, in water

of a depth of about 12 feet. On July 23 samples were taken in the same manner as described in Part 2, section 2. The record is given in table IX. The bundles were hanging lengthwise with the float or with the vertical sides against the current. A similar series was hung at 2001. Here the water was only 6 feet deep allowing for two bundles in the series. The current was running through the collectors. At both stations an increase in the settlement of spat was found with depth. At 2003 this increase is represented by the figures at 2003, to 30, bottom 294 and at 2001 by top 0, and bottom 19. The horizontal surfaces were observed to have a greater settlement than the vertical surfaces. The upper surface of the upper horizontal and the lower surface of the lower horizontal yielded the greatest counts while little difference or consistency was observed in the vertical surfaces of the same bundle. A great many of the samples had a whitish yellow deposit on its surface. This could be soaked off and collected in a vial. Very marked was the superior set at 2003 over 2001. In addition to the fact that there were simply more larvae at 2003, this might be explained by the set at 2001 coming one day earlier than at 2003, thus perhaps partially missing the collectors put out there.

It is most unfortunate that the bundles were hung in different directions in relation to the current for it is very probable this influenced the results, although this does not explain the scarcity of set at 2001 for there the bundles were against the current or in the most advantageous position.

C. FOULING.

1. Vertical distribution of fouling. Two series of collectors similar to those put out for vertical distribution of sets were placed at 2001 and 2003 on July 5. On July 13 they were taken up and hung on the surface. A control for the variation of sets according to the position on the float was arranged.

The maximum height of spat settled on any collector in the experiment on vertical distribution of sets (see B above) at 2001 was 3.5 units and at 2003, 3 units. One unit = 301 microns. Thus in the counts made in those stations for the vertical distribution of fouling, all spat larger than these units were rejected as having settled before July 13. These bundles were all hanging parallel with the float or with the vertical ends into the current.

Table X gives the counts and the controls for both stations. From these data it may be noted that those bundles which hung the deepest have the largest collections of spat and that increase is continuous from the surface to that depth. It might be assumed then, that the optimal setting conditions are directly proportional to the depth and independent of occurrence of larvae. But one result cannot be considered definite, especially without the consideration of other variants. By visual inspection fouling is more intensive.

on the upper surfaces of the horizontals than on the lower, and coincident with this, the set is greater on the upper than the lower. It is also evident that the sets recorded on collectors previously fouled exceed the sets obtained in the experiment on vertical distribution of sets (B above) where they were put out fresh directly before the set. It would appear that there is an advantage in the fouling. Yet what then is the factor of variance with depth? At station 2001, however, the bottom of No. 2 collector showed an increase of the bottom surface over the upper, and it was also noted that these bundles were more silty than the others.

Eighty-five percent of the figures obtained were of spat near the border line of 3.5 units and 3 units which were the heights of the largest spat in experiment B. The results may thus be inaccurate as to the actual count, due to the error in measurement, but the fact that there is such a small percentage of the later broods on the collectors is significant in a fouling experiment.

The vertical sides disclosed a superior set on the surfaces facing down the float or away from the anchor. The float was free to swing with the current.

2. Surface fouling in relation to time. A one-puncheon float at 2001 was hung with the collectors in the positions indicated in the accompanying illustration and in the following proportions: July 5, 24 collectors; July 9, 23 collectors; and July 13, 23 collectors.

The vertical sides of the collectors were pointing into the current. Samples for examination were taken on July 24 from one end of the float only, the end nearest the mooring. Since the experiment was concerned only with a set which affected the three groups simultaneously, spat larger than 3 units in length were rejected in bundles put out on July 5 and 9 as having settled before July 13 when the last group were placed in the water. Conclusions drawn from the data in table XL are as follows.

(1) Fewest spat settled on the experimental collectors which were put out immediately before the set of July 13-14.

(2) Most spat settled on collectors put out on July 9, or 5 days before the set of July 13.

(3) The number of spat settling on collectors put out 9 days before the set of July 14 exceeded the number settling on collectors put out July 14 but was excelled by those of July 9.

(4) Bundles put out 9 days before the set showed a number of spat on the top of the upper horizontals and the bottom of the lower horizontals. Bundles put out 5 days before the set showed an excess of spat on the lower surfaces of both horizontals over the upper surfaces. Bundles put out immediately before the set showed an excess of both lower surfaces over the upper.

(5) Vertical surfaces which were down float from the current showed more spat than those surfaces which were against the current.

(6) A deposit of whitish yellow substance was found on 85% of the collectors put out immediately before the set of July 14. There was a decrease in the number fouled in this way on those collectors out 9 days before July 14. Where this deposit (termed X deposit, because its character is unknown) is found, a very marked decrease in the number of spat prevails.

(7) On collectors put out 9 days before the set, the upper horizontals possessed spat which were 80% of the day before set (July 23) while only 10% were on the border line of 3 units or of the July 14 set. On the lower surfaces of the horizontals they were nearly all on the border line of 3 units.

(8) Collectors put out 5 days before the set showed the same conditions as (6) but not to such a great extent.

(9) On collectors put out July 13 the spat were all small or young, mostly of the day before, some 3 days old, 4 spat over 2 units and one on the border of 3 units. This held for tops, bottoms or verticals.

(10) Fouling seemed concerned mostly with silt and X deposit. Algae did not appear this year to be a limiting factor except on one collector No. 5g of July 5.

(11) Bryozoans became more serious as the season advanced, sometimes spreading over the whole surface of a horizontal or vertical side. No larvae were observed to settle on top of a bryozoan or to survive if they were covered. Bryozoans do not seem to readily surround a spat after it has reached a two weeks growth.

(12) The vertical sides of a collector remain more free from silt than do the upper horizontals.

D. VARIATION OF SPATFALL WITHIN THE SINGLE BUNDLE.

Because of the observation that the majority of bundles showed the greater number of spat on the top surfaces of the upper collectors and the bottom surfaces of the bottom collectors, complete rows of horizontals were taken on August 18 and examined for the transition of spat intensity. As a comparison the vertical surfaces were examined in the same manner. With the naked eye a count was made of the visible spat on adjoining horizontals in the vertical series and of the adjoining verticals in the horizontal series, thus giving a rough picture of the transition of spat down the bundle and across the bundle on both surfaces.

Data obtained may be found in table XII. There appears to be no great consistency in the results. The surface on which the first set of the season occurs dominates eventually the position of the catch on the collector. The large ones will crowd out the smaller ones even though the total count is not the greatest on that surface. Thus the counts of the visible spat are the counts of the first sets regardless of the numbers which could have settled since that time.

In the horizontal series, there is a minority of set in the centres of the collectors, the ends of the upper and the top of the lower collector. The bottom of the upper collector has a higher count than the top of either the upper or lower, and the bottom of the lower has the highest of any position in the bundle.

In the vertical series, the down-stream surfaces exceed the counts on the top and bottom of both collectors, while in the centre, the up-stream surfaces exceed the down. The up-stream counts of the bottom collector are greater than the up-stream of the top collector, and the down-stream counts of the top collector are greater than the down-stream of the bottom.

3. Effect of current direction on the intensity of spatfall. This experiment entailed the examination of tarred boards arranged at various angles in relation to the tidal currents, and exposed to spat fall east of the stage from July 12 to August 4. These boards were supported on horizontal cross bars between two upright poles, or as in the case of the 3rd, 4th, and 5th parts of the experiment, on single vertical poles sunk in the mud.

Exact counts were made and averages taken of two unit representative areas on the experimental surface of each board. The results are summarized in table XIII.

Notations of the proportions of predominant spat lengths of these areas are included. On many of the boards spat settlement appeared to predominate along the smooth depression beside the grain showing on the roughly planed boards. In addition, the more silty sides of the boards showed a majority of mortality among the newly settled bivalves, and unlike any condition on other spat collectors, these bivalves when dead, appeared chalky white and calcified. Comparative observations were thus made on both the experimental surfaces and the under surfaces next the supporting poles, concerning silt deposit, degrees of calcified bivalves, and percentage of set along the wood grain.

5. Conclusions: (1) Spat prefer the down-stream surface of a collector. To supplement this, reference may be made here to table IV where the predominance of spat on the down-stream portion of the verticals of the experimental collectors may be noted. An examination was also made of several painted boards used in *Teredo* experiments.

Down stream surface.

1-8 $\frac{1}{2}$ inches = 4 spat per square inch.

Down stream surface.

1- 8 $\frac{1}{2}$	inches =	4 spat per square inch.
8 $\frac{1}{2}$ -17 $\frac{1}{2}$	" =	28 " " " "
17 $\frac{1}{2}$ -18 $\frac{1}{2}$	" =	14 " " " "
18 $\frac{1}{2}$ -19 $\frac{1}{2}$	" =	20 " " " "
19 $\frac{1}{2}$ -20 $\frac{1}{2}$	" =	13 " " " "
2 feet 5 inches - 2 feet 6 inches	=	32 spat per square inch.
2 feet 16 inches - 2 feet 11 inches	=	1 spat per square inch.

On the up-stream surface there were 20 spat on the whole board, 16 of which were on the bottom 6 inches. Aside from the significance of this in a current experiment it is interesting in connection with the vertical distribution of sets in No. 2, Part 4. In all the experiments where counts were taken of vertical surfaces a certain amount of consistent variation between the two sides is noticeable, but where the collectors are supported by floats which may swing with the current, this amount of variation is lessened. An exception to this is table XII, where the examination was made late in the season and perhaps allowing for the position of the earlier sets to predominate the survival of the summer's catch. But why wouldn't the first sets respond to this favoritism of down-stream surfaces?

(2) More spat settled on surfaces facing the station shore (south) than the opposite shore. In experiment No. 4, and by visible spat inspection of commercial collectors it was noted that the edges of verticals nearest the station shore showed the greatest set.

(3) Depth of the surface examined influences and confuses the results of the experiment, giving greater counts on one end of the board than on the other and irrespective of position in relation to current.

(4) The extent of silt deposit is proportional to the degree of set and the degree of calcification of the bivalves.

(5) In connection with a current experiment attention should be drawn to table V where counts made at 2001 from float C.M.O. with the current running through the collectors gave 6,888 spat per collector, while ^{with} the current against the sides there were 3,024. Also at 2003 with current running though there were 11,765 spat per collector and with current against sides 5,176.

TABLE I.

Set predictions at tow stations.

