2002 Progress Report: Interaction Between Water Column Structure and Reproduction in Jellyfish Populations Of Mobile Bay(SGER)

http://es.epa.gov/ncer_abstracts/centers/trc/aces/graham.html

EPA Grant Number: R827072C004
Subproject: R827072
Center: Alabama Center For Estuarine Studies (ACES)
Center Director: Shipp, Jr., Robert L.
Title: Interaction Between Water Column Structure and Reproduction in Jellyfish Populations Of Mobile Bay (SGER)
Investigators: Graham, William M.
Institution: University of South Alabama/Dauphin Island Sea Lab
EPA Project Officer: Perovich, Gina
Project Period: October 1, 1999 through September 30, 2000
Research Category: Ecological Restoration

Description:

Objective: This study is and continues to investigate the fertilization dynamics of Aurelia aurita in the coastal waters off the Mobile Bay estuary and northern Gulf of Mexico. This cosmopolitan species of jellyfish has increased in both distribution and population size in the northern Gulf, and it has the potential to strongly influence energy and nutrient flow within the planktonic food-web. Accurate assessment of the nature of reproduction, including fertilization, is fundamental to understanding long-term population changes in this region. The central questions, pertaining to the synergistic biological, chemical and physical interaction, of this study are:

Do density discontinuities serve as centers of male medusae gamete release?
Do sperm strands, released in these discontinuities, have a greater probability of being intercepted by females?

Progress Summary:

Biological

To date, we have assessed the seasonality of A. aurita in the northern Gulf and have measured endogenous reproductive characteristics such as residence time, level of fecundity, peak fecundity, sex ratio, and gonad indices.

Chemical

To date, preliminary data indicates that, for the first time among scyphozoa, a chemical inducer (extracted from female gonadal tissue) may facilitate sperm strand separation and sperm activation. It is not yet known if this chemical inducer operates prior to or after the males spawn. However, the potential for this chemical signal to facilitate successful fertilization within density discontinuities remains high.

Physical (Hydrodynamics)

To date, successful in situ dye dispersion studies have been conducted in the coastal waters of the northern Gulf of Mexico (research cruises aboard the R/V Pelican-2001, 2002, and the R/V Walton Smith – 2002). Underwater digital video techniques provided qualitative evidence supporting our hypothesis that strong density gradients (pycnoclines) and concomitant vertical shear gradients minimize vertical diffusion of parcels of water. Diffusion of dye clouds within these gradients occurs as 'sheeting' of the parcels effectively trapping neutrally buoyant particles (presumably including gametes) within these layers. Qualitative evidence from in situ video and sample collection within dispersing dye clouds has also been obtained. Diffusion rates and shear values are lowest (least detrimental) below the pycnocline and highest (most detrimental) above. Within the pycnocline is characterized by middle range values and the greatest difference in shear. These middle values are presumed to be low enough so as to not be detrimental to spawned gametes but high enough to facilitate gamete transfer.

Additionally, our in situ video profiling data do indicate that medusae are usually concentrated in these layers. This supports our hypothesis that vertical stratification of water enhances fertilization of A. aurita in two ways. First, accumulation of medusae along the pycnocline decreases the distance between individuals thus minimizing gamete dilution. Second, the sheeting of gametes in only two dimensions overcomes a large problem associated with broadcast spawning of pelagic animals by keeping gametes in a predictable location.

Future Activities

The next and final phases of this study will be conducted from July to October in 2003 and 2004. In 2003 we will assess the viability of sperm with time and conduct experiments aimed at determining whether fertilization success depends on sperm packaging. We have conducted initial trials using a vital fluorescence stain for sperm viability that shows great promise for application in future experiments.

In 2004 a series of experiments will be conducted to assess the effects of shear on male gametes. Shear values calculated from field data will be recreated in a laboratory set-up. Staining will again be used to assess any damage to the gametes.

Upon completing the laboratory experiments a theoretical model will be developed to explain the biological, chemical and physical interactions that influence fertilization success of A. aurita in the northern Gulf of Mexico.

Supplemental Keywords: estuarine research, coastal ecosystem, human modifications, land and water use, watersheds, aquatic ecosystems, bay ecosystem, wetland stabilization, Gulf of Mexico, nutrients, dye dispersal models. , Ecosystem Protection/Environmental Exposure & Risk, Geographic Area, RFA, Scientific Discipline, Aquatic Ecosystem, Aquatic Ecosystems & Estuarine Research, Chemical Engineering, Chemical Mixtures - Environmental Exposure & Risk, Chemistry, Ecological Effects - Environmental Exposure & Risk, Ecological Effects - Human Health, Ecological Indicators, Ecology, Ecology and Ecosystems, Ecosystem Protection, Ecosystem/Assessment/Indicators, Environmental Chemistry, Gulf of Mexico,

exploratory research environmental biology, Aurelia aurita, Mobile Bay, aquatic ecosystems, bay ecosystem, coastal ecosystem, coastal environments, ecosystem, erosion, estuaries, estuarine research, human modifications, jelly fish population, jelly fish populations, jellyfish, land use, water use, watersheds, wetland stabilization