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Estaurine Macrobenthic Community Succession:

The influence of hypoxia, salinity fluctuations, sediment resuspension and disturbance frequency

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Succession theory describes community changes over time in the absence of disturbance. The theory was initially developed for terrestrial systems where the progress of succession was characterized by increasing community diversity, abundance, and biomass, and by changing species composition from species capable of rapid population growth (opportunists) to larger, more rare and slow growing species (Clements 1918; Cooper 1939). The application of succession theory to estuarine ecosystems is comparatively new (Pearson and Rosenberg 1976; Rhoads et al. 1978; Dauer 1993) and is problematic due to the great amount of environmental heterogeneity (e.g., salinity, oxygen, temperature) that affect organisms present.

Macrobenthic succession models focus on defining the characteristics of early succession versus climax (e.g., late succession) communities. A key characteristic of early succession communities is dominance by opportunistic species (e.g., the bivalve Mulinia lateralis; Dauer 1993). Other characteristics include lower biomass and diversity compared with that of a climax community (Dauer 1993). Larger infauna (e.g., Ophiuroida, Enteropneusta), often associated with climax communities, may facilitate oxygenation of deeper sediments by bioturbation (Flint and Kalke 1986). The oxygenation of deeper sediments allows infauna (e.g., bivalves) to become more deeply distributed, enhancing colonization by still other infaunal species (Flint and Kalke 1986), facilitating an increase in diversity and promoting the progression of succession.

The benthic estuarine environments of south Texas bays appear to be in a state of perpetual early succession (Montagna et aI, 1998). Benthic communities in this area are characterized by low diversity and opportunistic species. There are three possible explanations for this observation. First, present sampling methods may not adequately sample larger deep dwelling species typically characteristic of late succession communities. Second, benthic communities of south Texas may be in a state of constant disturbance due to sediment resuspension (natural and anthropogenic), broad salinity variations, and seasonal hypoxia (low oxygen). Third, estuarine succession models developed for application in other areas may not be suitable for south Texas estuaries due to physical (e.g., depth, tides) and climatological (e.g., rainfall, wind speed) differences.

To determine why Texas estuarine benthic communities appear to be in a state of constant disturbance, I conducted three experiments. The climax community study determined the adequacy of the present sampling effort and characterized a late succession estuarine community for Corpus Christi Bay. The hypoxia study determined the effect of hypoxia on benthic communities, proposed models describing how community characteristics respond to declining oxygen levels, and examined the present definition of hypoxia. The flow resuspension experiment determined the effect of three flow/turbidity regimes on natural bottom and colonization of trays filled with defaunated sediment. In addition, the macrobenthic effects of frequency of physical disturbance and flooding were determined in the context of flow/turbidity disturbance. Based on these investigations, a theoretical model is being developed to describe the roles of disturbance frequency and intensity in the temporal context of estuarine benthic succession.

Summary of Findings Pertinent to Mollusks

Climax Community Study

Macrobenthic communities of station C and E in Corpus Christi Bay (Figure 1) were markedly different with station E having much higher diversity, abundance and biomass than station C. This trend is reflected in the mollusk fauna of these stations (Table. 1). No gastropods, and very few bivalves «1% annual abundance and biomass), were found at station C, probably because of the fine sediment and possible high sediment deposition and resuspension. Mollusks at station E comprised 2.3% total community abundance and 3.2% of biomass.