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Locality	Date of examination	Temperature Indications	Height of modal group (microns)	Brood total at stage	Modal comparison with total at max. stage	Av. temp. from probable max. spawning	Prediction date	Length of free-swimming period	
	Date	Temp. (°C)			%	(°C)		days	
Stage	July 4	June 10	20.7	272	No. 1	3.3	20.1	July 8	28
Stage	July 4	June 17	22.5	181	No. 2	17.7	21.4	July 14	27
Stage	July 12	July 18	20.1	201	No. 3	12.0	21.0	July 15	27
Stage	July 12	June 21	21.2	226	No. 4	11.0	21.0	July 18	27
Stage	July 19	July 7	20.2	148	No. 5	7.7	22.4	July 30	23
2001	July 5	June 9-10	20.7	311	No. 1	9.0	20.1	July 7	27
2001	July 5	June 15	22.3	207	No. 2	12.0	20.2	July 12-13	27
2001	July 18	July 2	19.9	188	No. 3	7.7	20.6	July 28	26
2001	July 18	July 6	19.0	134	No. 4	20.0	22.2	July 30	24
Trout river	July 5	June 10	19.9	246	No. 1	3.3	19.6	July 9	29
Trout river	July 5	June 17	21.3	174	No. 2	16.6	20.8	July 14-15	28
Trout river	July 29	July 7	19.8	310	No. 3	5.5	21.9	July 31	24
Conway Narrows	July 6	June 21	20.5	142	No. 1	5.5	20.3	July 10	27
Conway Narrows	July 29	July 7	20.0	337	No. 3	9.0	21.7	July 30	23
Brown's creek	July 13	June 16-17	20.5	285	No. 1	7.5	19.0	July 15	29-30
Brown's creek	July 13	June 20	18.2	259	No. 2	6.6	19.4	July 17	28
Schooner creek	July 13	June 17	20.6	285	No. 1	10.0	19.1	July 15-	29
Schooner creek	July 13	June 20	18.3	259	No. 2	5.5	19.5	July 17	28
Shipyard creek	July 4	June 22	22.1	142	No. 1	3.3	22.0	July 16	24
West of Grand river bridge	July 7	June 17	21.6	202	No. 1	3.3	20.6	July 15	28
West of Grand river bridge	July 19	June 22	21.6	337	No. 2	3.3	20.7	July 20	27
Nebraska creek	July 7	June 16	22.0	207	No. 1	9.0	20.6	July 14	28
Nebraska creek	July 19	June 22	21.8	350	No. 2	3.3	20.7	July 19-20	26-27

TABLE I. (Continued)

Locality	Date of examination	Height of		Modal group	Brood	Modal comparison total at stage at max.	Av. temp. from probable spawning	Prediction date	Length of free-swimming period days
		Temperature Indications	Temp. (°C)						
Bentinck cove		Date	Temp. (°C)				Date		
(Inman B.)	July 14	June 21	20.0	298	No. 1	9.0	20.0	July 17	27
(Inman B.)	July 19	June 25-30	20.6	262-360	2-3	15.0	20.2	July 20-24	27+
(Inman B.)	Aug. 1	July 6-7	19.0	337	No. 4-5	22.0	20.8	Aug. 1-2	26+
Carr's bed	July 14	June 16	21.3	324	No. 1	3.3	19.8	July 14	29
Clark's creek	July 7	June 22	20.5	155	No. 1	2.5	20.0	July 20	28
Beaton's creek	July 19	June 25-30	20.6	262-360	No. 2-3	8.0	20.2	July 20-24	27+
Barbara Weit	July 4	June 17	21.1	181	No. 1	5.5	20.0	July 14	26
Curtain Island	July 11			213				July 18	?
Foxley river	July 6	June 20	19.8	155	No. 1	4.0	20.5	July 18	28
Foxley river	Aug. 1	July 11	21.5	202	No. 3	9.0	21.2	Aug. 6	25
Dunk river	July 20	July 6	19.2	148	No. 1	3.0	22.0	July 30	24
Wilmot river	July 20	July 6	19.2	148	No. 1	3.0	22.3	July 30	24
Wharf (Bedeque R)	July 20	July 6	19.2	148	No. 1	11.1	21.4	July 30	24
" "	" Aug. 3	July 10	21.1	337	No. 2	16.6	22.2	Aug. 4	24
" "	" Aug. 3	July 13	20.3	269	No. 3	5.5	22.4	Aug. 5	23

3.8 3.9 4 4.1 4.2 4.3 4.4 4.5 4.6 4.7 4.8 4.9 5 5.1 5.2 5.3 5.4 5.5 5.6

1 1 1
 4 2 2 2 3 1 7 5 8 3 2 2
 6 2 4 2 4 2 3 7 5 8 3 2 2
 3 1 6 1 1 2 7 3 1 4 3 1 2 1
 5 2 9 7 2 k 1 2
 1 1
 1 1 1 2 4 1 1
 2 1 3 4 8 4 2
 1 1 1 1
 2 1 4 2
 1 1 2 1
 1 1

75 H. F. 11.30 a.m. Mod.N.W. (cl
 76 Mod.N.W.
 71 Mod.S.W.
 51 H.F. 7.45 a.m. FreshSW(17.8
 53 H.F. 8.45 a.m. FreshSW(17.9
 6 $\frac{3}{4}$ F. 11.30 a.m. Mod.NE(18.3°
 9 $\frac{1}{2}$ F. 12.noon Mod.NE(19°C)
 15 $\frac{1}{2}$ R. 7.30 a.m. Mod.NW(19.1°
 22 H.F. 1 p.m. Mod.NE(19°C)
 28 $\frac{1}{2}$ R. 3.30 a.m. Mod.NW(19°C)
 11 $\frac{1}{4}$ R 3.00 a.m. FreshNE(20.5
 0 $\frac{3}{4}$ H 9.00 a.m. Mod. NE
 0 $\frac{1}{2}$ R 3.00 a.m. N.W. Mod.
 1 $\frac{1}{4}$ R 7.00 a.m. Mod. NW
 5 $\frac{1}{2}$ F 1 p.m. NE gale
 31 H.R. 8.00 a.m. Fresh SW
 3 $\frac{3}{4}$ R. 9.00 a.m. Mod.NE(18.4°
 6 $\frac{1}{4}$ R. 7.00 a.m. Mod.NW(19.3°
 9 $\frac{1}{4}$ R. 7.30 a.m. Mod.NW(19.5°
 10 H.R. 8.00 a.m. FreshSW(19.5°
 0 $\frac{3}{4}$ R. 9.30 a.m. Mod.NE(18.4°
 5 $\frac{1}{4}$ R. 7.30 a.m. Mod.NW(19.5°
 0 $\frac{1}{4}$ H. 7.00 a.m. FreshNW(16.6°
 23 $\frac{1}{2}$ F. 6.00 a.m. Mod. NE
 10 $\frac{1}{4}$ F. 2.30 p.m. NE gale 19.0
 16 Mod. NW
 10 L.F. 2.15 p.m. Fresh SW
 18 $\frac{1}{2}$ H. 11.20 a.m. Mod. NW
 3 $\frac{1}{2}$ R. 12.30 p.m. Fresh SW
 0 $\frac{1}{2}$ H. 2.30 p.m. Mod.NW 21°C
 0 $\frac{1}{2}$ R. 2.00 p.m. " " 21.3°

TABLE II. (Continued)

		108	115	121	128	135	142	148	155	162	168	175	182	189	195	202	209	216	222	229	236	243	
		1.6	1.7	1.8	1.9	2	2.1	2.2	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3	3.1	3.2	3.3	3.4	3.5	3.6	
Nebraska creek	July 19											1											1
Trout river	July 29											3		1							1		
West of Grand river bridge	July 19									1					1				2				
Bentinck cove																							
Inman bed (E)	July 19				1			2	1		1							1			1		1
Inman bed (W)	July 19											2							3		2		
Inman bed (E)	Aug. 1				1					5		10		7	9		2						1
Conway Narrows	July 29											1		2	3		1	2			1	1	2
Foxley river	Aug. 1							2			2	3		2	8		2	3	4		4	1	
Wilmot bridge	July 20			2	3	3		5										1					
Dank river	July 20					2		3			1												
Bedeque wharf	July 20			1		5	1	10		7	3	1											
Wharf	Aug. 3							3		2					2	2	1	1			1		1

TABLE II. (CONTINUED)

AND corresponding micrometer units																	% of stage	Tide	Time	Weather		
3.7	3.8	3.9	4	4.1	4.2	4.3	4.4	4.5	4.6	4.7	4.8	4.9	5	5.1	5.2	5.3	5.4	5.5				
											1		2		4		1	1	12	$\frac{1}{4}$ R.	8.00 am	Mod. SW
	1		2			3		3			2		2						25	L F	3.30pm	Fresh SW
	3		1			2		2			1		4		3		3		26	$\frac{1}{4}$ R.	9.00 am	Mod. SW 20.5
		2		1		2				2		2	1		2		1		23	$\frac{1}{2}$ R.	6.00 am	Mod. SW
	2					2		4		1					1				13	$\frac{1}{2}$ R.	6.00 am	" "
	4					6		4		2	1	9	1	20	x	20	1	9	130	$\frac{1}{4}$ R.	6.00 am	" "
	7		6	3		5		2		1	1	5	3	12		4		3	72	H.F.	10.45 am	Fresh SW
2			1							1									32	$\frac{3}{4}$ F.	2.00 pm	Mod. SW
													1						16	$\frac{1}{2}$ F.	9.30 am	" " 21.6
									1										6	$\frac{1}{2}$ F.	9.00 am	" " 22°
																			2	$\frac{1}{2}$ F.	9.30 am	" " 21.6
	1	3	5			3			2	3		6		15	2	3	6		70	$\frac{1}{2}$ F.	8.00 am	" " 22°

Oyster sets on experimental collectors at landing stage

		July											August																							
		4	5	6	7	8	9	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8
depth out	12"	0	0	1	0	0	1	0	0	3	1	0	1	0	0	0	0	1	0	0	0	0	0	0	-	0	0	0	-	0	0	0	0	0	0	0
at	6	2	1	1	1	3	0	-	1	1	5	8	2	0	0	0	0	2	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	
half	24	0	0	0	1	0	1	0	0	0	1	1	0	1	0	0	1	0	-	2	0	0	2	0	0	3	0	0	0	0	0	0	0	0	1	
tide	42	0	0	2	0	-	4	1	1	1	9	0	0	0	0	0	1	1	1	0	0	0	0	1	1	5	2	1	1	0	0	0	0	0		
	60	0	1	0	1	2	4	0	1	3	3	0	1	1	0	0	0	1	0	0	0	1	1	0	3	-	1	1	1	9	9	0	0	0		
depth out	12"	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	-	2	0	0	-	0	0	0	0	0	0		
at	6	0	0	0	0	1	-	-	0	0	0	0	1	0	0	0	1	3	1	0	7	7	5	7	5	2	4	3	0	0	2	1	0	0		
half	24	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	2	0	-	8	5	5	5	5	56	46	8	1	1	0	2	3	3		
tide	42	0	0	0	0	-	1	0	0	0	0	1	0	0	0	2	0	11	1	0	6	7	5	7	5	60	8	14	3	1	0	1	1	1		
	60	0	0	0	0	0	0	0	1	1	1	0	0	2	0	1	2	7	3	5	7	9	16	9	16	60	-	16	4	2	5	5	2	2		
total		2	2	4	4	6	11	1	4	9	20	9	6	4	0	0	6	5	28	5	5	32	31	34	12	60	43	10	5	7	9	7	7	7		
average/sq. cm.		.12	.12	.25	.25	.37	.33	.06	.25	.56	1.3	.56	.19	.25	0	0	.37	.31	2.8	.5	.5	3.2	3.1	2.4	6.3	3	4.3	1	.5	.7	.5	.7	.7			

Surface with greatest set	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	T	
depth of	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"	6"
greatest set.	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"	42"	60"

Experimental collector - 1 side = 84 sq. cm.
 Commercial collector square - 1 side = 51 sq. cm.
 Commercial collector blocks
 first used July 23-24.

