Oyster Study Summary 2003

Nice, HE, D Morritt, M Crane and M Thorndyke. 2003. **Long-term and transgenerational effects of nonylphenol exposure at a key stage in the development of *Crassostrea gigas*. Possible endocrine disruption?** Marine Ecology Progress Series 256:293-300.

In experiments exposing larval oysters to a single dose of nonylphenol at levels commonly found in the environment, a team of English scientists finds that **nonylphenol can alter the sex ratio of oysters, cause some to become hermaphroditic, and dramatically impair survivorship of offspring**.

They conclude that these effects are extremely deleterious to the survival of oysters and "may result in severe consequences, not only for natural populations but also for commercial hatcheries situated in areas where nonylphenol is present in the water.

Their research is the first to show that "a single exposure to a pollutant at environmentally realistic levels, administred through water during a key stage of larval development can cause transgenerational effects in oysters."

What did they do? Nice *et al*. exposed larval Pacific oysters *Crassostrea gigas* to two different levels of nonylphenol (1 µg/liter and 100 µg/liter) for a single 48-hr period during days 7-9 after fertilizing the eggs.

They then allowed the larvae to mature to adulthood, monitoring growth and development monthly during maturation, and then at adulthood calculating the sex ratio and determining the proportion of hermaphrodites.

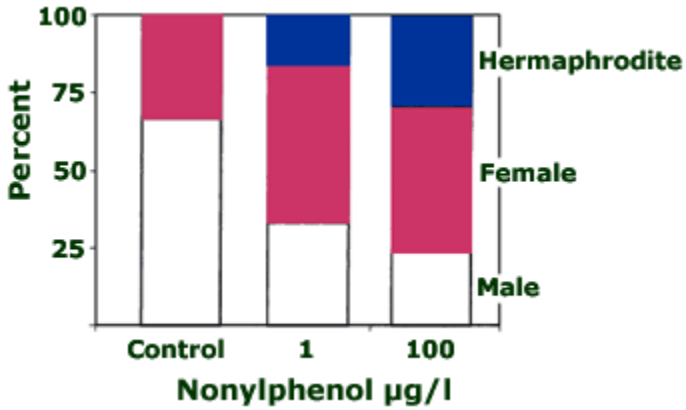
Some important background: Oyster reproductive biology has some unusual twists. A normal oyster can change sex between reproductive seasons. Once a given reproductive season begins, however, the oyster cannot switch sex until the season is over.

Usually during during the first year of reproduction, most Pacific oysters are males. As they grow over the years, they are increasingly likely to switch from male to female.

Also, hermaphroditism has been observed before in oysters, but only at extremely low frequencies...usually below 1%. And when observed, they usually do not contain both eggs and sperm simultaneously, and hence are incapable of self-fertilization.

When the oysters reached adulthood, they were bred in various combinations: controls with controls, 1 µg/liter-treated animals with 1 µg/liter-treated animals; 100 µg/liter-treated with 100 µg/liter-treated, and all cross-combinations (e.g., controls with 100 µg/liter-treated animals). The scientists then examined the development of embryos and larvae produced by these combinations 48 hrs after fertilization.

What did they find?



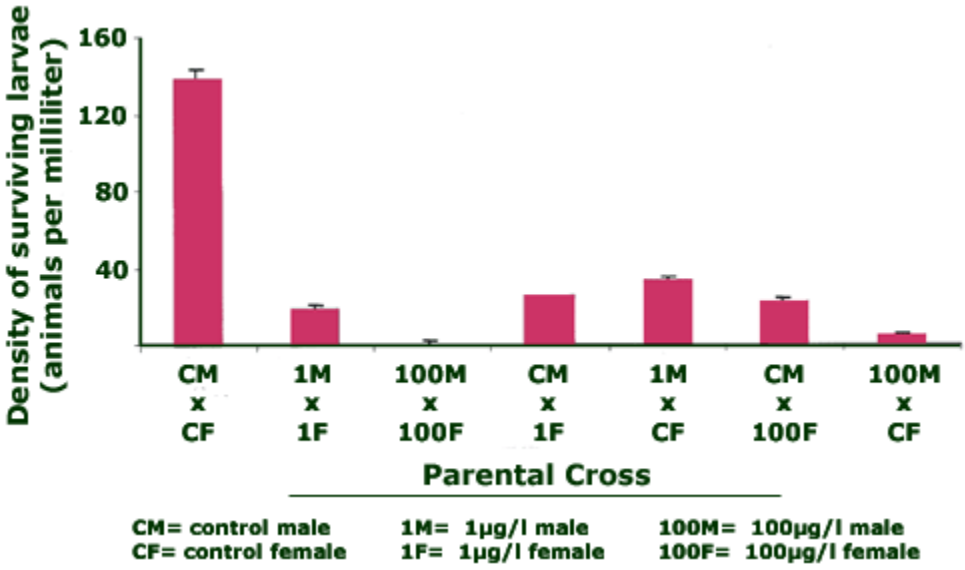
adapted from Nice *et al*.

At 10 months post-fertilization , when the oysters reached sexual maturity for their first breeding season, not only was the sex ratio of treated animals shifted toward a more females than the controls, many individuals were functional hermaphrodites... 30% in the group treated with 100 µg/liter and 17% in the lowest dose of nonylphenol tested. No hermaphrodites were observed in the control group.

These differences in sex ratio and percentage of hermaphrodites are highly significant statistically. The scientists observed no difference, however, in growth rates comparing treated to control animals.

Exposure of the larvae to nonylphenol also affected the survival rates of their offspring

Larvae from control parents (CMxCF) survived at much higher rates than larvae from any other combination of parents. This result was highly significant statistically ($p < 0.001$).



adapted from Nice *et al*.

The graph to the right shows the survival rate of the offspring of different combinations of parentage.

What does it mean? Nonylphenol has a profound effect on sexual development of oysters, even at low, environmentally relevant doses. Because the tests found positive results even at the lowest dose tested, ascertaining a "no-effect" level is impossible based upon these data. Clearly it is lower than 1 µg/liter. Other molluscs have been found to be exquisitely sensitive to another endocrine disrupting compound, bisphenol A.

The authors summarize a suite of studies indicating that sex determination of oysters is likely to be influenced naturally by pheremones. Their results in this study suggest that nonylphenol may be interfering with that chemical communication system, to the detriment of the exposed oysters.

The extreme sensitivity of oysters to nonylphenol, combined with the frequent presence of nonylphenol in sewage discharge waters, raises concerns about the effect of nonylphenol and related compounds on natural and farmed populations of oyster. Some natural populations of oysters have undergone dramatic population crashes, which typically are attributed to overharvest (e.g., in the Chesapeake Bay). These results suggest that endocrine disruption should be examined as a contributing factor.