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# THE EFFECT OF INHERENT PARENTAL FACTORS ON GAMETE CONDITION AND VIABILITY IN STRIPED BASS (*MORONE SAXATILIS*)

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One hundred years ago (1879), 332 juvenile striped bass from the Navesink River on the east coast of the United States were released into the San Francisco Bay-Delta estuary of California in a successful introduction of an east coast species to the Pacific.

Over the intervening years, sport and commercial catch records have indicated considerable fluctuations in the Pacific striped bass population (Smith and Kato, in press). To determine the causal mechanisms controlling these fluctuations, California Department of Fish and Game (CDF&G) has conducted extensive studies since 1958 on the California striped bass and their habitat.

CDF&G field data indicate that mortality during the first 60 days after hatching determines the size of the adult population. Abundance of young-of-the-year juveniles is related to river outflows and diversion volumes in the Sacramento-San Joaquin River Delta (Chadwick et al., 1977).

However, aside from direct export of eggs and larvae out of the estuary via water diversions, the primary causes of mortality remain undetermined. There is no clear understanding of the primary mortality factors determining survival of striped bass during the first two months of life. In 1976 the NMFS Tiburon Laboratory in an effort to improve abundance forecasts of striped bass recruitment began intensive laboratory studies on mortality factors affecting egg and larval stages of striped bass (Eldridge et al., 1977; Eldridge et al., 1978). Studies were also initiated on the effects of selected inherent factors such as the condition of spawning adults and their genotypes on gametic viability of eggs. Our previous research on effects of aromatic petroleum hydrocarbons showed that fish during spawning condition were extremely sensitive to short, low-level exposures (Struhsaker, 1977; Whipple et al., 1978). There were also subsequent deleterious effects on survival and growth of eggs and larvae from exposed females.

In the spring of 1978, samples of adult striped bass were collected off Antioch, California on the San Joaquin River during their upstream spawning migration and after they passed through the heavily industrialized Carquinez Straits area. Post-spawning adults were collected in San Francisco Bay near the Tiburon Laboratory.

A total of 73 migrating, pre-spawning and 100 post-spawning individuals were collected, and 165 parameters were measured for each fish. Complete autopsies were performed and subsamples taken for various measurements. The purpose of this sampling was: (1) to determine the condition of parental fish just prior to spawning and to ascertain whether certain measures of parental condition correlated with measures of gametic viability, and (2) to identify factors which might relate to the annual "fish kill" of adult striped bass in the Carquinez Straits during the summer.

We have obtained results which indicate that pre-spawning fish, their gonads and gametes, and post-spawning fish are being deleteriously affected during their migration through the San Francisco Bay-Delta estuary, and that the degree of this effect is determined by interaction of the parental genotype with environmental stress factors, including pollutants. Factor analysis of 165 variables (22 data sets, Table 1) and covariance analyses of factors were performed.

Table 1. Striped bass field samples (1978): data sets collected. (Total of 165 variables measured).

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| 1. | Field sampling — environmental and capture data |
| 2. | Meristics; length, width, age, etc. |
| 3. | Color pattern |
| 4. | Gonads; length, width, weight, fecundity |
| 5. | Liver, gall bladder, stomach |
| 6. | Parasites and disease |
| 7. | Histology — gonads |
| 8. | Histology — other — liver, spleen, kidney, etc. |
| 9. | Chemistry — lipids, carbohydrates, proteins, calorimetry |
| 10. | Chemistry — iron and heavy metals |
| 11. | Chemistry — pigments |
| 12. | Pollutants — petroleum aromatic hydrocarbons, aryl cyclohexanes |
| 13. | Pollutants — pesticides — chlorinated hydrocarbons, PCBs |
| 14. | Pollutants — other pollutants |
| 15. | Electrophoresis — total protein, TFN, albumin |
| 16. | Blood — hemoglobin, hematocrit, erythrocyte fragility |
| 17. | Blood cells — red blood cells |
| 18-21. | Blood cells — white blood cells; thrombocytes, lymphocytes, monocytes, macrophages, granulocytes, neutrophils, eosinophils, basophils |
| 22. | Egg diameters |

In summary, the results show there is genotypic variability in the serum proteins albumin and transferrin, the egg pigments (varying shades of green to yellow), melanistic color patterns, and certain meristic characters. The variability in some of these characteristics correlates with different physiological types, varying in their resistance to environmental exigencies and parasitism.

A high percentage of the parental fish were in poor condition, as indicated by body condition factors (low), macroscopic observations during autopsy, body lesions (approx. 35%), level of parasitism (approx. 50% showing parasitic damage to organs), and the blood cells (low numbers of lymphocytes, high numbers of granulocytes), among other parameters. Liver and ovarian tissues sampled were found to contain high levels of zinc (up to 90 ppm; wet weight) and aromatic and aryl cyclohexane petroleum hydrocarbons (up to 2 ppm; wet weight). There was a correlation between the poor condition of parental fish and the ability to reproduce (12% of adult females did not ripen, 20% of those ripening had damaged ovaries, parasitism, or dead eggs in ovaries). Fecundity and viability of eggs was reduced in the adults in poorer condition and/or with high pollutant content.

The overall decline in the striped bass population may be partially attributable to decreased reproduction and fecundity due to increasing effects of pollution, interacting with diversion and the low outflow years to increase mortality. Some mortality in the adult population also occurs, possibly because the adults are highly stressed from the interaction of pollutant and parasitic stress with spawning stress. The adults experience further stress as they migrate downstream through Carquinez Straits after spawning, encountering salinity and pollution stresses in the null zone, and a proportion of "weaker" fish die. The interaction of these factors may explain the annual "fish kills" in early summer (Kohlhorst, 1973). Further studies are being conducted.

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