TABLE V.

COMMERCIAL COLLECTOR COUNTS OF SETS

Location	Date	position of sample				Remarks	Av. per square	Set per Collector						
		Upper collector of bundle.		Lower collector to bundle										
		<u>Horizontal</u>		<u>Horiz.</u>		<u>Vert.</u>								
		side	side	up	down	Surf.	Surf.	up	down					
		up	down	stream	stream	up	down	Stream	Stream					
2001 (B)	July 16	7	9			14	16	4	6	12 spat from 1st set	12	2,016		
2001 (B)	July 18		11			80	16	7	5	From very bottom sur	24	3,024		
2001 (B)	July 12					38	14		3	" " " "	9	1,512		
2001 (B)	July 20	10	62		14	14	69		19	" " " "	31	5,544		
2001 (C.D.D.)	Aug. 18	52	28	32	47	26	55	42	29	C.M.O.Coll. Current running through Co.	41	6,888		
2001 (B)	July 18	23	18	20	27	6	16	19	14	Current against end:	18	3,024		
stage (B)	July 14					59		18		Very bottom surface	19	3,192		
stage (B)	July 18					42	24		17	" " " "	20	3,024		
stage (B)	Aug. 18	32	23	35	66	30	40	74	28	Edges against curre	42	6,976		
2003 (B)	Aug. 18	50	22	11	23	52	20	54	25	" " " "	32	5,376		
2003 (B)	Aug. 18	66	36	40	56	40	32	47	65	Current running thrh collector	47	11,765		
Smelt creek head (b)	July 14					8	15		16	From bottom surface	97	1,629		
Smelt creek head	July 18					24	39		5	From bottom surface	17	2,876		
Ellerslie creek (Roy Ings)	Aug. 1	82	79	73	68	58	119	63	71	Undetermined positi on collector	75	12,600		
Inman bed stage-shells	Aug. 1	79	27	22	21	54	56	15	34	Current running thrh	49	8,232		
	Aug. 8	147	100(rough side)			92	74							
stage	Aug. 18	0	2	1	0	Tarred collectors		3	2	23	8	Edges against curre	5	840

TABLE VI.

Occurrence of Mytilus, Mya, Teredo and Venus larvae.

(Approximate sizes of largest individuals in tows)

Date	Location	Mussels (u)	Clams (u)	Teredos (u)	Quahaugs (u)	Remarks
June 20	Stage	340	320	Umbo stage	-----	Mussels 75% of bivalves.
June 20	2001	350	332	215 deep	-----	Mussels all stages.
June 27	Bentinck cove Inman bed	220	200	Umbo stage	-----	Few bivalves.
July 2	stage	Str.hinge mostly	337	All stages	Str.hinge-few	Quahaugs first noted.
July 4	Stage	" " & 320u	Str.hinge st.	" "	Str.hinge- numerous	
July 4	Inman bed	300	230	" "	300u	Quahaugs seem far ahead here.
July 4	Clark's creek	290	230	" "	280u - few	
July 4	West of Grand river bridge	259	311	Umbo stage	323	Few str.hinges or anything
July 4	Shipyard creek	312	250	Umbo stage	300	
July 4	Nebraska creek	300	300	All stages	390(length)	
July 6	Waite's creek	300	250	All stages	none	Few bivalves
July 7	Stage	280	350u-few 200u-many	198u majority	1st stage umbo	
July 7	E. of Carr's bed	300	250	All stages	358	
July 7	Inman bed	324	259	Many str. hinge	330	
July 8	Trout river	320	232	All stages		Teredo - 1.3% of population.
July 11	Curtian Island				210u to 290u	Great many larva especially quahaug
July 11	Inman bed	Mostly str.hinge	Mostly str.h	str.hinge	220ulst umbo stage	

TABLE VI. (CONTINUED)

Date	Location	Mussels	Clams	Teredos	Quahaugs	Remarks
July 14	Stage	350 (u)	354 (u)	280(u) deep	470(u) length	Relatively few teredos and mussels
July 14	Conway narrows	311	239	220	380	
July 14	Foxley river	291	226	All stages	str.hinge	
July 14	Inman bed	317	265	193	436 (length)	
July 19	Stage	Very few of any stage	Few of any stage	Some beginning umbos	Few in water	
July 19	Nebraska creek	229	229		350	Few str.hinges quahaugs dead and transparent.
July 19	West of Grand river bridge	296	269	200		
July 20	Bedeque bay	283	229	Str.hinges and 1st umbos	-----	
July 20	2001	none	none	none	none	High wind
Aug. 1	Inman bed	Few str.hinges	Very few	few 1st stages of umbos	none	
Aug. 1	McDonald's creek					Many str.hinge stages.
Aug. 2	Stage	Str.hinge stages	Few 345	Str.hinges	None in water	Teredos 75% of bivalves.

TABLE VI

Settlement of molluscan larvae other than oysters at landing stage.

June	22		23		24		26		27		28		29 July		1	3		4		5		6		7		8		10			
Depth	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	T	B	
Mytilus																															
12"	79	5	2	1	13	0	6	0	10	1	0	0	0	1	0	0	-	-	0	0	-	-	0	0	0	0	0	0	0	0	0
6"	107	7	3	0	3	0	4	3	2	1	1	1	2	0	5	0	1	0	0	0	4	0	-	-	0	0	0	0	-	-	
24"	55	7	13	0	2	0	10	3	2	0	2	0	4	2	14	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	
42"	12	3	0	0	40	1	24	3	0	0	6	3	5	1	21	2	2	1	2	2	0	0	2	0	1	1	-	-	4	0	
60"	2	2	3	0	2	1	10	4	3	0	8	4	12	3	14	5	2	2	1	1	2	2	1	0	1	0	2	0	4	0	
Mya																															
12"																															
Out	0	0	2	1	0	0	0	0	7	0	0	1	0	0	0	0	-	-	0	0	-	-	12	0	4	1	1	0	-	-	
6"	8	2	2	0	1	2	0	1	0	2	2	0	2	0	0	0	4	0	0	0	0	0	17	0	3	0	0	0	0	0	
24"	2	1	5	1	4	5	2	2	2	1	1	0	1	1	4	0	3	0	1	1	0	0	31	0	7	2	0	0	2	0	
42"	0	0	3	0	8	0	3	3	0	0	1	2	2	2	11	1	9	0	1	1	10	0	10	0	2	1	-	-	6	0	
60"	0	0	8	0	0	0	4	4	3	2	1	1	6	3	7	1	1	0	2	1	5	2	12	0	2	0	2	0	4	0	
Teredo																															
12"																															
Out	0	0	24	3	45	8	14	0	15	3	10	0	7	4	0	0	-	-	3	0	-	-	25	1	6	1	3	0	0	0	
6"	18	3	4	1	18	2	10	6	10	8	8	1	6	1	2	0	14	1	8	4	14	0	21	2	22	8	84	0	-	-	
24"	12	2	21	3	11	5	18	2	5	3	17	3	2	3	11	2	3	1	9	4	6	5	16	2	10	12	0	0	15	0	
42"	6	1	26	0	5	2	24	10	11	3	40	13	16	8	124	10	14	3	22	2	20	0	50	8	30	6	-	-	38	3	
60"	4	0	66	0	7	3	6	4	20	7	15	3	10	2	19	20	7	4	0	32	7	30	0	266	2	45	4	53	0	84	5
Venus																															
12"																															
Out																															
6"																															
24"																															
42"																															
60"																															
12"																															
Out																								14	0	6	1	2	0	0	0
6"																							16	4	8	2	7	0	-	-	
24"																							4	0	22	8	0	0	4	0	
42"																							8	0	14	6	-	-	2	0	
60"																							0	0	7	3	0	0	3	0	

TABLE VIII.

Vertical distribution of larvae, July 14-15, 1938.

Time	Depth			Centre	Remarks
	Surf.	Centre	at Bottom		
12:00 noon Thursday July 14	950	1216	---	4 ft. 3 in.	Hose too near bott Sample too silty examine.
3:00 p.m.	1850	2584	992	3 ft. 5 in.	Few large umbos in surface sample.
6:00 p.m.	1278	792	336	3 ft. 10 in.	
9:00 p.m.	260	45	427	4 ft. 2 in.	
12:00 mid- night	242	453	30	4 ft. 8 in.	
3:00 a.m. Friday July 15	1073	105	102	4 ft.	Surface had more teredos than any other sample.
6:00 a.m.	63	103	97	3 ft. 11"	
9:00 a.m.	405	160	27	3 ft. 11"	
12:00 noon	140	194	27	4 ft.	
3:00 p.m.	369	1032	34	4 ft. 1 in.	Surface - few umbo Centre - many str. hinges and young umbos.

Spatrall on experimental collectors, July 14-15

Time	Upper side						Lower side				
	1	2	3	4	5		1	2	3	4	5
6:00 p.m.	0	0	0	4	1		0	0	0	0	0
9:00 p.m.	0	0	0	0	0	0	0	0	0	0	0
12:00 mid- night	1	3	0	5	2		0	0	0	0	0
3:00 a.m.	0	1	0	0	0		0	0	0	0	1
6:00 a.m.	0	1	1	0	0		0	0	0	0	0
9:00 a.m.	0	3	0	0	0		0	0	0	0	0
12:00 noon	0	1	1	0	0		0	0	0	0	0
3:00 p.m.	0	4	0	0	0		0	0	0	0	0

TABLE IX.

