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Richard L. Hoffman
Virginia Fisheries Laboratory

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Summary of Experiments

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During the summer of 1948 the writer was employed at the Virginia Fisheries Laboratory, for the purpose of assisting with routine work in connection with oyster population studies as well as to devote some time to investigation of the practicability of utilizing chemical repellents in control of the oyster drills (Urosalpinx and Eupleura).

Initial work was carried on to determine tolerance of the young oyster spat to various chemicals, and usually the optimum conditions were determined before introduction of drills.

Considerable difficulty was encountered in securing sufficient quantities of materials from one time to the next, as well as maintaining animals alive in the laboratory tanks. The latter was complicated by fouling through deposition of sediments in the river, and affected wire cages suspended in the open water as well as indoor tanks.

In addition to quantitative experiments, some observations were made from time to time on the behavior of the oyster drills that were kept alive. These notes are appended as they may be of some interest.

EXPERIMENTS WITH CHEMICALS

Copper sulphate:

This metal salt was first used because of its alledged success at other localities. Unfortunately, a handicap was imposed by the lack of exact information regarding concentration of solution and mode of application. Considerable time and effort was spent investigating these factors, and no really satisfactory conclusions were reached.

On July 2, oyster shells including nearly 150 young spat (greatest size range up to about 40 mm) were treated by immersion in 3 different concentrations of copper sulphate, as indicated in the following table. In all three cases the solvent was 1 liter of fresh water, to which 10 ml acetic acid was added. This resulted in a solution of nearly the same acidity as ordinary vinegar. Five minutes was the time of immersion in all cases. The three batches were placed in wire baskets suspended in an aquarium. After several hours many were slightly open, and seemed to be none the worse for their experience (closing readily when touched). On July 5, the following observations were made: Many spat dying, the shells gaping and the meat easily seen. This is true of spat dipped in all three concentrations. The spat in the control aquarium do not show any injury or mortality.

TABLE I

Lot No.	CuSO4, gms. per L.	No. Spat	No. Dead on July 10
198	1	46	43
199	5	50	42
200	25	47	34

The mortality rate as indicated above is not reflective of concentration, the death rate does not correspond to the higher amounts of copper sulphate. However, the next experiment was directed along the lines of very low concentrations, and furthermore the spat were washed in fresh water following immersion. On July 12, approximately 36 spat were used in a way as follows: 12 were dipped, for 5 minutes, in the solution of 10 ml. acetic acid in one liter of water, with the copper concentrations 1, 1/10, and 1/100 gms. per liter.

TABLE II

Lot. No.	Solution	No. Spat Used	No. dead July 17
198	1 gm. CuSO4	13	9
199	1/10 gm. CuSO4	12	7
200	1/100 gm. CuSO4	12	6

The resultant mortality of nearly 80%, regardless of concentration, cast a reflection on the advisibility of continuing use of aquarium for experimental material. This was amplified by the fact that about a dozen spat, dipped at the same time in a solution of 1/10 gm. $CuSO_4$ per liter for five minutes but placed in a shallow enamel pan with running water suffered a mortality of but about 10%. A second experiment of the same nature was commenced, with the same conditions, after a week, and yielded about the same results. Therefore, it was decided to place treated spat in wire baskets and suspend these in the river.

On July 15, six lots of spat were treated under the conditions indicated below (numbers refer to compartments in the wire cage used):

26. Control. Undipped spat, 18 in number.

25. 21 spat dipped in dilute acid solution (15 ml per L.) for 5 minutes.

24. 21 spat dipped in 1 gm. $CuSO_4$ per liter, for 5 minutes.

23. 25 " " " 1/2 " " " 1 minute.

22. 25 " " " 1/10 " " " 5 minutes.

21. 18 " " " 1/100 " " " " " .

On July 19, examination of these lots, following 4 days in the river, shows that "most if not all of the spat are still alive."

Accordingly, since the initial high mortality seems to have been caused by laboratory envoirnment rather than chemicals, it was decided to increase copper concentrations and commence experimental use of drills. The table indicates conditions and results. Time of immersion was five minutes in all cases.

TABLE III

Lot No.	Conc. of $CuSO_4$ in gms. per L.	No. Spat	No. Dead on July 28
181	1	21	3
182	5	23	2
183	10	20	1
184	15	20	4
185	20	20	7
186	Control, no copper	21	1

At the same time (July 19) about 21 spat were dipped in a solution of 1 gm. per Liter for five minutes and placed in a separate wire basket with 25 specimens of Urosalpinx of all sizes. On July 28 it was discovered that the solution did not repel the drills. "The wire baskets containing the 21 spat...was examined. 13 were drilled, all sizes up to 50 mm. Drills all seem well and happy. Some have laid eggs. Most drilling at time of observation."

The results of the experiment summarized in Table III indicated that solutions of more than 10 gms. per liter were unduely toxic to the spat. At the same time, the concentration of 1 gm. per liter did not in any sense serve to repel the attacks of drills. Therefore the amount was raised in an attempt to determine if a greater concentration would be efficient. The following experiment was made on July 29 and checked a week later:

TABLE IV

Lot No.	Conc. in gms. per L.	Time Dipped	No. Spat	No. Dead
198	10	10 min	37	9
199	10	15 min	28	10

25 drills were used in each instance.

On August 24, additional work was done with copper sulphate as well as with other chemicals, the latter discussed under their respective places. 17 spat were dipped for one minute in a solution of 100 gm. $CuSO_4$ per liter slightly acidified with 5ml acetic acid. These were placed in a basket with 10 drills. On August 30, seven of the spat were dead and 10 were alive, and none were drilled.

