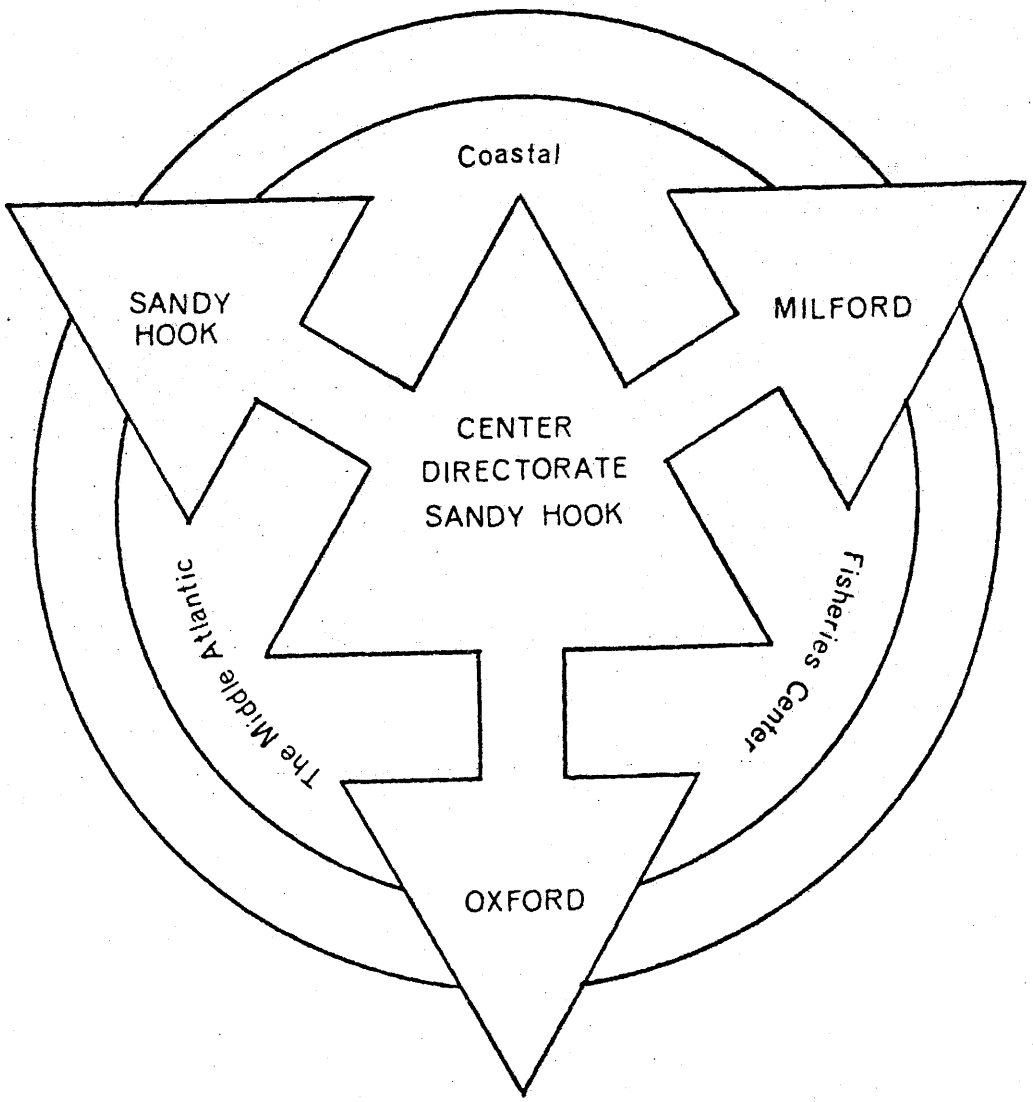
PRE-PROPOSAL -- MUTAGENIC EFFECTS OF ULTRA-VIOLET RADIATION ON FISH EGGS AND LARVAE

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Northeast Region

MIDDLE ATLANTIC COASTAL FISHERIES CENTER



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Middle Atlantic Coastal Fisheries Center

Background on Why Genetic Research is Pertinent

Nucleoproteins of the chromosomes of living organisms absorb highly and selectively in the region of the short (1850-3000A) ultra-violet spectrum. Like ionizing radiation, non-ionizing radiation in these wavelengths is mutagenic. The mutation rate at low doses, and its increase at higher doses, is even less certainly known for ultra-violet than it is for ionizing radiation. There are also reasons to assume that a mutation, induced by ultra-violet, predisposes toward other mutations thereby increasing the mutation rates of cells remaining after the first mutation.

