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**ABSTRACTS**

Ayvazian, Suzanne G. Dept. of Forestry and Wildlife, Univ. of Mass. Amherst.

Phenotypic variation in the blackspotted stickleback Gasterosteus wheatlandi.

A series of intra and intrapopulation crosses were conducted between 1984 and 1988 with adult blackspotted sticklebacks from Chatham, MA and Niantic, CT, in order to investigate the genetic basis of phenotypic variation in lateral plate number and phenotype. Full-siblings were reared at either 18° or 23°C. Full-sibling heritability estimates ( $h^2$ ) of lateral plate number and phenotype; and genetic and phenotypic correlations ( $r_G$  and  $r_p$ ) were calculated by analysis of variance and analysis of covariance, respectively. The results demonstrate that lateral plate number is sensitive to culture temperature. In general, lateral plate number increases between full-siblings reared at higher temperatures. Heritability estimates for both meristic traits are highly variable and suggest complex interactions between environmental conditions and, development. The significant positive values derived for the genetic correlation may be attributable to pleiotrophy. It may be suggested that restricted gene flow between populations maintains a stable cline; while intrapopulation variation is maintained by some degree of environmental modulation of the genotype.

Butler, E\*\*, Hersh, D\*, Valiela, I\*. Hampshire College\*\*, Amherst, MA and Boston University Marine Program\*, Marine Biological Laboratory, Woods Hole, MA.

THE EFFECTS OF UCA PUGNAX BURROWING ON SPARTINA ALTERNIFLORA PRODUCTION: ARE PREVIOUS RESULTS TYPICAL?

Marsh ecologists have long attempted to isolate and assess the importance of the several factors affecting Spartina alterniflora production. One previously supported hypothesis claims that the high productivity of S. alterniflora is due to Uca pugnax burrowing which reoxidizes marsh sediment allowing enhanced N up-take to be expressed in increased biomass. In the Great Sippewissett salt marsh S. alterniflora biomass is not correlated with burrow density; this finding led us to reexamine the hypothesis. We experimentally increased fiddler crab burrow concentrations to medium ( 150/m<sup>2</sup>) and high ( 200/m<sup>2</sup>) densities by punching holes into the low marsh sediment. Burrow density did not change redox potentials of the sediment or S. alterniflora biomass. In light of this experiment the role of U. pugnax as a keystone species, maintaining and generating the high productivity and structuring the North East U.S. marshes., must be reexamined and reevaluated.

D'Avanzo, C\*\*, M. Alber\*, and I. Valiela\*. School of Natural Science, Hampshire College\*\*, Amherst, MA, and Boston University Marine Program\*, Marine Biological Laboratory, Woods Hole, MA  
AMORPHOUS DETRITUS: A POORLY STUDIED FOOD SOURCE FOR COASTAL CONSUMERS

Most studies of detritus feeding by marine consumers have focused on morphous detritus (fragments of macrophytes). A different detritus pathway, involving amorphous detritus (formless aggregates), is much less studied. Amorphous aggregates form from dissolved organic matter by poorly understood pathways. We produced 15N labeled amorphous detritus from the leachate of 3 macroalgae and Spartina alterniflora. Three different coastal animals assimilated 15N from the aggregates, demonstrating the potential food value of amorphous detritus for consumers. The rate of N assimilation by one of the animals was 10x greater with amorphous compared to morphous S. alterniflora detritus.

DeMeo-Anderson, B., and P. Peckol, Biological Sciences, Smith College, Northampton, MA.  
EFFECTS OF N-ENRICHMENT ON SEAWEED GROWTH AND PRODUCTION IN  
WAQUOIT BAY, MA.