Vertical distribution of sets at 2003

Date put out	Date Sampled	Upper collector				Lower Collector				No. in series or Depth	Current
		Horiz. Top	vert. Bot.	Up st.	D. st.	Horiz. Top	Vert. Bot.	up st.	D. st.		
July 13	July 23	30	20	10	11	17	31	22	20	No. 1	Vert. ag at curre
July 13	July 23	42	28	16	22	23	25	9	15	No. 2	"
"	"	63	48	33	23	36	87	40	32	No. 3	"
"	"	128	119	55	61	200	246	114	121	No. 4	" "
"	"	264	232	149	130	215	294	220	168	No. 5	" "

Vertical distribution of sets at 2001.

Date put out	Date sampled	Upper collector				Lower Collector				No. in Series	Current.
		Horiz. Top	Vert. Bot.			Horiz. Top	Vert. Bot.				
July 13	July 25	0	1	0	0	0	0	0	0	(1)	Current running through.
"	"	8	32	9	10	15	19	21	25	(2)	" " "

TABLE X.

Vertical distribution of fouling.

Station 2003																			
No. 1				No. 2				No. 3				No. 4							
Upper coll.		Lower Coll.		Upper coll.		Lower coll.		Upper coll.		Lower coll.		Upper coll.		Lower coll.					
Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.				
T	B	uf	df	T	B	uf	df	T	B	uf	df	T	B	uf	df				
82	24	15	48	72	32	17	22	62	42	18	19	82	14	23	24				
												<u>Total of all sizes</u>							
												173	69	63	58	134	54	30	62
No. 1 A				No. 2 A				No. 3 A				No. 4 A							
70	25	28	33	64	26	25	29	62	15	20	27	84	22	17	30				
												<u>Total of all sizes</u>							
												139	79	81	45	142	120	58	104
Average				Average				Average				Average							
76	24	21	40	68	29	21	25	62	29	19	23	83	18	21	27				
Station 2001																			
No. 5				No. 1				No. 2											
Upper coll.		Lower coll.		Upper coll.		Lower coll.		Upper coll.		Lower coll.		Upper coll.		Lower coll.					
Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.	Hor.	Vert.				
T	B	uf	df	T	B	uf	df	T	B	uf	df	T	B	uf	df				
28	50	28	30	153	81	53	51	72	36	15	32	66	54	17	36				
												108	76	14	16	128	131	46	41
No. 5 A				No. 1 A				No. 2 A											
37	25	25	29	92	68	28	45	66	69	16	27	88	112	20	27				
Total												102	26	13	21	36	96	15	20
50 98												Average				Average			
83	36	27	30	123	75	35	48	68	56	16	30	77	83	18	37				
												105	51	14	18	82	118	31	31

TABLE XI.

surface fouling in relation to time.

Date put out	Position No. on Pole.	Upper Collector			Lower Collector			Remarks			
		Horiz. T	up float B	Vert. down float	Horiz. T	up float B	Vert. down float				
July 5	1	b	16	7	4	9	10	7	4	7	
	1	c	12	5	4	6	5	11	3	11	
	2	a	15	8	5	7	4	14	6	8	
	2	d	18	6	4	8	9	17	10	14	
	2	g	12	11	4	5	0	5	5	12	
	3	c	16	9	4	8	3	13	8	14	Bottom horizontal w
	3	r	10	6	2	3	4	13	2	4	X deposit around ed
	4	b	13	15	4	7	10	7	6	11	
	4	c	17	15	6	16	14	10	8	15	Verticals with a li
	5	a	29	20	7	13	23	28	11	9	X deposit.
	5	d	13	23	11	10	5	30	6	7	
	5	g	13	3	6	10	3	24	7	9	Algae present in gr
			178	122	59	102	70	179	76	120	other.
			14.9	10.2	5	8.5	5.8	15	6.3	10	
July 9	1	a	15	11	9	13	4	18	16	8	Algae present.
	1	d	8	13	4	6	4	25	7	12	
	1	g	3	4	2	5	3	4	2	2	Horizontals with X
	2	c	25	16	11	14	15	20	4	12	deposit.
	2	f	13	12	4	14	12	16	6	7	
	3	b	8	14	6	13	8	15	8	7	
	3	c	15	8	6	9	9	12	10	12	
	4	a	5	30	7	18	11	45	8	14	
	4	d	6	7	7	9	5	13	6	9	Algae on lower coll
	4	g	18	22	9	15	16	48	3	4	or.
	5	c	8	15	15	16	8	27	6	15	some X deposit on
	5	f	5	23	12	10	15	27	8	10	upper collector.
			129	175	92	132	110	270	85	112	
			10.8	14.6	7.6	11	9.2	22.5	7	9.3	

TABLE XI. (CONTINUED)

Date put out	Pole No.	Position on Pole.	Upper Collector				Lower Collector				Remarks
			Horiz.		Vert.		Horiz.		Vert.		
			T	B	up float	down float	T	B	up float	down float	
July 13	1	c	3	4	2	4	3	4	3	3	Upper collec
	1	f	9	17	3	6	10	16	7	9	with X depos
	2	b	8	8	2	4	4	0	0	0	Lower collec
	2	c	4	6	4	7	5	7	2	1	with X depos
	3	a	4	5	2	0	4	7	0	0	Both collect
	3	d	5	3	3	0	2	1	0	2	with X depos
	3	g	4	0	3	0	1	0	3	3	
	4	c	4	3	0	1	1	2	2	4	
	5	r	2	3	0	2	10	7	6	27	X deposit ve
	5	b	0	2	0	0	0	6	0	2	heavy both c
5	c	3	0	1	2	4	3	2	3	ors had X de	
											Some X depos
											on both
Total			46	51	20	26	46	53	25	33	
Average			4.6	4.6	1.8	2.3	4.2	4.8	2.2	3	

2001 (Exp. Coll-No. 2.1d)

August 18

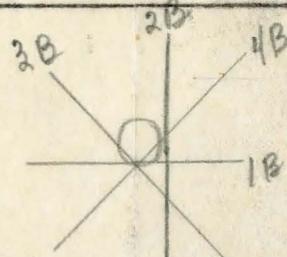
Row No.	Horizontal (total) (count)		Vertical (visible spat)				Remarks
	Top	Bottom	Row No. 4		Row No. 5		
			Down fl.	Up float	Down fl.	Up float	
1	7	9	13	8	8	11	
2	10	13	7	6	8	7	
3	18	13	4	7	5	3	
4	41	16	6	8	7	3	
5	14	11	11	7	9	4	
6	47	18	8	5	8	6	
7	10 17	14					(8B) Completely covered
8	10	4	5	4	4	0	Bryozoan
9	26	15	9	7	5	8	
10	40	15	6	6	8	6	(10T) 4 spat only are 1 or above 3 days old
11	28	32	11	10	8	2	
12	23	36	5	8	12	11	(13B) 13 large spat cov the surface.
13	38	18					
14	36	57	13	8	8	11	

TABLE VIII

Current Effects on Spatfall (Stage)

Exp.	Position of poles	Position of boards on poles	Board No.	No. of spat per 17 sq.cms.	Proportion of predominant spat lengths		silt	Proportion of population calcified	Comparative No. of set on wood grain
1	Against the current or across the stream. No. 1 is nearest the station shore.		1A	3	2.6 +++	(a)	++++	++++	0
				2	2.6+++	opp.side	0	0	++
			1B	216	(1.8 +++, 2.3 ++,)	(b)	+	0	+ (-)
				181	(1 day olds, +2.3)	opp.side	++++	+++	0
			2A	2	1 day old	(a)	++++	++++	0
				1	1 day old	opp.side	0	0	+ (-)
			2B	94	2.2 +++, 2.4 -2 ++, 3.6 +	(b)	+	0	+
				118	2.4 +++, 2.2 ++, 2.6, 3.6 +	opp.side	++++	++++	nothing - no bivalves
			3A	2	(1 day old	(a)	++++	++++	0
				0		opp.side	+	+	+++
			3B	112	2.2 +++, 1.8 +++, 2.2 +	(b)	0	0	+
				83	2 day +++, 1.8 +++, 1.6 +	opp.side	++++	++++	no bivalves
	4A	97	2.2 +++, 3.6, 2.6 ++	(a)	0	0	+		
	Flat of boards against current	115	2 +++, 2.2 ++, 3.6 +	opp side	++++ (-)	++++	0		
	4B	3	(1 day olds, +++)	(b)	++++	++++	0 - many teredo		
		5	(opp.side	+ (-)	0	0		
2	With current or parallel with the stream		1A						
			1B	208	2.2 +++, 3.4 +++, 4.6 ++	(b)	+	0	+++
				158	2.2 +++, 1.8 ++, 3.4 +	opp.side	++++	++++	0
			2A	22	(2.2 ++, 1 day +	(a)	+++	0	0
				12		opp.side	+ (-1)	0	+
						(opp.end)	++	+ (-)	0
			2B	2	1 day +	(b)	++++	++	0 - mostly gastropods
					5	1.8 ++, 1 day +	opp.side	++	0
	No. 1 is up-stream			(other end)		0	0		

TABLE XIII (CONTINUED)

Exp.	Position of poles	Position of boards on poles	Board No.	No. of spat per 17 sq.cms.	Proportion of predominant spat lengths	Silt	Proportion of population calcified	Comparative No. of set on wood grain		
2 Cont'd			3A	112	2.2 +++, 3.4 ++, 1.6 +	(a)	++	0	+	
				136	1.8 +++, 2.2 ++	opp.side	++++	++	0	0
			3B	3	2 +++)	(b)	++++	+++	+ (many clams	
				2	1 day +++)	opp.side	+	0	++ one end)	
			4A	15	1.6 +++, 2 ++	(a)	++++	++	0	
				9	1.6 +++, 2 ++, 3 +	opp.side	+++	0	+++ (one end)	
		Edge of boards into current	4B	5	1. day +++)	(b)	+++++	++++	0	
				4	1 day +++)	opp.side	0	0	++++	
3	up and down stream Single pole.	B was towards the station shore. Edges into current.	1A	8	(3.2 +++, 1 day +	(a)	+++	+	0	
				10	(opp.side	+	+	0	
			1B	42, 10 32, 14	(1.4 +++, 1.3 ++, 2.2 +, no old or young)	(b)	++	0	0	
						opp.side	++ (-)	0	+ (one end)	
4		B was facing up-stream. Boards flat against current.	1A	30	(2 day +++, 2.4 ++)	(a)	0	0	0	
				22	(1 day +)	opp.side	+++	++	+ (one end)	
			1B	18	(1 day +++, 2.4 +	(b)	++ (+)	+ (-)	0	
				10	(opp.side	++	+ (-)	++	
5		Boards diagonally A was up-stream towards station shore.	1A	6	(1 day +++, 2. ++,	(a)	++++	++	0	
				6	(2.8 ++	opp.side	+	+	+ (one end)	
			1B	45		(b)	+	0	+	
				26		opp.side	+++	+	0	

THE PREDICTION OF OYSTER SETS AND NOTES
ON TEN UNIDENTIFIED BIVALVE LARVAE
OF MALPEQUE BAY.

