

Spawning of the American Oyster, *Crassostrea virginica*, at Extreme pH Levels

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(Plate 45)

THE AMERICAN OYSTER, *Crassostrea virginica* (GMELIN, 1791), is the most important commercial mollusk of the Atlantic Coast and the Gulf of Mexico. Of the various interacting biological, physical, and chemical factors that affect oysters in these waters, pH has received less attention than any other major factor. PRYTHERCH (1928), who measured pH at several stations in Milford Harbor and the Milford area of Long Island Sound, found that it ranged from 7.2 to 8.4 during the day. He observed that oysters in Milford Harbor spawned at pH 7.8 and 8.2 and concluded that low pH inhibited oyster spawning and that oysters in Milford Harbor spawned at high tide because this was the only tidal stage at which the pH was between 7.8 and 8.2.

In laboratory experiments LOOSANOFF & TOMMERS (1947) determined that adult oysters kept in water adjusted to pH 4.25 remained open, on an average, 76% of the time, but pumped only 10% as much water as did control oysters kept in water of pH 7.75. Oysters kept at pH 6.75 and 7.00 initially pumped more vigorously than the controls, but the rate of pumping later decreased to less than that of the controls.

Although the pH of sea water usually ranges from 7.5 to 8.5, the pH in tidepools, bays, and estuaries may decrease to 7.0 or lower due to dilution and production of H₂S (SVERDRUP *et al.*, 1942). These inshore areas constitute a major portion of the habitat of oysters, and DAVIS & CALABRESE (1964) suggested that these regions may also be exceedingly important as nursery grounds for larval stages. Since oyster larvae must, at times, encounter a wide range in pH in their natural habitat, it is possible that success or failure of recruitment in some areas may be determined by variations in pH.

In previous studies CALABRESE & DAVIS (1966) found that normal development from the fertilized egg to the 48-hour, straight-hinge larval stage took place within the pH range from 6.75 to 8.75. In experiments with oyster larvae, which were terminated after 12 days at experimental pH levels, more than 68% of the larvae survived within the pH range from 6.25 to 8.75, and the lowest pH limit for survival was 6.00. The optimum pH for larval growth was from 8.25 to 8.50, although growth was good from 6.75 to 8.75. At pH 9.00 to 9.50 the percentage of eggs that developed normally, the percentage of larvae that survived, and the percentage increase in mean length decreased rapidly.

The present experiments were initiated to determine the minimum and maximum pH at which oysters will spawn and to determine the length of time that eggs and sperm remain viable at these extreme pH levels. The methods used at this laboratory for conditioning oysters and obtaining gametes have been described previously by LOOSANOFF & DAVIS (1963). In these experiments we placed oysters in normal laboratory sea water (pH approximately 7.8) and sea water adjusted to the desired pH level with either HCl or NaOH. We attempted to induce spawning by either of two methods: (1) by raising the temperature of the sea water to approximately 29° C and simultaneously adding to the sea water small quantities of sperm suspension made from gonadal material of ripe male oysters (combined thermal and chemical stimulation), and (2) by thermal stimulation only (Plate 45).

We concluded from these experiments that the minimum and maximum pH levels at which American oysters will spawn are 6.0 and 10.0, respectively. A summary of



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