In Waquoit Bay, Gracilaria tikvahiae and Cladophora vagabunda have become predominant components of the macroalgal assemblage of this estuarine bay, possibly due to nitrogen (N) enrichment, proportional to the density of surrounding housing units. We evaluated site-specific physiological responses of plants from Child's River (high N-loading), Sage Lot Pond (low N-loading), and the mouth of the Bay (well-flushed Bay conditions). In general, Cladophora showed higher rates of photosynthesis than Gracilaria, particularly at lower experimental irradiances. Gracilaria and Cladophora populations from the high-nutrient site had higher photosynthetic performance and pigment concentrations than plants from the other two sites. Surprisingly, although Waquoit Bay is quite shallow (< 2 m in most areas), photosynthesis was light-limited except during sunny days. In fact, both Gracilaria and Cladophora showed no net photosynthesis at 2 m when bottom irradiances were below  $40 \mu\text{E}\cdot\text{m}^{-2}\cdot\text{s}^{-1}$ . A two-week, in situ growth experiment for Gracilaria emphasized the potential impact of nutrient loading in this bay. Fertilized plants showed much higher growth rates than unfertilized individuals for the shallow (0.5 m) treatment; growth was not greatly enhanced by fertilization for the 2.5 m treatment (irradiance became limiting). Because water depth at the area of highest nutrient loading, Child's River, is ca. 0.5 m, photosynthetic and growth measurements strongly suggest that sewage nitrogen from surrounding homes will affect algal species diversity and abundances, and possibly, the long-term "health" of this Bay.

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Eller, F. C., and B. L. Welsh, Marine Sci. Dept., Univ. CT, Groton, CT. THE DEVELOPMENT  
AND USE OF A MULTIPLE PROBE IN SITU OXYGEN SENSOR.

We have constructed a device for making long-term in situ measurements of dissolved oxygen (DO), temperature, salinity, and depth. SNOSHU (Stable Near-bottom Oxygen Sensing Hydrographic Unit) uses four "pulsed" polarographic oxygen sensors that can be variably spaced over the vertical to measure fine-scale differences near the benthic surface. The probes are sampled every 15 minutes, and oxygen, temperature, conductivity, and pressure data are stored with a time stamp in a data-logging device.

We have deployed SNOSHU in Long Island Sound and smaller estuaries for periods of 8 to 24 hours to quantify diurnal and tidal effects on DO. During summer, DO in the small estuaries fluctuates daily from supersaturated in late afternoon to near-hypoxic by dawn. This cycling is related to the interaction between light and tidal effects. Using SNOSHU, we have also investigated the dynamics of the oxygen concentration gradient within 1 m of the sediment-water interface.

Godfrey, P.J., and E.J. Klekowski. Dept. of Botany, Univ. of Massachusetts, Amherst, MA. 01003. ALBINO RED MANGROVE (RHIZOPHORA MANGLE) SEEDLINGS IN SALINE AND HYPERSALINE WATERS OF SAN SALVADOR ISLAND: A NEW DISCOVERY - MENDEL'S LAWS ARE ALIVE AND WELL IN BAHAMIAN MANGROVE SWAMPS.

Albino seedlings of Rhizophora mangle were discovered for the first time in two locations on San Salvador Island and sampled over as extensive a shoreline as possible by canoe and on foot; 11.8 km. in Pigeon Creek; and 5.5 km. in Great Lake. Pigeon Creek is still open, to tides, and serves as a control population while Great Lake is a hypersaline lake in the center of the island, cut off from ocean tides and surrounded by Pleistocene dunes. Viviparous albino seedlings were counted while still attached to 26 parent plants giving average ratios of 3 green : 1 white seedling per plant. The mutation rate for albinism in Pigeon Creek was .0079 mutations per haploid genome per generation (26 times that reported for other plants), while in Great Lake it seemed much higher, but more data are needed. Field and greenhouse studies are underway to substantiate these results.

Kipp, Katrina, U.S. Environmental Protection Agency Region I, JFK Federal Building, Boston, MA.  
EPA STUDY OF QUINCY BAY CONTAMINATION.

EPA recently released the findings of a one year study of the chemical contamination of Quincy Bay, Massachusetts. The scope of the study included a review of historical data, analysis of sediment chemical contamination, measurement of tissue chemical residues and histopathology of fish and shellfish, and an assessment of risk to consumers of seafood from Quincy Bay. Chemical levels, especially PCBs, in the sediment and tissues were generally high, and the marine life appeared to be in poor health. Details of the study findings will be presented, including recommendations generated by EPA based on the findings and a discussion of the management and policy implications and the public reaction to the issue of seafood contamination.