Like other mutagenic agents, the incidence of mutations induced by ultra-violet is dependent also upon such factors as temperature (a second aspect of the total problem of a reduced ozone shield), on physiological stress and on the presence of other mutation-inducing substances.

Ultra-violet radiation is far less penetrating than, for example, x-radiation, and its genetic effectiveness is consequently limited to the superficial cell layers of complex organisms. It can, however, be a significant mutation-inducing factor for unicellular organisms and for free-floating gametes such as pollen. If sea water cannot provide an adequate shield against an increase in short ultraviolet radiation, resulting from reductions in the ozone shield, pelagic fish eggs, floating near the water surface, may well evidence significantly increased rates of chromosome mutations. Eggs of marine fish, as well as other components of the neuston, would suffer similar types of genetic damage to varying degrees dependent on species-related susceptibility as well as on pigmentation which could reduce absorption by the nucleoproteins of exposed cells. Work of some years ago on plant pollens strongly suggests that such increases may well be measureable in a subject such as fish eggs.

Relevant On-Going Research

On-going research at the Milford Laboratory involves documentation of the chromosomal mutations in mackerel eggs developing in variously polluted areas of the New York Bight. Any ultraviolet-induced mutations would as of now be included in our background mutation rate and could not be separated from mutations induced by other so-called background factors. However, using the same methodologies developed for study of the mutagenic effect on fish eggs of chemical pollutants in the New York Bight, the effects of increased ultra-violet radiation and temperature on such eggs and possible other neuston components, could be determined. Use of cytogenetic procedures on eggs does not require long-term fish culture. Ripened fish for experimental work might be obtained from the Narragansett Laboratory, or Milford might expand its own culture facilities to include fish if additional funds were available for such use.

Back-Up Experimental Research Proposed

Determine experimentally the genetic sensitivity of pelagic eggs of 2 or 3 species of valuable commercial and recreational fish through a series of controlled ultraviolet exposures. Fish would be ripened and spawned in the laboratory-hatchery. Eggs would be exposed and sampled throughout a series of developmental stages from early cleavage to hatching. Genetic damage would be appraised by cyto-genetic study of the chromosomes and nuclear divisions of cleaving zygotes, in developing embryos and in selected superficial tissues of hatched embryos.

Experimental exposures would be given at a range of temperatures consistent with normal development of the species. Also exposures would be administered while fish eggs were held in relatively clean water, and in water deliberately polluted with known amounts of a significant marine pollutant such as polychlorinated biphenyls.

Field Research Proposed

Once data are available on the effects of ultraviolet radiation on developing fish eggs at various temperatures in both clean and pollution-stressed waters test the same in the sea with eggs ripened and spawned in nature.

Capture pelagic eggs from large spawns of commerical fish in traps which traps would be also suitable for culture of the eggs through all developmental stages to hatching. Chamber-traps would be designed to block various degrees and wave-lengths of light from all to none and to maintain eggs near the water surface while permitting a water flow. If controlled heating or cooling of the chambers were technically impossible or impractical, field studies would be conducted at various temperatures anyway choosing different spawning sites or dates. Similarly studies would be conducted in relatively clean and in badly polluted oceanic areas.

Aliquots of eggs would be removed from the chambers at various developmental stages and appropriately fixed for study of chromosome level mutations.

With instrumentation NOAA is charged with developing, exact determinations would be made of the light, of various wave lengths, entering the several chambers during the several days of field experimentation. These chambers should be developed by NOAA along with the required other instrumentation for measuring light in the water. Chambers could be used indefinitely by a number of investigators for a variety of exposures of eggs to chemical pollutants in the upper millimeters of the sea.

Personal Service/Benefits	110.1
Supplies/Material	30.0
Fabrication of facilities	8.5
Travel	12.0
Maintenance and procurement of Live Specimens (Contracts)	20.0
ADP	15.0
Support	120.0
	315.6