TESTING THE ENERGY SIGNATURE HYPOTHESIS OF MANGROVES, USING CARBON ISOTOPE RATIO ANALYSIS

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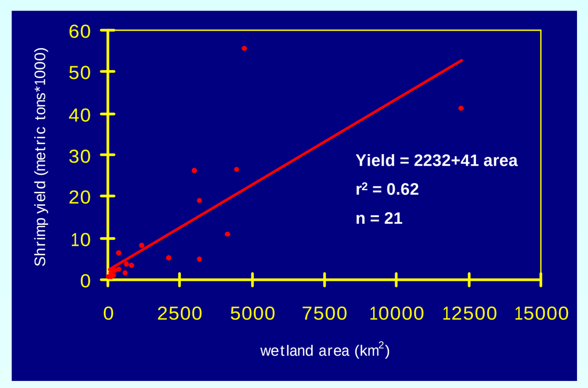
Introduction:

A central paradigm of estuarine ecology over the past four decades is that large exports of organic matter from coastal wetlands represent a major energetic pathway and support much of the secondary production of estuaries and nearshore waters (Odum 1968). This value has been extremely influential when used as a rationale for conserving mangroves and tropical estuaries. Nevertheless, contradictory results haven presented that question this celebrated attribute (Fig.1). Particularly problematic is understanding the utilization of detritus produced by mangroves and transported to adjacent waters.

1. Gut content analyses and habitat utilization:

Mangrove leaf litter supports higher trophic levels (Odum & Heald 1972, 1975)

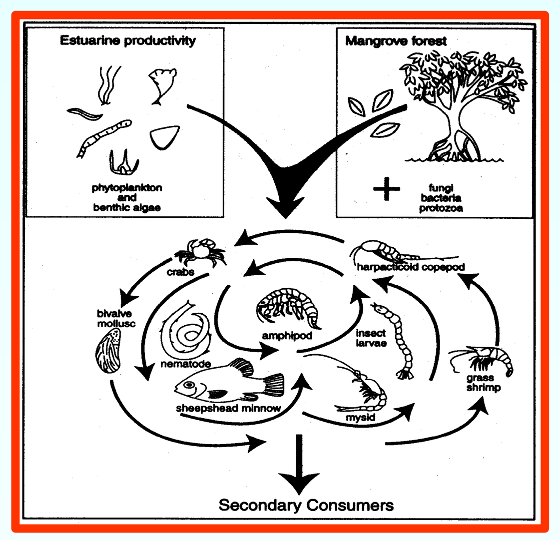
2. Statistical correlation: wetland areas & fish or shrimp catches



(after Turner 1977)

yes

yes



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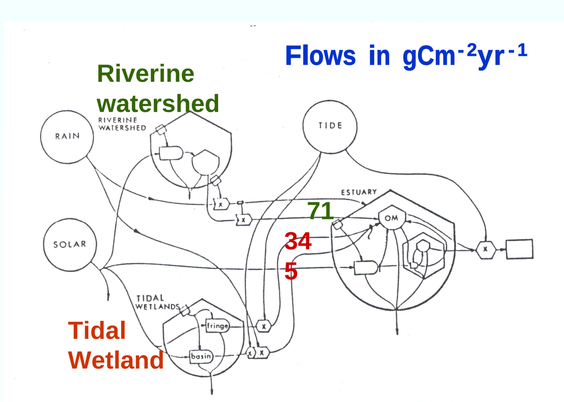
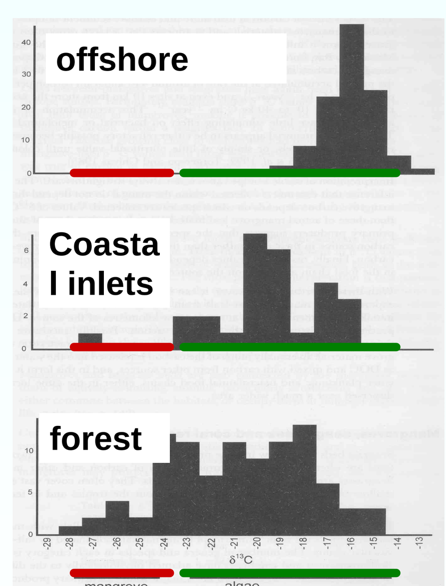
3. Mass balance calculations:



Mangrove detritus may be a significant source of energy for secondary productivity

(Twilley 1988).