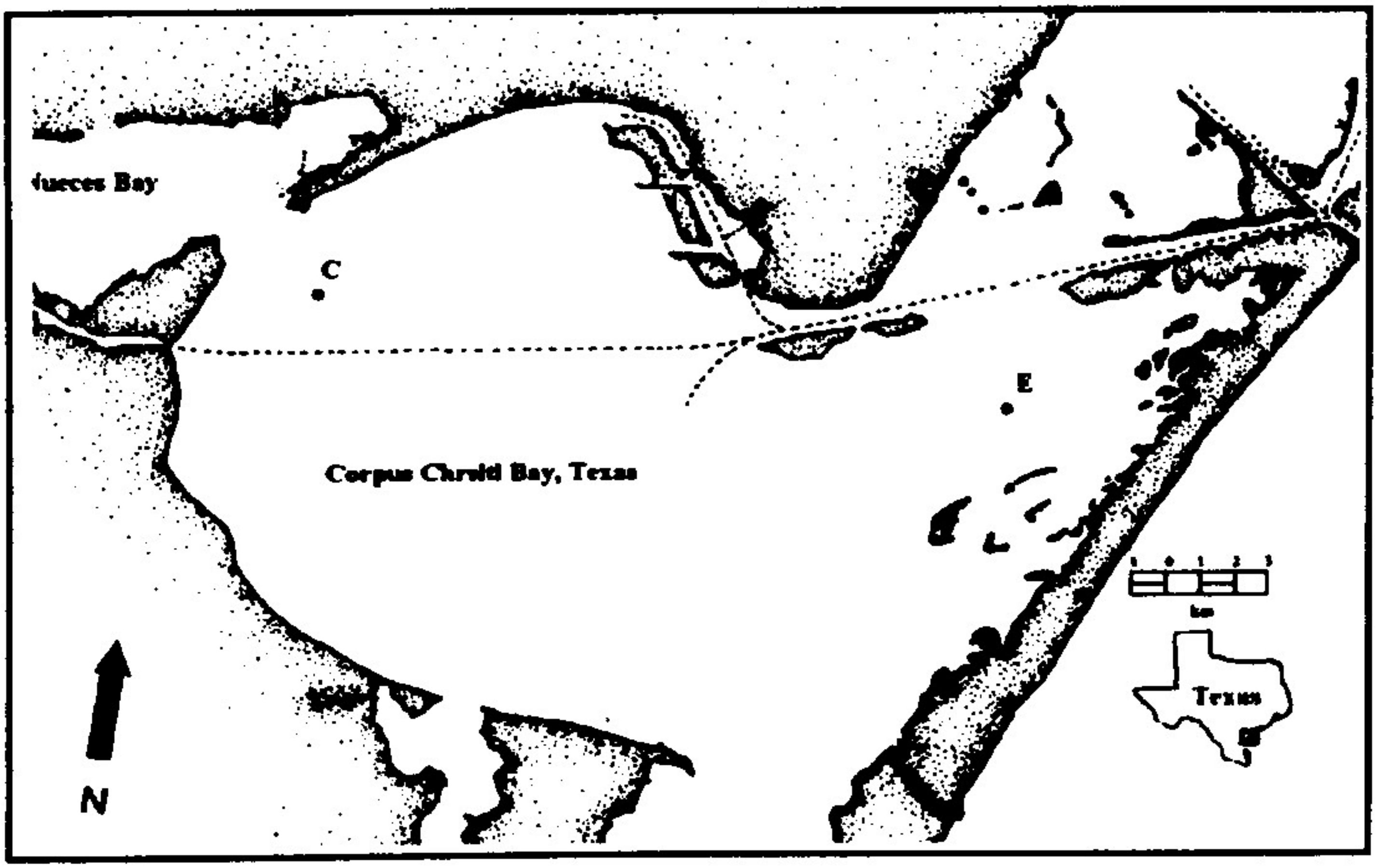

Figure 1: Map of Corpus Christi Bay, TX denoting station C and E (adapted from Martin and Montagna 1995).

Table 1: Average Mollusc abundance and biomass at stations C and E by species and identified with class, feeding guild and life history. Class: G=Gastropoda, B=Bivalvia. Guilds: C=carnivore/omnivore, I=Interface Feeder, D=Deep Deposit Feeder, E=Ectoparasite, and F=Filter Feeder. Life Histories: E=Equilibrium Species, O=Opportunistic Species. References: [1] Dauer (1993), [2] Weisberg et al. (1997), [3] Ranasinghe et al. (1994).

Species Name	Class	Feeding Guild	Life History	Station C $n\ m^{-2}$	Station C $g\ m^{-2}$	Station E $n\ m^{-2}$	Station E $g\ m^{-2}$
Crepidula sp.	G	I				70.91	0.0021
Polinices duplicatus	G	C				70.91	0.0090
Nassarius acutus	G	C				6.45	0.0026
Pyrgiscus sp.	G	E				25.79	0.0032
Nuculana acuta	B	D	O[2]	6.45	0.0629	6.45	0.0001
Anadara transversa	B	I[3]	E1			6.45	0.0004
Aligena texasiana	B	I				221.33	0.0826
Mysella planulata	B	I				6.45	0.0002
Mulinia lateralis	B	I	O[2]			47.27	0.0071
Ensis minor	B	I	E[2]			23.64	0.7821
Tellina sp.	B	I	E[2]	23.64	0.0047		
Mercenaria campechiensis	B	I[3]	E[1]			6.45	0.0760
Corbula contracta	B	I				23.64	0.0643
Lyonsia hyalina floridana	B	I				6.45	0.0007
Periploma cf. orbiculare	B	I				260.00	0.0560

Hypoxia Study

Mollusks were found at only two stations, neither of which were subjected to the seasonal Corpus Christi Bay, Texas low oxygen (hypoxic) event.

Flow-Resuspension Experiment

Mulinia lateralis was found infrequently in undisturbed sediment of normal and reduced flow treatments indicating the possible inability of this bivalve to tolerate high water velocities of the increased flow treatment. Although M. lateralis is an opportunistic species (Table 1), it did not recruit to defaunated sediment trays during the experiment indicating that the ability of this species to respond opportunisticallymay depend on environmental conditions. Because of the infrequency of M. lateralis at the study site, neither of these hypotheses have been tested yet.

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Mary Christine Ritter was born in Austin, Texas on July 7, 1966. After completing Stephen F. Austin High School, she went to Trinity University, San Antonio, Texas. While at Trinity she attended summer school at the University of Texas, and the Bermuda Biological Station. She also attended field based courses offered by Boston University and Northeastern University. After graduating from Trinity with a Bachelor of Arts degree in Biology, May, 1988, she attended Texas A. & M. University where she received a Masters of Science in Wildlife and Fisheries Sciences in May, 1991.

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