A final trial was made on September 3, using solutions without acidification. Time of immersion was one minute. On September 8 a check was made on mortality and several drills were introduced into each compartment, and further checks were made on September 16 and 27.

TABLE V

Lot No.	Conc. of $CuSO_4$ in gms./L.	No. Spat	No. Dead Sept. 8	No. Dead Sept. 16 Box-	Drll.	No. Dead Sept. 27 Box-	Drll.-	Total
43	1	25	1 box	1	0	1	0	2
44	5	22	none	2	0	2	0	4
45	10	24	4 boxes	4	0	8	5	13
46	25	27	12 boxes	17	0	18	3	21
47	100	23	5 boxes	13	0	20	1	21

From the above it will be seen that the higher concentrations caused a very high mortality, up to 90% in lot No. 47, and usually resulted in a high initial mortality. It is noteworthy that concentrated solutions did not interfere with drill activities.

It would seem that the results of immersion in low concentrations, up to 5 gms. per liter, gave the best results. This information compares very favorably with that found in Table III, for Lot. No.182.

Mercuric Chloride:

Two experiments were run involving this chemical, in which immersion of the spat in a very dilute solution was the mode of application.

On August 24, the following solution of HgCl was made up, amounting to about one liter: 1 pt. saturated HgCl solution, 10 pts. water, 1 pt. saturated (Be 40) sodium silicate solution. Spat were dipped for about a minute, and placed in a wire cage with 20 drills. After an interval of one week it was found that 12 spat were dead, 15 alive, and none drilled. In all cases the drills were rarely on, or even near, the spat.

On September 3, another experiment was initiated involving use of HgCl and run simultaneously with one using copper sulphate (cf. Table V supra).

TABLE VI

Lot. No.	Conc. of HgCl in gms. / liter	No. Spat	No. Dead Sept. 8	No. Dead Sept. 16 Box.-Drill		No. Dead Sept. 27.-Total Box.-Drill		
38	1	25	3	2	0	5	0	5
39	5	23	9	7	0	17	1	18
40	10	20	8	6	0	6	0	20.

Here again lower concentrations seems to be more satisfactory, although the lowest mortality of 20% is rather high for practical purposes. In this chemical there seems to be a correlation between death rate and concentration.

In conclusion, it may be said that the use of a solution of 5 gms. of copper sulphate in water, without acetic acid, appears from the available data to be the most profitable condition to recheck, if that is deemed necessary. It may be that the acid has an effect causing the spat to relax their adductor muscles and permit entry of the copper sulphate.

NOTES ON BEHAVIOR OF OYSTER DRILLS

A more or less casual, qualitative series of observations were made on the behavior of oyster drills maintained alive under varying conditions. All notes (mainly by J. D. Andrews) are herewith appended inasmuch as they may have some slight bearing on the wide aspects of the drill control problem.

July 20. "Massmann brought in some jingles from Wormley's Rock this morning. A few of the cleanest shells bearing jingles were selected and the remaining macroscopic organisms cleaned off. These shells did not have any boring sponge. Jingles were selected and numbered from 1 to 13.

Jingles 1-4 had the upper valves roughened with the point of a knife under a binocular miscroscope.

Jingles 5-9 were not treated in any manner.

These two batches of jingles were put in a wire basket suspended in a large aquarium and a dozen drills added.

Jingles 10-13 were not treated but were placed in another wire basket in the same aquarium for controls.

A vigorous aerator has been installed in the aquarium to replenish the oxygen and cause some movement of the water."

July 21. "At first a couple of drills hovered at the entrance to jingle shells for an hour or two. All this time the jingles next to the drills were opening and shutting their top valves with apparently no fear from the presence of drills. Today the drills have not even stayed near or on the jingles and no indications of any boring are seen. All the jingles are alive and feeding. This whole observation suggests that there is something refractive about the jingles other than difficulty in boring the shell. For I see no evidence that any drill has tried to bore through the shell.

Tonight I put an oyster shell with 5 spat (4 on top and 1 on the lower shell) in the aquarium to see if they will drill oysters. Another shell with 3 spat was put in the control basket. All barnacles, dead and alive were cleaned off so nothing macroscopic remains for them to eat. JDA."

July 24. "Four of the five oyster spat placed in the aquarium on 21 July have been drilled and the meat is gone. The remaining spat has been drilled some but interruptions caused by too frequent examination have saved it is far. All of the jingles are healthy and living. There is no indication of drilling."

July 26. "After their excellent feed last week end (all spat put in 26 July are dead) about half of the drills have found it possible to lay a batch of eggs - several groups of 5 or 6 egg cases are visible now where there were none Saturday (24th)."

August 16. "Two large flat pans were set up with the idea of trying to determine what drills do in the presence of various foods as well as jingles.

In pan 1, about 50 x 40 cm. with 1 cm of water, ten drills were placed in the center with boring sponge in one corner, mussels in another, spat in a third, barnacles in the fourth, and jingles along one side under the water supply. The drills began to move almost at once and dispersed to one side of the pan where they by-passed the barnacles and made for the water supply. By the next day all had accumulated there, and in about a week began to filter towards the organisms, showing no special preferences. Jingles were ignored.

In pan 2, same size as above, and with same water conditions, 10 drills were placed in the center and a number of jingles placed directly under the water supply. Within a day the drills had either gathered under the running water or gone over the side of the pan. After a week no signs of drilling were noted despite the fact the jingles were serving as a substratum."

Similar observations made at frequent intervals during the summer all point to the fact that some intrinsic factor other than possible invulnerability of the jingle shell is responsible for the indifference of drills to Anomia.

On several occasions hungry drills were offerred shucked jingle meat but never showed interest in it before it had time to become bad.