4. Abundance of natural isotopes: d^{13}C, d ^{15}N, d^{34}S



Detritus outwelled from the mangrove forest into the surrounding waters is refractory to biological assimilation (Rodelli et al. 1984).

Fig.1. Approaches to analyze the importance of mangroves to estuarine food webs:

Are mangroves important source of food to consumers?

Materials and methods:

Rationale:

•The energy signature hypothesis: The amount and seasonal timing of detritus export from mangrove forest depend on specific environmental settings (Twilley 1995).

•The Paradigm "you are what you eat:" Different primary producers have different d values. A consistent degree of fractionation occurs between the isotopic signal of the diet and that of the consumer (Haines & Montague 1979;Fry & Sherr 1984).

Sample collection and preparation:

Samples were collected by hand, transported in a cool box to the laboratory, and washed. The muscle tissue of each specie was removed and dried at 60°C for 72 h. These tissues were ground to a fine powder. Stable isotope ratios were measured on a isotope ratio mass spectrometer and are expressed relative to the conventional standard.

Site selection:

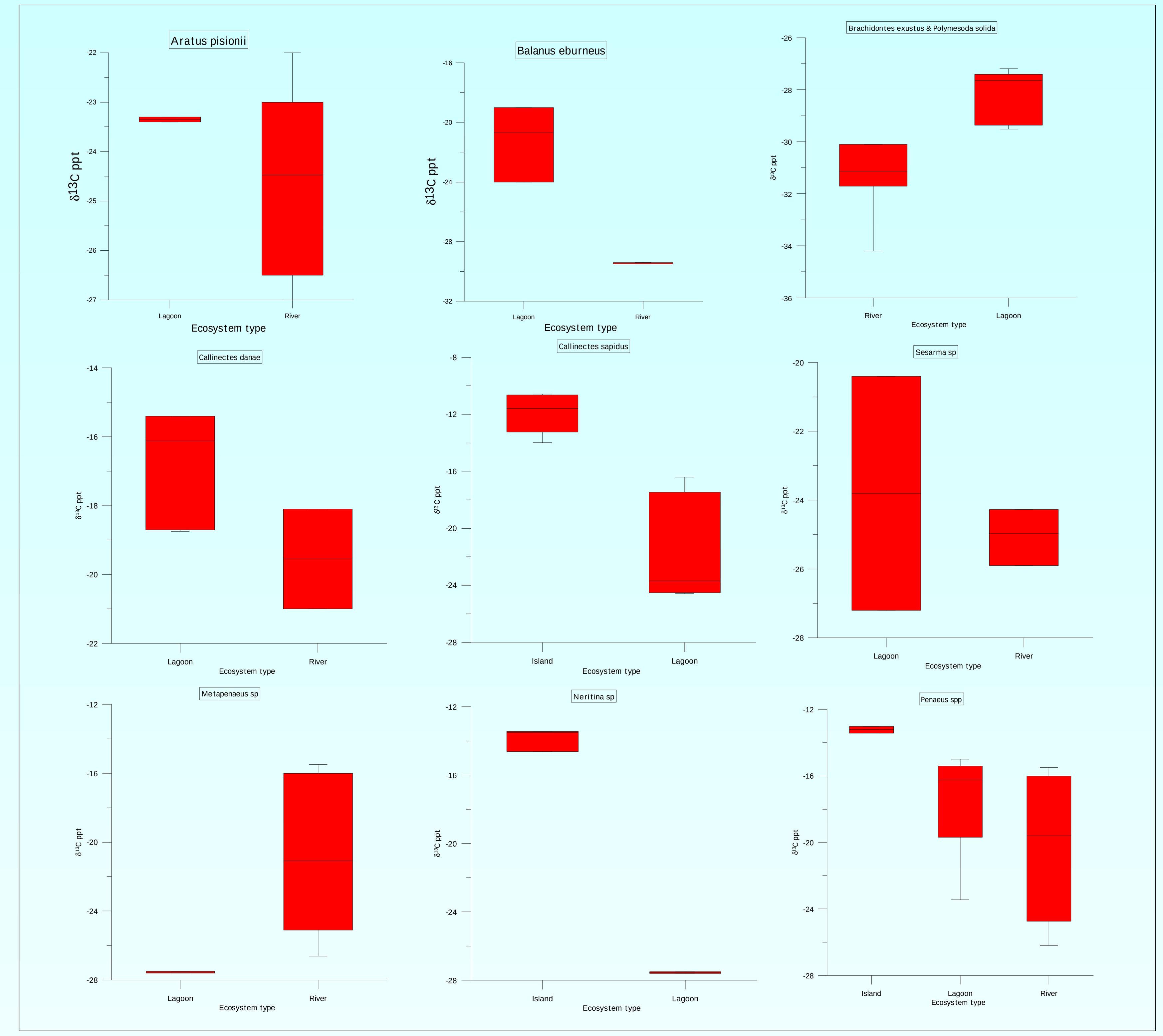
Three mangrove sites were selected for this study:San Andres-Island, Cienaga Grande de Santa Marta, and Shark River (Table 1). These sites were visited during rainy and dry seasons in 2001 and 2002. In addition, information from 9 more sites was used for comparison porpoises.