Partial report for summer of 1939

by

Margaret Miller.
Prince Edward Island Biological Station

I. PREDICTIONS OF SETTLEMENT OF OYSTER SPAT.

Ten-minute plankton tows were taken with number 18 net at the following localities: Landing stage and Station 2001 by Mr. C. R. Hayes; Trout river; Conway narrows, Foxley river, Mill river, Hill river, near Riverside Inn, and Mill creek by Inspector of Fisheries L. J. Murphy; Inman bed, Barbara Weit river, Waite's creek, Grand river and Bedeque bay by Inspector of Fisheries H. V. Carr. Predictions of oyster sets were attempted for each of these districts, and the findings will be dealt with below, each tow station being considered in turn.

Figure 1 presents the temperature readings at surface and bottom at the landing stage at the Prince Edward Island Biological station. The following are the approximate temperatures differences calculated for each tow station by comparison of the temperatures taken at the times of the tows with the temperatures at the stage on corresponding days.

Station 2001.....	same as the station.
Trout river.....	same as the stage.
Conway narrows,.....	average of 1°C. higher.
Mill river.....	average of 1°C. lower.
Foxley river.....	average of .4°C. lower.
Hill river.....	same as the stage.
Riverside Inn.....	
Mill creek.....	same as the stage.
Grand river.....	

Inman bed.....same as stage.
Waite's creek.....same as stage.
Barbara Weit river.....same as stage.
Bedeque bay.....average 1°C. lower.

The data obtained from each tow has been assembled in table I and figure 2 and, the conclusions drawn therefrom, employing Dr. Medcof's growth curve compiled in 1938, may be found in table II.

The settlement of oysters on 51 square cm. of surface was recorded on alternate days at the landing stage and station 2001. Thus each item of this data, found in table III, represents the settlement of oysters over the period since the date given for the previous examination, which is usually two days. For the collection of this data cardboard squares were cut from commercial collectors and attached to an upright rod at intervals of 18 inches. The protected horizontal top and bottom surface was examined in the same manner as last year. Number 1 square at the landing stage was out of the water about 18 inches at half tide and at station 2001 the top square was out about 12 inches at half tide.

Total sets at the various localities were calculated from samples of commercial collectors brought in by oystermen after the heavy sets were over.

Because of the long fairly cold spring the gonads of oysters had ample time to mature fully in every district (except perhaps Bedeque bay) by the time the weather brought the water temperature above the spawning threshold. Thus at all tow station mass spawning occurred at practically the same time, causing

predictions of sets to fall on much the same dates for all districts. Earlier in the spring temporary rises in temperature to the spawning threshold, followed by equally sudden drops, caused small quantities of oyster straight-hinged larvae to appear in the water for a short time. Very few survivors were noticed.

Only approximate quantitative comparisons of numbers of larvae at the various tow stations were attempted this year. Boat tows only and no pump samples were taken. The larvae were preserved, allowed to settle to the bottom of the jar and the excess liquid decanted. The sample to be examined was taken from the remaining aggregation. The number of larvae found in each c.c. examined afforded the rough quantitative comparison.

In addition to the unusually long cold spring, the season was exceptional in the very high temperatures which persisted over a month following the initial permanent temperature increase. This unexpected high temperature average brought the oyster broods to metamorphosis and settlement before the date indicated when the broods were younger. Calculation of the length of the free-swimming period proved to be between 18 and 23 days, with the exception of the first brood which has a more normal larval period of 28 days. The average water temperature during the larval life of a brood was as high as 24°C.-- which is 2° above those recorded by Dr. Medcof.

(1) Landing stage at Biological station. Spawning activities, as indicated by the stages of development of the gonads of adult oysters, were followed throughout the season. A

few active sperm were observed to be present in the gonads of landing stage oysters on June 12, but previous spawning seemed improbable. On June 16 Cooper bed oysters were found to be still immature. Nine landing stage oysters on June 17 showed an increased number of active sperms and the gonads were believed to be mature but no spawning was indicated to have taken place. Oyster examinations made on June 27 give the following results:

<u>Male</u>	<u>Female</u>
$\frac{3}{4}$ spent.	$\frac{3}{4}$ spent.
$\frac{1}{4}$ spent.	$\frac{1}{4}$ spent.
no spawning.	No spawning.
	No spawning.

On July 7 the following was observed:

<u>Male</u>	<u>Female</u>
$\frac{3}{4}$ spent.	$\frac{1}{4}$ spent.
$\frac{1}{4}$ spent.	$\frac{2}{4}$ spent.
Nearly spent.	Nearly spent.
" "	" "

Thus most of the oysters spawned between June 17 and July 7. On August 2, oysters still showed the presence of spawn in the gonads, and with the active sperm were observed some spermatids, still undeveloped.

On June 12 the temperature rose to 21.5°C. and as a result a few straight-hinged larvae were observed in the tows on June 15 and 17, but the number decreased until June 20. On June 22 the temperature rose again to 21°C. and a new brood of oyster larvae appeared with a few 166 micra in height from the former spawning. A few days later only an isolated one or two of any size were observed. On June 30 there again appeared very young gray straight-hinged stages and on July 3 they occurred in the greatest numbers observed to date.

On July 7 there were calculated to be about 2100 larvae per c.c. (concentrated) The first prediction for the modal group was made employing a very conservative temperature average and was placed at July 26-27. The temperature remained unusually high and the final prediction was brought ahead to July 24. Smaller and earlier broods were estimated to settle on July 18, 19, and 21. Post-peak sets were expected on July 26 27, 30, August 1, 14, 15, and 24. July 18 set was too insignificant to be termed a brood.

According to the experimental collector squares examined on alternate days with station 2001, the spat began to come down on July 20-21 with the peak on July 23-24, and continued with lesser settlement up to August 5-6-7. Another fair settlement occurred on August 12-13-14. No oyster spat appeared on the experimental collectors after August 26.

From samples taken from collectors hung from floats in Ellerslie creek above the station the following counts were made.

July 28.....	2600 per bundle.
August 1.....	672 per bundle.
August 3.....	4700 per bundle.

From just opposite the stage on August 10, 2800 per bundle were calculated to have settled in that area, and from 2003 on August 4, 4700 per bundle.

It was noted that on the collectors were a great number of oysters larvae smaller than settling size. Height measurements were made of about 40 larvae from experimental collectors, only ten of which showed the growth of dissoconch shell. These ranged from 311 to 346 micra in height. The others, presumably unsettled

larvae, ranged from 201 to 305 micra. Spat with dissoconch shell showing were measured on various subsequent dates and it was found that the greatest number were 332 micra in height - 18 micra below the recognized settlement size for oysters. This fact is paralleled by the exceedingly high temperature average for the oyster free-swimming period. These temperature averages ranged from 22° to 23.8°C. for all the broods, a range of 1.5°, so perhaps any brood differences in height could not be expected. At any rate none were found although this could be attributed to the fact that too small a number were measured to be significant.

(2) Station 2001. No adult oysters from the vicinity of 2001 were examined. The degree of maturity of the gonads was assumed to be similar to that of the stage.

A very few straight-hinged oyster larvae were observed in the tow taken on June 13 as a result of the temperature rise on June 12. These increased in numbers until June 16 and then began to disappear until, on June 19, only 3 or 4 per cc. remained. On June 23, a new brood appeared in the tow, resulting from a temperature of 20° on June 21. Then these also dwindled away in numbers in the succeeding tows. On July 3, a third brood was evident which increased in numbers to July 6. The temperature having risen above the spawning threshold on June 29, remained above this point for a period of nearly two months. Mass spawning took place at the onset of this period and a very nearly continual set was predicted to take place from July 21 to 30, with the peak on the 24th. Later broods were expected to settle on August 12 and

16-17. As indicated by the counts made on the experimental spat collectors hung at 2001, the heaviest sets occurred on July 23-24-25, with the peak of the subsequent broods on August 12. Spat continued to settle until August 23.

Sections of commercial collectors taken from floats hung at 2001 gave the following spat counts:

July 25	29,600 per bundle
August 1.....	7,390 per bundle
August 3.....	24190 per bundle.

(3) Trout river. Adult oysters on July 10 showed the gonads to be:

<u>Male</u>	<u>Female</u>
$\frac{3}{4}$ spent.	$\frac{3}{4}$ spent.
$\frac{3}{4}$ spent.	$\frac{3}{4}$ spent.
$\frac{3}{4}$ spent.	$\frac{3}{4}$ spent.
$\frac{3}{4}$ spent.	

On July 14 the gonads were:

<u>Male</u>	<u>Female</u>
$\frac{1}{4}$ spent.	slightly spent
	$\frac{3}{4}$ spent.
	$\frac{3}{4}$ spent.
	$\frac{3}{4}$ spent.

Although the degrees of spawning as indicated by the gonads was not as great as that of oysters at the landing stage, the dates of prediction were very much the same. From a tow taken near William's lane on July 19th, sets were predicted to occur from July 22 to July 28 with the peak on the 24. Subsequent sets were expected on August 13 and August 15-16.

From sections of cardboard collectors taken from Trout river floats it was indicated that this district had a heavier set than any other station:

July 24.....	2,680 per bundle
July 31.....	50,400 per bundle.
August 7.....	7,392 per bundle

(4) Conway narrows. Adult oyster examinations on July 6 showed:

<u>Male</u>	<u>Female</u>
Slightly spawned	No spawning
No spawning but active	" "
$\frac{1}{4}$ spent.	

From a tow taken on July 19, the same settlement dates were predicted as for the tow stations previously dealt with, e.g. from July 21-28 with the peak on July 24. One or two subsequent tows revealed on examination large quantities of straight-hinged larvae and this fact coupled with the relatively unspawned state of the gonads on July 6 might indicate a heavier second brood settling approximately August 19.

No samples of collectors came in from this district.

(5) Foxley river. Adult oyster examined July 6:

<u>Male</u>	<u>Female</u>
$\frac{2}{3}$ spent.	$\frac{3}{4}$ spent.
$\frac{2}{3}$ spent.	$\frac{1}{2}$ spent.
$\frac{1}{4}$ spent.	$\frac{1}{4}$ spent.

Young straight-hinged larvae of about 68 micra were observed in a tow taken on July 6 at McDonald's creek, thus indicating, in correlation with the spawned state of the adult gonads, that the late temperature rise had caused a spawning in that district and that a set might be expected a little later than at the stage because of the slightly lower temperature average at Foxley river. No other tow came in from this district until July 26 in which there were no larvae of any kind. Tintinnoidea were observed in large quantities. On August 9 a very few oyster larvae were found and on August 17 none. The obvious scarcity of oyster larvae at any time in these tows,

would suggest that Foxley river would not yield a very good set. No collector samples were brought in to be examined.