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Liu, J.T., G.S. Giese, and D.G. Aubrey, Dept. of Geology and Geophysics, Woods Hole  
Oceanographic Institution, Woods Hole, MA 02543 IMPACTS OF TIDAL INLET FORMATION  
ON A BAR-BUILT ESTUARY

The barrier beach of a bar-built estuary in eastern Cape Cod, Massachusetts, was breached in January 1987, forming a widening tidal inlet. The existence of the new inlet increases the water exchange between the estuary and ocean, resulting in increased tidal range, wave action, and tidal velocities within the estuary. As a response to the new hydrodynamic regime, the system is undergoing morphological and bathymetric re-organization, causing severe localized erosion and accretion along the inner shore of the estuary. Morphological and hydrodynamic changes also cause subsequent ecological changes in the estuary. The estuary has developed into two separate circulation systems which are hydrodynamically de-coupled. Water exchange between Atlantic Ocean and the northern part of the estuary takes place now mainly through the new inlet, leaving the southern part 'relict'. Geomorphological changes in the entire system are likely to continue in the next few decades, resulting in further alterations in the characteristics of the estuary.

Loder, T.C. and T.J. Smayda, EOS, University of New Hampshire, Durham, NH 03824 and  
GSO, University of Rhode Island, Kingston, RI 02881.  
WATER COLUMN STABILITY AND NUTRIENT-PLANKTON DYNAMICS IN  
WESTERN MASSACHUSETTS BAY DURING SPRING AND SUMMER PERIODS.

Studies have been carried out during summer, 1987 and spring, 1988 in relatively clear and shallow coastal waters 5-10 km east of Boston Harbor. During both periods the photic zone extended over most of the water column and to the bottom on several occasions. The critical depth was always below the bottom. Except during early March, nutrients were well depleted throughout the water column even though the water column was stratified during the summer months. Oxygen values were close to 100% ( $\pm 20\%$ ) saturation during all of the periods as well. A conceptual model of how the system appears to presently function and implications of the placement of Boston's secondary treatment sewage effluent outfall in this area will be presented.

Macfarlane, S. L., Town of Orleans Shellfish Department, Orleans, Ma.  
SHELLFISH RESOURCE DEGRADATION AS A FUNCTION OF LAND USE PRACTISES.

Environmental degradation with respect to shellfish resources is becoming a serious problem on Cape Cod as a direct result of rapid coastal development. Close to 6,000 acres were closed to shellfishing in 1983 compared to 712 acres in 1980. Closures were due to bacterial contamination from such sources as storm-water runoff, inadequate on-site septic systems and warm blooded animals. In addition, shellfish habitat is being lost due to eutrophication from nutrient enrichment caused by the cumulative effects of current land use practises. Individual communities and the entire county are beginning massive educational and action oriented programs to ameliorate the situation. But research is needed in a wide range of disciplines to maintain high water quality standards and a viable shellfish industry.

Maier , Christine M., Dept. of Biology, Vassar College, Poughkeepsie, NY  
NITRATE REDUCTASE ACTIVITY IN EELGRASS (*ZOSTERA MARINA*) AS A POTENTIAL INDICATOR OF GROUNDWATER INPUT OF NITRATE.

Eelgrass (*Zostera marina*) grows throughout the year in shallow coastal waters. While most nitrogen for growth appears to be assimilated as ammonium by roots, some plants utilize nitrate and exhibit high nitrate reductase activity in the leaves. Since nitrate concentrations are low in coastal waters during summer, we postulated that nitrate may become available to eelgrass via groundwater inputs that enter the nearshore water column. To address this idea, we measured nitrate reductase activity in eelgrass collected from three shallow meadows in the vicinity of Woods Hole; Massachusetts: two of the sites (Great Harbor and Shore Lab) were adjacent to the mainland, with potential for groundwater input, while the third site (Lackey's Bay) was offshore and isolated from groundwater input. Plants from Lackey's Bay and Great Harbor responded to slightly elevated nitrate availability (10 to 25  $\mu\text{M}$ ) in the laboratory, with higher nitrate concentrations ( $\leq 200 \mu\text{M}$ ) yielding less dramatic responses. The increase in nitrate reductase activity was roughly three times higher for Great Harbor plants. Plants collected from the Shore Lab site exhibited very low activity. Measurements of pore water nitrate and efflux of nitrate from beach sediments at the Great Harbor and Shore Lab sites indicate that groundwater nitrate is present at levels from 200 to 500  $\mu\text{M}$  and is diluted as it enters the water column very close to the shoreline.