Table 1. Mangrove site relation and associated invertebrate species

Type	Location	Country	Site	Species cod	Reference
Reef	San Andres, Island	Colombia	B.Honda	5,6,7,9,10,11	This study
			B.Hooker	5,9	This study
Lagoon	Cienaga Grande de Santa Marta	Colombia	CGSM	4,5,10	This study
			El Torno	5	This study
			Isla Boqueron	10	This study
			Poza Verde	5,12	This study
			Pueblo viejo	4	This study
			Salamanca	5	This study
	Gazi Bay	Kenya	mangrove	8	Marguiller et al.1997
	Laguna Joyuda	Puerto Rico	mangrove	1,2,4,5,10	Stoner & Zimmerman 1988
	Sementa Besar coast	Malaysia	mangrove	2,9,10,11	Rodelli et al.1984
	Whitewater Bay	USA	mangrove	5,10	Harrigan et al.1989
River	Deep Bay, eastern Pearl River	China	mangrove	1,8	Lee 2000
	Embley river	Australia	mangrove	8,10,	Loneragan et al.1997
	Itamaraca Island	Brazil	mangrove	1,4,6	Wiedemeyer 1997
	Matang	Malaysia	mangrove	1,11,8,10,	Newell et al.1995; Hayase et al.1999; Chong et al.2001
	Riverine mangrove in Guimaras	Philippines	mangrove	8,10,	Primavera 1996
	Shark River	USA		2,3	Fry & Smith in prep.
			SRS4	3,7	This study
			SRS5	7	This study
			SRS6	1,7,6,11	This study

Aratus pisionii	(1)	Callinectes danae	(4)	Melamphus coffeus	(7)	Penaeus spp	(10)
Balanus eburneus	(2)	Callinectes sapidus	(5)	Metapenaeus sp	(8)	Sesarma sp	(11)
Brachidontes exustus	(3)	Littorina angulifera	(6)	Neritina sp	(9)	Polymesoda solida	(12)

Results:



Our results indicate that the same or very close related invertebrate species exhibit large differences in their d^{13}C signature (Fig.2). Invertebrate species found in high-energy mangrove systems (Riverine) present d^{13}C signatures closer to mangroves (-32 to –24d^{13}C), than similar species found in low-energy systems (reef). These data suggest that mangrove-derived carbon utilization could be a function of geomorphic and topographic elements that collectively represent the energy signature of mangroves.

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