(6) Mill and Hill rivers. Mill river and Hill river, although they are close together, have apparently about 1° difference in average temperature, Mill river being the lower. Hill river is similar to the stage in temperature average. Hill river also gave indications of sets similar to those expected at the stage from July 21 to 27, while Mill river extended from July 24 to 30. On July 28 at both stations oysters were beginning to disappear from the water and none were observed in tows taken on August 17. On August 2, however, there was observed to be considerable spawn left in the oysters at Mill river. Other bivalves seem to be very numerous at these districts and a heavy mussel set was noted to take place on July 26.

(7) Riverside Inn. At the mouth of Hill and Mill river just opposite Riverside Inn, there were found to be on July 18 less quantities of oyster larvae than at either of the other two neighboring stations, but growth conditions were similar to those in Hill river. On July 26 no larvae of any kind were observed in a tow taken from Riverside Inn waters.

(8) Mill creek (Brown's creek). A July 5 tow from Mill creek contained a very first stages of oyster larvae. The first brood however did not seem to be predominant in later tows although the water temperature average seemed to be about 1.2°C. above the stage. The oyster sets were predicted to start on July 23 and continue to July 28 with July 26 as a definite peak. On July 25 there were not enough larvae to warrant any attempt at prediction. No collector samples came in from Mill creek.

(9) Grand river, just above bridge. Only one tow, on July 7, was brought in from Grand river, Quagmire creek. Straight-hinged larvae, 68-97 micra were present in a concentration of about 100 per cc. It was thus assumed that a set on July 24 would be likely to occur, similar to surrounding districts.

(10) Inman bed, Bentinck cove. Adult oyster gonads examined on July 10 showed:

Female

Male.

$\frac{1}{4}$ spent.	$\frac{1}{4}$ spent	$\frac{1}{2}$ spent.	$\frac{1}{2}$ spent.
$\frac{1}{2}$ spent.	$\frac{1}{4}$ spent.		$\frac{1}{4}$ spent.

A tow taken on July 6 yielded a very few straight-hinged larvae and on July 10 there were 40 per cc. of 68 micra. On July 17 no oyster larvae were observed but this was decided to be due to a faulty net undetected until too late for prediction. On July 29, a size-frequency curve showed a peak set on August 4 and previous smaller sets on August 1 and 3. On August 12 there were no oyster larvae in the water but about every other bivalve was present in large quantities. There was a very poor set at Inman bed this year if the samples brought in are representative. On July 29 there was an average of 1 spat per cardboard square of the collector and on August 10, a tin can surface, 7 inches by 10, had 12 spat settled on it.

(11) Waites creek. Only one tow was brought in from Waite's creek - on July 12. There were no larvae present, and only a very few snails.

(12) Barbara Weit river. Adult oysters were examined on July 12 and the gonads were observed to be:

<u>Male</u>		<u>Female.</u>	
$\frac{2}{3}$ spent.		$\frac{3}{4}$ spent.	$\frac{1}{4}$ spent.
$\frac{1}{4}$ spent.		$\frac{1}{4}$ spent.	$\frac{3}{8}$ spent.

The tow which accompanied these oysters showed that a peak set might be expected on July 23 with a slightly smaller set on July 24. No oyster larvae of any size were in the water on August 12. Collector samples brought in on August 12 showed only 366 per bundle.

(13) Bedeque bay. Oysters from Bedeque bay on July 7 were observed to be:

<u>Male.</u>		<u>Female.</u>	
$\frac{2}{3}$ spent.	slightly spent.	slightly spent.	undetermined.
$\frac{1}{4}$ spent.	no spawning.	$\frac{1}{4}$ spent.	nearly spent.
$\frac{1}{2}$ spent.			

On July 18 the gonads were:

<u>Male.</u>		<u>Female.</u>	
barely spent.	$\frac{1}{2}$ spent.	$\frac{1}{4}$ spent.	$\frac{3}{4}$ spent.
$\frac{1}{4}$ spent.	$\frac{3}{8}$ spent.	slightly spent.	$\frac{1}{4}$ spent.
$\frac{1}{2}$ spent.		$\frac{1}{2}$ spent.	

There were fairly numerous straight-hinged larvae in a tow taken on July 7 but on July 18 and 22 there were too few to make any definite estimate of sets. There were indications, however, that some spat would be coming down on July 28 to August 3 with a smaller set on July 24. From a tow taken August 11 there were strong indications of a fairly heavy set in progress at the time the tow was taken, and there appeared to be a greater total of larvae at this time than at any other time during the season. On August 25 there was again observed to be a set in

progress and a continuation of this set was indicated to the end of the month with a slight peak on August 29.

No collector samples were examined from Bedeque bay. were found to be very nearly constant in various individuals of the same type and to vary in individuals of different types.

These were:

1. The UMBO - which was found to be either high, low, wide, narrow, square or round.
2. The SHOULDERS - or the slope of the prodissoconch shell from the original straight hinge. These could be equal on or unequal on the two sides of the umbo, high, square, long, short, slanting or a combination of these.
3. The BODY - which could be wider than the shoulders, continuing the slope of the shoulders, narrow or flat.
4. The BASE - either pointed, flat or curved.
5. The COLORING - Coloring although it varies considerably in individuals from different districts, and even from the same place, is distinctive enough to warrant its use as a diagnostic characteristic. The location of the coloring in the bivalve and its changes were noted.
6. ADDUCTOR MUSCLES - In the advanced stages, location and size of the adductors may be considered a check in distinguishing bivalves, but in itself not significant other than in placing the organism in its family.

Camera lucida drawings were made to illustrate these studies.

II. UNIDENTIFIED LARVAE.

In distinguishing between the various types of larvae observed in the tows, there were noted several features which were found to be very nearly constant in various individuals of the same type and to vary in individuals of different types.

These were:

1. The UMBO - which was found to be either high, low, wide, narrow, square or round.
2. The SHOULDERS - or the slope of the prodissoconch shell from the original straight hinge. These could be equal or unequal on the two sides of the umbo, high, square, long, short, slanting or a combination of these.
3. The BODY - which could be wider than the shoulders, continuing the slope of the shoulders, narrow or flat.
4. The BASE - either pointed, flat or curved.
5. The COLORING - Colouring although it varies considerably in individuals from different districts, and even from the same place, is distinctive enough to warrant its use as a diagnostic characteristic. The location of the colouring in the bivalve and its changes were noted.
6. ADDUCTOR MUSCLES - in the advanced stages, location and size of the adductors may be considered a check in distinguishing bivalves, but in itself not significant other than in placing the organism in its family.

Camera lucida drawings were made to illustrate these studies.

(1) Quahaugs (venus). The appearance of quahaug larvae will be described briefly. This year they appeared first on July 7 with the first settling on July 17. They occurred from then to the end of the summer in small amounts in most of the tow samples.

Quahaugs may be confused with several forms, namely with "B's" and "G(2)" (see below) in the straight-hinged stages and with "D" in the early umbo stages. Quahaugs have a yellow strip between the mantle and the edge of the shell when young, which remains in more or less the same place while the developing prodissoconch grows out below it. In older free-swimming stages, the yellow colouring is confined to the lower portion of the gills and surrounding shell. The rest of the larva is nearly white with transparent grey digestive organs, and greenish-yellow oval-shaped liver. The liver moves down from the umbo, the oval pointing from the posterior adductor upward, and pales in colour as the quahaug nears metamorphosis. By this time it is quite distinguishable by its outstanding size. The even roundness of the shoulders and their equal length distinguishes the quahaug from the "B's" with the shoulders of unequal length and slant, in the straight-hinged stage. The "D's" have a characteristic large flat umbo and high shoulders which differ from the high round small umbo and round sloping shoulders of the quahaug.

(2) Clams (Mya). Mya at first was believed to be larva "A" (below) because the latter most closely corresponded to Stafford's description. The adductor muscles of Mya are, however, equal, according to Parrott, which was not found to be so in "A" larvae. The only other bivalve which could be fitted into his

description, is the one illustrated here, and it does not seem a quite satisfactory identification.

This larva is quite large in its last free-swimming stage, sometimes found to be 370 micra in length. They are not as numerous as "A" larvae and are of a light olive colour which tends to blacken in formalin as do Teredo larvae. It is mentioned here in comparison with unknown forms.

(3) Larvae "A". These larvae are distinguished for the brown pigment spots scattered throughout the mantle. In younger stages particularly they line the mantle edge with a few beneath the umbo line. In the advanced stages the pigment is found in chains in various portions of the whole animal. The hinge line is short, early being covered by the advancing umbo. The umbo is low, broad, and gradual in slope, its line following the slope of the shoulders. The shoulders are low and very nearly straight, and the body and base merge into a continuous curve, slightly flat on one side - the side which possesses the adductor muscle. One shoulder is slightly higher and shorter than the other. In the early stages the bivalve is silvery with faint yellow liver and the characteristic brown pigment spots outlining the mantle. Later these chocolate brown spots cause it to stand out from all the other bivalve larvae regardless of other variations. The liver also later takes on an orange brown colouration. The adductor muscles are very unlike in size, the one beneath the higher shoulder being the only one visible in the last stage of larval growth.

These larvae first appeared on July 3 this summer. Thus spawning probably takes place at about 20° C. On July 12 they had reached their full larval size. They were present in

The water until the middle of August.

(4) Larvae " " Advanced Stage: The umbo is low, wide, and very square. The shoulders are high, square, long, one higher than the other with the body below this one sloping more sharply to the base making it slightly pointed on one side. The body slopes inward from the shoulders to the rather narrow base line giving the larvae a top-heavy appearance. The colouring is a bright lemon yellow, the brightest yellow of any larvae noted. Directly beneath the umbo is a white-grey area shading into the drab grey of the organs with no distinct colouring in the liver. Scattered throughout the liver are numerous transparent circles. The adductors are unequal in size, directly opposite each other, the larger being on the thicker side of the body.

Smaller stages: The younger stages are most easily confused with quahaugs, the yellow band around the outside of the prodissoconch and the shoulder slopes, being common to both. If examined more closely the larvae considered here will be noted to have straight shoulders, one slant from the hinge line being longer than the other and the slope on one side of the body resembles the adult. The longer, square and distinct umbo is also diagnostic.

These larvae were first noticed about the middle of July and were then in an advanced stage. Thus spawning must have taken place around the first of the month. They were

only taken from collectors once - on August 4 and thus apparently do not attach themselves easily. At the stage they were not noticed after the middle of August. In regard to the proportions they are similar only to clams, for there is a difference of about 35 micra between length and height of both. The greater slant of the body edge in clams and the brighter colour of these "B" larvae distinguish them.

