The relationship between reproduction and mortality in triploid Crassostrea virginica: a matter of economic importance

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Joseph L. Matt and Dr. Standish K. Allen, Jr.

Oyster Reproduction

Diploid vs. Triploid

Slides courtesy Kate Ritter; photos courtesy Dr. Eric Guévelou

Figure 1: Histological cross sections of the visceral mass of Crassostrea virginica. Left: A ripe diploid oyster filled with gametes (purple); Right: a triploid oyster showing signs of significant gametic production.

Oysters expend considerable amounts of energy to reproduce each year. In summer months, Crassostrea virginica exhibit vast amounts of sperm or eggs (above, left), unless they are genetically manipulated to be sterile (above, right).

Different Physiological Races

Sea Water Temperature (°C)

Maine

Virginia

Louisiana

Figure 2: Monthly average sea water temperature (°C) in Bar Harbor, Maine (top), York River, Virginia (middle), and Grand Isle, Louisiana (bottom) from 2005-2012. Error bars represent standard deviation. Color boxes represent estimated season in which local oysters spawn.

Water temperature largely determines the seasonal timing in which oysters spawn, and therefore oysters from different geographic regions have distinct reproductive patterns.

Virginia Oyster Industry

The vast majority of oysters farmed in Virginia are triploids. Triploids are preferred for their reduced fecundity, which has been linked to a higher growth rate and better meat quality during the warmer months.

Mass Oyster Mortality

Unusually high mortality reported in 2014

Figure 3: Number of market oysters sold in Virginia from 2005-2013.

Data from Hudson, K., Murray, T., 2014. Virginia Shellfish Aquaculture Situation and Outlook Report

The Investigation

Brood stock origin

Test Subjects

Table 1: Total oysters sampled, percentage of sampled oysters containing eggs, percentage of oysters considered ripe, and supposed origin of brood stock used to produce sampled triploids in 2013 and 2014.

<table>
<thead>
<tr>
<th>Triploids sampled</th>
<th>With eggs</th>
<th>Ripe</th>
<th>Origin</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prior summer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(typical fertility)</td>
<td>689</td>
<td>14%</td>
<td>1%</td>
</tr>
<tr>
<td>Summer of mass mortality</td>
<td>127</td>
<td>41%</td>
<td>15%</td>
</tr>
</tbody>
</table>

Figure 5: Diagrammatic of oyster crosses for production of experimental oysters. Left: Four genetic varieties of triploid oysters produced from VA (Virginia), LA (Louisiana), and ME (Maine) brood stock. Right: Four genetic varieties of diploid oysters produced from VA and ME brood stock.

To test our hypothesis that triploids produced from brood stock with differing reproductive patterns have different gametogenic patterns, and are thus more susceptible to mortality, eight different genetic varieties of triploid and diploid oysters were produced at Oyster Seed Holdings (Gwynn's Island, VA) as experimental material.

Experimental oysters have been deployed to three commercial sites on the eastern shore and, as well as two sites on the western shore. Oysters will be sampled monthly February-October, 2016.

Figure 6: Map of eastern Virginia with symbols that denote the three commercial sites on the eastern shore and the two sites on the western shore where experimental oysters have been deployed.

Figure 7: Three different histological observations in triploid C. virginica from 2014 triploid mortality event. Left: Arrested oogenesis surrounded by interstitial tissue. Middle: Gonadal follicles filled with mature gametes. Right: Abundant follicle development empty of gametes.

Sampling will consist of monitoring growth and survival, as well as assessing the condition, gametogenic characteristics, and reproductive effort of triploids and diploids of each variety at each test site. Histology will be the primary tool for assessing the gametogenic characteristics and reproductive effort of sampled oysters.