Mazurkiewicz, M., Dept. Biol. Sciences, Univ. Southern Maine, Portland, Maine.  
DISTRIBUTION AND ABUNDANCE OF THE MUD SNAIL, *ILYANASSA OBSOLETA* IN OVERWINTERING INTERTIDAL CLUSTERS AT BACK COVE (PORTLAND, MAINE)

A recent survey revealed at least 2 million mud snails overwintering intertidally in 774 clusters containing 2000-80,000 individuals each at Back Cove. Winter survival is high (est. 98%) even though the clustering snails are often entrapped in ice during tidal exposures. The clusters consist almost entirely of sexually dimorphic adults apparently not immobilized by infections of trematode larvae, as was once suggested, since only 50 of 2162 snails examined were harboring these parasites.

ADVECTION, DIFFUSION, AND PLANKTON PROFUSION: SPECULATIONS ON RETENTION.  
Bernie McAlice, University of Maine, and Gil Jaeger, Dodge Cove Marine Farm.

A range of explanations have been advanced to account for the retention of zooplankton in estuaries and for the recruitment of meroplanktonic larvae into the benthic breeding populations. Exegeses embrace a spectrum from spiritual (invocation of finely tuned behavioral responses) to mundane (mechanical response to physical forces). Estuaries with markedly different circulation regimes can harbor similar suites of plankters. Abrupt change in the circulation dynamics of the Sheepscot River estuary, the result of human intervention, provided a field experiment whose outcome was not definitive, but was certainly suggestive. Zooplankton are but crudely tuned to the physical system, and may be transported by diffusive as well as by advective flows.

Orson, R. A. Center for Coastal and Environmental Studies, Rutgers University, New Brunswick, New Jersey 08903. SOME EFFECTS OF MAJOR COASTAL STORMS ON THE DEVELOPMENT OF TWO TIDAL SALT MARSHES IN SOUTHERN NEW ENGLAND: HISTORIC VEGETATION CHANGES.

Utilizing plant macrofossil identification and aspects of sedimentology major storm events were identified in the peat for two southern New England tidal salt marshes. The two systems, Waquoit Bay located on Cape Cod, Massachusetts and Barn Island in southeastern Connecticut, represent flooded coastal embayments that have developed during the last few millenia. Results from core analyses suggest that storm events can induce changes in the percent species composition of roots and rhizomes preserved within salt marsh peat. The changes at Waquoit Bay are characterized by a clay band at about 13 cm in depth followed immediately by a shift in rhizome composition towards *Spartina alterniflora*. Barn Island contains a sand lense at approximately 12 cm in depth and a subsequent shift to *Distichlis spicata/Spartina patens* dominated peat. Based on historic information and depth of changes within the substrate both systems have been accreting at an average rate of about 2.5 mm/yr since the late 1930's. The ability of storm events to change the composition of the belowground component may eventually lead to changes in the structure of the aboveground plant community sometime into the future. This investigation suggests that storm events may play an important role in the long term development of tidal salt marshes.

Pitts, L.P., Dept. of Environmental Sciences, Univ. of Mass., Boston, Ma.  
LEAD DEPOSITION IN THE SHELLS OF MYA ARENARIA

Biologically formed carbonates have long been used to understand properties of the waters in which they were formed. Mya arenaria shells in this study have been found to incorporate lead in a manner consistent with observed dissolved lead. Mya were collected from three sites, one on Cape Cod Bay and two in Boston Harbor representing low, moderate and high levels of lead pollution. The shells from these organisms were analyzed for lead and the waters from these sites were monitored once a month for lead. Experiments were conducted to test shell cleaning procedures and to show that observed lead concentrations in shells were not due to contamination from the sediment. Shells radiocarbon dated to be 1600 years old were analyzed to indicate prehistoric lead concentrations in Boston Harbor.

Pyott, C.P., Dept. of Earth Sciences, Univ. of New Hampshire, Durham, New Hampshire, 03824. HYDROLOGIC AND NUTRIENT FLUX COMPARISON OF SPARTINA PATENS AND PANNE ZONES OF BASS BEACH MARSH, NORTH HAMPTON, NEW HAMPSHIRE.