(5) Larva "C". These larvae are a great deal like *Mytilus*. In fact they were not distinguished until about the middle of the summer. It was thought at that time that they might be *Modiolus* although in *Modiolus*-prevalent areas in Cape Breton Island no significant quantities of these larvae were found in the tows. However, this may be due to the fact that the tows were obtained in the middle of July at Cape Breton Island when, at the Station, the larvae had very nearly disappeared from the water.

The hinge line is practically the same length in relation to the larval length as is found in *Mytilus* but the corners are noticeably more indented. The umbo is broader and flatter than in *Mytilus* and proves the most easily recognized characteristic. The umbo line forms a dark, broad bar beneath the hinge line, while in *Mytilus* the umbo is faint and fine. The shoulders are not quite so straight or so long and the body line on the deep side is not as flat as that of *Mytilus*. Neither is the slope of the pointed side as sharp. Thus "C" larvae give a slightly more round appearance. The colour is perhaps a less intense yellow than in the *Mytilus*. The adductor muscles are similar in size and position to those of *Mytilus*.

This larva occurred at the same time as Mytilus and in the same broods. It was first found on collectors on July 14 and disappeared from the water at the end of July.

(6) Larva "DW" These larvae are distinguished by the fact that they are silvery all through the free swimming period. The later stages are most easily confused with quahaugs, mostly because of their colouring. The umbo is broader and higher but shaped somewhat in the same angular way. The outline is symmetrical with wide, round shoulders becoming straighter with age. The body continues the roundness of the shoulders and is broadest at the shoulder base. The base line is also round. There is a slight sharpness on one side formed by the sudden slope of the body to the base line, but this is not as distinct as in either Mytilus or "C" and lies between "C" and quahaugs. The colouring is confined to the liver and gills - the liver being a light greenish orange and the gills a lighter shade of the same. The adductors are very unequal, the only distinct muscle being found on the pointed side of the body.

The younger stages cannot be confused with quahaugs because of their r under shoulders and almost complete absence of colouring. They are silvery, resembling "A" larvae with lighter liver but without the brown spots and with rounder shoulders and a distinct line continuing the straight hinge line into the bivalve and closely surrounding the digestive organs.

These larvae seem to follow along the with the quahaugs, having a slightly higher spawning threshold than Ostrea. They were found on collectors the least of July. The height in

proportion to the length most resembles quahaugs. These larvae are not really very numerous, certainly not more so than quahaugs.

(7) Larvae "E". In the advanced stages the umbo is small, rather pointed like a blunt inverted V. The shoulders are very slanting, one higher than the other. The shoulder and umbo are outlined by a dark purplish refractory line. The base of the shoulders are not quite the point of the greatest length, but the length line extends from below the high shoulder base to below the low shoulder base in a slanting direction. The base line is oval with the lowest point to one side and below the high shoulder, making the valve thicker on one side than on the other. The colouring resembles *Mytilus* except that it is of a more greenish-yellow with a more definite orange colouration in the liver. Below the umbo is a narrow area of transparent grey. The whole bivalve gives the appearance of being very much cluttered up with internal organs. The mantle is greatly convoluted and the adductors are equal on both sides and directly opposite.

The younger stages are characteristic in their very narrow anterior and very wide posterior ends.

These larvae first appeared about July 10 which means they have a spawning threshold near 20° as do the oysters. They were present more or less continuously the rest of the summer. Some were found on collectors - apparently being able to attach themselves. If it is a *Prionodesmacean* then it may be *Yoldia*, for both adductors are present and of equal size. This bivalve is most easily confused in general outline with larva "F", but the proportion of height to length is greater in "E" than in "F".

(8) Larva "F". These larvae were noted in the summer of 1938 in August in very great numbers. This summer due to the lateness of the season the early stages were noted about the first of August whereas last year they were full grown larvae at that time. They appeared in the tows in various stages of development until the first of September.

In the later larval stages, when the animal is on a slant, which is the most usual position because of the bottom-heavy shape of the shell, the straight hinge line is still visible with the umbo rising above it. The umbo is high, somewhat square and fairly large, although the shoulders, which fall sharply away from the narrow hinge line, give it a narrow appearance. The shoulders are unequal in length and slope, the longer showing the most abrupt drop. This is more apparent in the earlier umbo stages. The body line curves slightly outward from the shoulder base giving the greatest width of the larva near the free edge of the valves, and nearer the rather flat curving base line. The body beneath the short shoulder has the greatest height and contains the larger round adductor. The colouring of "F" is greenish yellow with characteristic green horseshoe-shaped liver. The digestive organs are slightly more of an orange-yellow.

The younger stages were differentiated from similar forms, especially "E" in the following way. The "E" were noted to have a more reticulated interior, with a slightly convex curve in the shoulder line, and a more indistinct body and base outline. The clear green horseshoe-shaped liver is also lacking in "E". Because the base is heavy in "F" the consequent tilt of the

larva causes the projecting umbo to give a more pointed impression than the straightened round form.

No "I's" were found on collectors. In relation of length to height they most resemble "E". The hinge-line length and squareness of the shoulders are distinguishing characteristics.

(9) Larvae "G(1)", "G(2)" and "G(3)". The bivalves of this group were only seen rarely. In fact these drawings represent the times they were observed, except (2) in which case the first occurrence was not recorded with sketches.

(1) was colourless looking and shaped much like "F" except that the proportions of length to height were unlike, and the green liver was not observed in (1)

(2) was only noticed five times and three of these were in a single tow taken at Bedeque on August 25. The first two were observed in a sample from Mill creek on July 15, but no drawings were made. They measured 97 x 97 and 83 x 85 micra. At this stage no shoulders were visible and the body seemed to fall directly away from the wide hinge line to the wider base line. The colouration was the same as that observed in older forms. It resembles "B" larvae in colouration and form except that the shoulders are equal and the height looks greater than the length due to the narrow shoulders and deeply convex base line. Most forms occur at the stage before they do at Bedeque bay due to the higher temperature at the stage. Since this form had not appeared at the stage at all, according to my observations, it might indicate that (2) is a form common to Bedeque and open waters only.

(3) resembles "F" somewhat in general outline with the heavier part of the larva below the shoulders. It, however, has two distinguishing features in the slightly concave shoulder line and the very distinct dark posterior limiting line to the gills, with a clear space between them and the posterior adductor, the larger of the two muscles.

(10) Larva "H". This form was not noted in the tows at any time, nor could it likely be confused on collectors with young stages of other forms because its height exceeded its length which is unknown in any other bivalve studied. The fact no internal structure could be discerned somewhat indicates that they are dead forms caught here or that conditions on the collector resulted in their death after settlement. Last year, 1938, they appeared on collectors from July 5-20 and this year were noticed around July 14. The closest resemblance to this form which was found in the tows was (1) of "G", although judging from the numbers which settled out in 1938 there would have been more in the water samples examined than were noted. This might possibly be explained by the small size at which they settle, thus getting through the meshes of the tow net, at least in the younger stages.

TABLE I.

Location		Frequency of height measurements in micra (with																								
		68	75	81	88	95	102	108	115	122	129	136	142	149	157	165	170	176	183	185	197	203	210	217	224	
Landing stage	July 12	15		16		17		18		19		20		21		22		23		24		25		26		
"	July 14	9	7	11	13	12	10	14	13	7	15	13	7	2	5	1										
"	July 14										38	57	40	19	23	8	1	2	1	3			1	1	2	
"	July 17								3	2	7	5	13	21	25	30	37	33	19	33	33	28	15	19	6	
"	July 21											2	1	3		10	5	8	8	8	4	15	5	10	7	
"	July 26																									
"	Aug. 7	Large numbers of small sizes										4	6	10	6	6	4	15	25	10	22	13	11	7	5	
"	" 11											9	5	4	2	4	8	16	12	4	23	26	8	8	4	
"	" 18											1		7	10	18	19	18	14	23	6	18	10	6	3	
Station 2001	July 11	11	11	17	34	38	8	3	5	4	1	6	7	3												
"	" 13	7	7	6	8	22	17	30	55	33	34	23	14	9	3	6	3	1	3		3	2	1			
"	" 20											10	5	20	5	23	15	18	12	13	11	24	8	20	18	
"	Aug. 10											3	1	8	12	17	13	13	20	13	7	11	5	10	2	
Trout river	July 14	1	1	35	34	20	17	35	18	3	23	36	5	8	2	2										
"	" 19	Large numbers										5	9	8	14	13	21	31	23	26	34	2	34	15	20	12
"	" 25											1	2	6	11	11	10	13	15	8	10	21	22	25	12	
"	Aug. 7											12	13	10	13	20	10	12	10	18	6	6	2	2	2	
Conway Narrows	July 19												15	5	10	10	14	11	12	16	24	22	27	17	17	
Mill river	July 19									13	22	37	20	42	23	31	18	17	9	7	4	8	3	3	3	
Hill river	" 19											21	17	22	22	27	13	23	6	11	15	25	15	12	14	
Inman bed	" 21											30	6	13	4	7	2		2	1	1	1		1	1	
"	" 29													7		10	5	12	8	21	17	16	7	17	7	
Mill creek	" 14	15	75	26	8	3	1	6	6	8	4	2		2												
"	" 18											14	11	19	19	33	23	19	16	20	14	15	6	15	3	
Foxley river	" 21											1			1	5	1	5	2	2		4		3		
Barbara Weit R.	" 12		4	8	3	5	3	15	10	3	23	18	22	6	3	3	2	1								
Bedeque bay	" 22											20				9		19	8		4	17	4	12		
"	Aug. 11											3			3	3					8	6		6	3	
"	" 25													6	2	4	6	4	10	14	12	16	5	8	13	

TABLE I (Continued).

corresponding micrometer units).																No. per cc.	Time	Tide	Temperature (°C.)		
231	237	244	251	258	264	271	278	285	292	298	305	312	319	325	332	339					
<u>17</u>		<u>18</u>		<u>19</u>		<u>20</u>		<u>21</u>		<u>22</u>		<u>23</u>		<u>24</u>		<u>25</u>					
																	1720				
																	392				
2	1		2			(ignoring all below 9.5 units)													800		
4	1	1	1	3		3				1	1	1			2		1625				
10	6	16	9	10	1	7	2	9	2	7	1	4					170				
20	10	6	7	4	7	10	3	3	5	6	2						620				
5		4		1	2	5											159				
8	17	9	7	8	3	7	10	4	5	16	8		2	1		3	110				
5	8	6		4		1		1									89				
																	800				
1																	1445				
31	17	11	19	13	5	16	4	9	4	7	2	1					884				
7	4	4	1	6	1	5		3		2	1					1	169				
																	1230	11:25 a.m.	21.6°		
20	23	9	7	6	1	3	2	1		1		1					2230	8:00 a.m.	20.2°		
12	10	11	11	13	4	9	4	2	4	7	7	2	1	3	2	2	852	5:45 a.m.	20.5°		
2		5															435	9:15 a.m.	23.2°		
12	15	5	16	5	4	2	4	3	1		1	1	2				371	4:15 p.m.	23.0°		
	2							1									1715	12:30 p.m.	22.4°		
15	5	13	13	14	8	11	4	4	1	4	2	1	7			2	1480	11:10 a.m.	23.5°		
5	2																76	4:00 p.m.			
8	13	7	5	5	4	16	5	7	7	5	2				2	1	114				
																	156	2:30	21.2°		
4	3	3	1			3				1	1	1					72	9:45 a.m.	21.0°		
1	1	1		3		1	2		1	1	1						5	1:45 p.m.	20.0°		
																	115	7:00 a.m.	20.0°		
	4			2		2										3	34				
9	9	3	12			6	3	6	6	9	6	3	6	9	2	9	64				
8	8	10	6	10	7	8	2	8	2	2	4		4	2	12	2	97				

TABLE II.

Set predictions at tow stations.

<u>Locality</u>	<u>Date of Examination</u>	<u>Temperature indications.</u> Probable sp. date and temp.	<u>Height of modal group.</u> (micra) (°C)	<u>Brood</u>	<u>Average temp, from probable spawning date.</u> (°C.)	<u>Predicted date of settlement.</u>	<u>Length of free swimming period.</u> (According to prediction)
Landing stage.	July 12	July 5 22.7	103.48	6	23.8	July 24	19 days
" "	July 17	June 12 ----	325	1	20.0	July 18	30 "
" "	July 17	June 21 21.1	264.32	2	20.8	July 19	28 "
" "	July 17	June 30 20.1	216.96	3	22.5	July 22	23 "
" "	July 17	July 2 ----	196.52	4	22.8	" 24	22 "
" "	" 17	July 4 21.7	169.58	5	23.0	" 26	22 "
" "	" 17	" 7 22.7	149.16	7	23.3	" 27	20. "
" "	" 26	26" 7 24.9	230	7	22.5	" 30	23. "
" "	" 26	" 9 23.4	208	8	22.3	Aug. 1	23 "
" "	Aug. 11	" 26 26.8	203	9	23.4	" 15	20 "
" "	" 11	" 27 25.9	179	10	23.2	" 17	21 "
" "	" 18	Aug. 3 22.4	193	11	23.2	" 24	21 "
" "	" 7	July 25 ²⁵ 22.2	183-196	9	23.8	Aug. 14-15	20 "
Station 2001	July 13	July 5 22.7	122	6	23.8	July 25 24	19 "
" "	" 20	June 29 21.1	298	3	22.6	July 21	23 "
" "	" 20	June 30 20.1	271	4	22.5	July 22	23 "
" "	" 20	July 2 --	230	5	22.8	" 24	22 "
" "	" 20	" 4 20.2	203	7	23.0	" 26	22 "
" "	" 20	" 8 23.4	162	8	23.0	July 29	21 "
" "	Aug. 10	July 29- 23.6	162-183	9	23.8	Aug. 16 & 17	19 "
" "	" 10	" 29 24.9	257	10	24.0	Aug. 12	18 "
Trout river	July 14	July 5 24.5	135	6	24.0	July 23	18"
" "	" 19	" 3 ----	237	5	24	July 22	19 "
" "	" 19	" 5 24.5	217	6	23.9	" 23	18 "
" "	" 19	" 6 25.5	184	7	24	" 24	18 "
" "	" 19	" 7 26.5	169	8	23.8	" 25	18 "
" "	" 19	" 8 24.9	149	9	23.5	" 28	20 "

TABLE II (Continued).

<u>Locality</u>	<u>Date of Examination</u>	<u>Temperature indications.</u> Probable sp. date and temp. (°C)	<u>Height of modal group</u> (micra)	<u>Brood</u>	<u>Average temp. from probable spawning date</u> (°C)	<u>Predicted date of settlement.</u>	<u>Length of free swimming period.</u> According to prediction. (days)	
Trout river	July 19	July 2	--	257.	4	23.5	July 21	19
" "	July 25	July 10	26.0	203-216	10	23.5	July 30-31	20
" "	Aug. 7	July 25	22.2	184	11	24 +	Aug. 13	18
" "	" 7	" 28	23.9	149-162	12	24 +	Aug. 15-16	18
Conway Narrows	July 19	" 5	23.7	203	2	23.7	July 24	19
" "	" 18	2 --	244	1	23.7	July 21	20	
" "	" 19	" 7	25.9	162	3	23.2	" 28	21
Mill river	" 19	" 3	20.2	203	1	22.7	" 24	21
" "	" 19	" 5	22.7	176	2	22.8	" 27	22
" "	" 19	" 7	24.9	149	3	23.1	" 28	21
Hill river	" 19	June 30	20.1	271	1	22.7	" 21	22
" "	" 19	July 3	20.2	203	2	22.7	" 24	21
" "	" 19	" 5	22.7	162	3	22.8	" 27+	22
Mill creek	July 14	July 1	--	74	1	23.0	" 22	21
" "	" 18	" 3	20.2	216	2	23.5	" 23	20
" "	" 18	" 7	24.9	162	3	23.0	" 26	21
Barbara Weit R.	July 12	July 3	20.2	122	1	23.2	July 23	20
" "	" 12	" 5	22.7	136	2	23.8	" 24	19
Inman bed	" 21	" 3	20.2	230	2	22.7	July 25	22
" "	July 21	" 3	23.4	162	3	22.6	" 30	22
" "	" 29	" 9	24.5	271	4	22.3	Aug. 1	23
" "	" 29	" 13	22.3	216	5	22.9	Aug. 3	22
" "	" 29	" 15	--	184	6	23.3	" 4+	20
Bedeque bay	Aug. 11	July 18	21.2	332	1	22.4	Aug. 11	23
" "	" 25	Aug. 3	21.4	339	2	23.0	" 25	22
" "	" 25	22.4	207	3	23.2	" 29	21	

TABLE III.

Oyster sets on experimental collectors at landing stage.

Depth at $\frac{1}{2}$ tide	<u>TOP</u>																	
	July							August										
	19	21	24	26	28	31	2	4	7	9	11	14	16	18	21	24	26	29
18"	0	0	-	4	0	0	0	0	0	0	-	-	0	0	0	0	0	0
Out 0"	0	0	5	3	0	0	0	0	0	0	0	-	0	0	0	0	0	0
18" under	0	0	7	11	0	2	0	0	0	0	-	0	2	0	0	1	0	0
32"	0	0	6	3	20	1	2	0	0	0	0	0	0	1	0	0	1	0
50"	0	1	72	7	0	4	5	1	1	0	0	0	3	0	0	0	0	0
68"	0	0	14	7	0	-	0	-	0	0	0	0	0	0	0	0	1	0

		<u>BOTTOM</u>																	
18"	1	0	0	1	0	0	0	0	0	0	-	-	0	0	0	0	0	-	0
Out 0"	0	0	3	0	0	0	0	0	1	-	0	-	0	0	0	0	0	-	0
18" under	0	0	4	3	0	5	0	4	4	0	-	2	1	0	0	0	0	0	0
(horizontal surface) 32"	2	0	29	0	3	6	1	0	3	0	0	5	0	1	0	0	0	0	0
50"	0	0	14	6	17	23	3	2	4	0	0	4	5	0	1	0	1	0	0
68"	<u>0</u>	<u>0</u>	<u>24</u>	<u>22</u>	<u>9</u>	<u>-</u>	<u>0</u>	<u>-</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>10</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>0</u>
Total	2	1	178	77	31	41	11	7	14	0	0	21	11	3	2	2	3	0	0

	B	T	T	B	B	B	T	B	B	B	B	B
Mode	32"	50"	60"	68"	50"	50"	18"	18	0	0	68"	50"

TABLE III (CONTINUED).

Oyster sets on experimental collectors at station 2001

Depth at $\frac{1}{2}$ tide	<u>TOP</u>																		
	18	20	22	25	27	29	1	3	5	8	10	12	15	17	19	22	25	28	30
12" out	0	0	0	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6" under	0	0	1	2	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24"	0	0	0	0	0	0	1	0	0	0	0	-	0	0	1	0	0	1	0
42"	0	0	1	49	0	0	3	0	0	0	0	0	1	2	0	0	1	0	0
60"	0	0	9	67	2	0	1	0	0	0	0	2	1	1	2	1	0	0	0
78"	0	0	0	12	4	0	2	2	0	0	0	6	0	1	0	0	1	1	0

Depth at $\frac{1}{2}$ tide	<u>Bottom</u>																		
	18	20	22	25	27	29	1	3	5	8	10	12	15	17	19	22	25	28	30
12" out	0	0	0	4	0	0	0	0	0	0	0	0	0	0	0	0	-	0	0
6" under	0	0	0	1	-	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24"	0	0	0	0	0	0	0	0	0	1	0	0	0	3	0	0	1	1	0
42"	2	0	1	68	2	0	0	0	0	0	0	0	2	0	1	1	0	0	0
60"	1	0	0	86	9	0	4	0	0	0	0	0	1	1	1	0	0	0	0
78"	<u>0</u>	<u>0</u>	<u>0</u>	<u>8</u>	<u>3</u>	<u>0</u>	<u>8</u>	<u>5</u>	<u>0</u>	<u>1</u>	<u>0</u>	<u>4</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>0</u>	<u>0</u>	<u>2</u>	<u>0</u>
Total	3	0	5	303	20	0	19	7	0	2	0	12	6	10	6	2	3	5	0

	B		T	B	B		B	B			T	B	B	T					
Mode	42")	60"	60"	60"	0	78"	78"	0	-	-	78"	42"	24"		60"	-	78"	0	

TABLE XII (CONTINUED)

Row No.	Vertical (total count)		Horizontal (visible spat)				Remarks
	Upper Collector Up stream	Down stream	Row No. 3 T B		Row No. 4 T B		
1	40	50	31	35	19	41	No. 1 of Horizontals points up stream.
2	50	65	15	30	21	46	
3	64	39	10	27	20	40	
4	64	77	39	24	26	59	
5	86	62	43	23	17	51	
6	114	77	44	9	24	23	
7	127	62	Row No. 11		Row No. 12		
	Lower Collector						
1	89	90	58	60	57	48	
2	102	112	44	70	68	43	
3	128	157		39	59	58	38
4	111	107	40	66	63	61	
5	110	100	47	50	60	40	
6	111	90	49	31	71	37	
7	71	111					