The continued development of coastal New England is causing increased disruption of natural tidal flooding, through flood control features such as tide gates and culverts. At Bass Beach Marsh, a 15 ha salt marsh in North Hampton, NH, a restricting culvert is causing enhanced inundation of tidal water. In some areas of Bass Beach, panne areas have resulted, consisting of blue green algal mats covering dead Spartina patens. In the summer of 1987, experiments comparing the hydrology and nutrient cycling processes which occur in the panne areas and healthy Spartina patens areas were conducted in this marsh. Data from each of the areas will be compared.

Reid, John B., Jr., School of Natural Science, Hampshire College, Amherst, MA.  
PAN FORMATION AT BARNSTABLE MARSH, MASSACHUSETTS.

Most theories of salt marsh pan formation fall into one of two categories. In one, tidally deposited wrack causes established marsh surfaces to rot, to trap water, and thus lose pace in upward growth rate with neighboring unaffected surfaces. Alternatively, pans may be primary features of marsh development, representing regions which become enclosed by vegetation, and eventually cease to communicate, with tidal exchange. Aerial photographs (1952-85) of newly emerging Duck Island indicate that Barnstable pans fall almost exclusively in the second category. Colonization by Spartina alterniflora of the initially barren domal island produced a sparse grass covering by 1971. By 1985, how-ever, levee development had outpaced growth behind the levees; these enclosed surfaces became completely covered by poorly drained mud. Nearby, more evolved regions show a complete progression between these initial pan enclosures and established pan-bearing high marsh.

Saucerman, S. E., Dept. of Forestry and Wildlife Management, Univ. of Massachusetts, Amherst, MA.  
DISTRIBUTION AND PRODUCTIVITY OF JUVENILE WINTER FLOUNDER (Pseudopleuronectes americanus) IN WAQUOIT BAY.

Estuaries are of vital importance as nursery areas for winter flounder. However, the distribution and growth of juveniles varies among habitat types. Age 0+ flounder were sampled quantitatively in different habitat areas of Waquoit Bay, MA. Significant differences were found in abundances; mean lengths, and length-weight relationships of flounder among habitat types. Areas adjacent to eelgrass beds supported as much as twice the abundance, and had mean lengths of up to one cm larger than juveniles from sandflat areas. I suggest that certain habitats are more important to the growth and recruitment of juvenile winter flounder in estuarine systems.

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FORAMINIFERAL ZONATION AND DEVELOPMENT OF A NEW ENGLAND SALT MARSH.  
SCOTT, D.K. and LECKIE, R.M., Department of Geology/Geography, University of Massachusetts,  
Amherst, MA, 01003

Foraminifera (Protista: Sarcodina), sedimentary analysis, and carbon-14 dating are used to trace the development of Great Sippewissett Salt Marsh (Falmouth, MA). Species of foraminifera are distributed at the surface in assemblages that correlate with elevation relative to mean sea level, proximity to tidal creeks, and salinity. Five species assemblage zones are defined from two surface transects in the outer marsh and central marsh.

The surface assemblage distribution serves as a model for interpreting assemblages in three cores, and, in conjunction with sedimentary analysis, provides evidence of marsh retreat and submergence with late Holocene sea level rise. Carbon-14 dates at the base of the thickest peat deposits give a minimum age of marsh formation at this site of 2675 +/- 240 years before present.

Welsh, B.L. and C. Eller, Marine Sciences Dept., Univ. of Connecticut, Avery Point, Groton, CT  
06340. SUMMERTIME HYPOXIA IN LONG ISLAND SOUND

Summertime dissolved oxygen concentrations in bottom waters of Long Island Sound have been measured for the last three summers and compared with historical data. The seasonal decline starts in mid-June and ventilation occurs in late August or early September. This temporal pattern is fairly predictable from year to year and is caused by temperature-controlled stratification. The intensity of the deficit, its areal coverage, and its effects on living marine resources are highly variable from year to year. These attributes appear to be strongly related to the timing and location of sewage spills, and to weather conditions. The break-up of the thermocline is popularly referred to as "fall overturn", a term adopted from limnology. The mechanism appears to be quite different. It involves tidal advection of warmed offshore water into the bottom layer so that mixing is induced as much or more from below the thermocline as from the cooling of the surface waters. Wind mixing does not appear to be as important as previously thought.