Microphytobenthos (end)

Class 7: Tu September 23, 2008

Slide 1 Conclusions on microphytobenthos

NOTES:

Conclusions on microphytobenthos

- Microphytobenthic production is often a major source of labile organic matter in shallow benthic systems from the intertidal to approximately the 1% light depth (or slightly deeper)
- Mucous production can have profound effects on sediment transport and organic geochemistry
- Microphytobenthic production is intimately coupled to the physics of the benthic boundary layer
- It can be measured using ^{14}C, O_2, or fluorescence
- Benthic diatom specific growth is often very slow

Slide 2 Microphytobenthos (end)

NOTES:

Class schedule

Order of topics

- *Today: Finish of benthic diatoms*
- *Thursday: Benthic community structure*
  - *overview of benthic community structure, including benthic population processes*
  - *Tools of the trade: alpha, beta & gamma diversity*
  - *Gallagher, E. D., G. B. Gardner and P. A. Jumars 1990. Competition among the pioneers in soft bottom benthic succession: field experiments and analysis of the Gilpin-Ayala competition model. Oecologia 83*: 427-442.
  - Whitlatch, R. B. 1980. Patterns of resource utilization an coexistence in marine intertidal deposit-feeding communities. J. Mar. Res. *38*: 743-765.
  -
  - Gallagher & Keay (1998)
-

Slide 3 Class schedule

NOTES:

Microphytobenthic production (end)

Benthic boundary layers, Revsbech & Jørgensen (1983) O_2 method and PAM fluorescence

Slide 4 Microphytobenthic production (end)

NOTES:

Serôdio & Catarino (2000)

O_2 microelectrodes & pulse amplitude modulated (PAM) fluorescence, diver-PAM, http://www.walz.com/

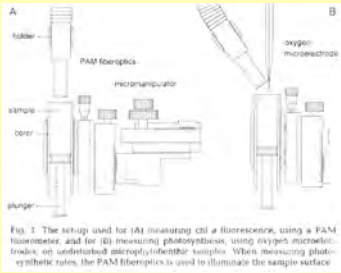


Fig. 1. The set-up used for (A) measuring chl *a* fluorescence, using a PAM fluorometer, and for (B) measuring photosynthesis, using oxygen microelectrodes, on undisturbed microphytobenthic samples. When measuring photosynthetic rates, the PAM fiberoptics is used to illuminate the sample surface

Slide 5 Serôdio & Catarino (2000)

NOTES:

Jørgensen & Revsbech (1985)

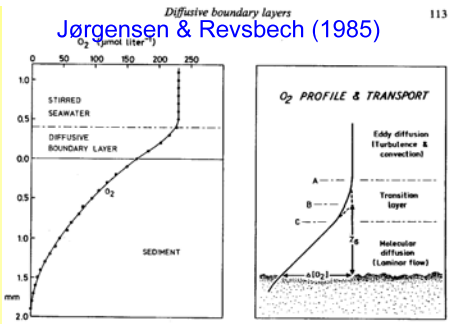
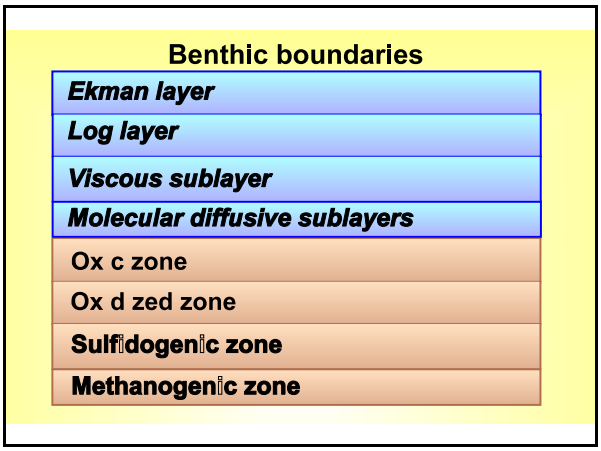


Fig. 1. Left. Oxygen microprofile in sediment collected from Aarhus Bay at 20-m water depth, July 1982. A transition (broken line) is seen above the sediment surface between the stirred seawater with homogeneous O_2 distribution and the diffusive boundary layer with a steep O_2 gradient. Right. The boundary layer at the sediment–water interface as determined by chemical transport processes and gradients. The oxygen microgradients are here used to define the outer limit (A) of the diffusive boundary layer as well as the true (C) and the effective (B) diffusive boundary layer.

Slide 6

NOTES:



Slide 7

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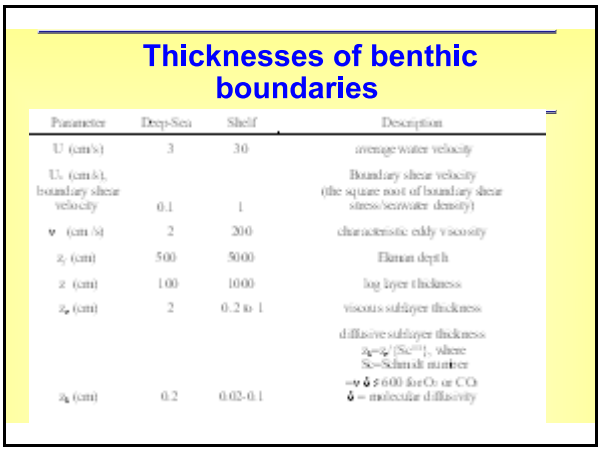

Slide 8 Thicknesses of benthic boundaries

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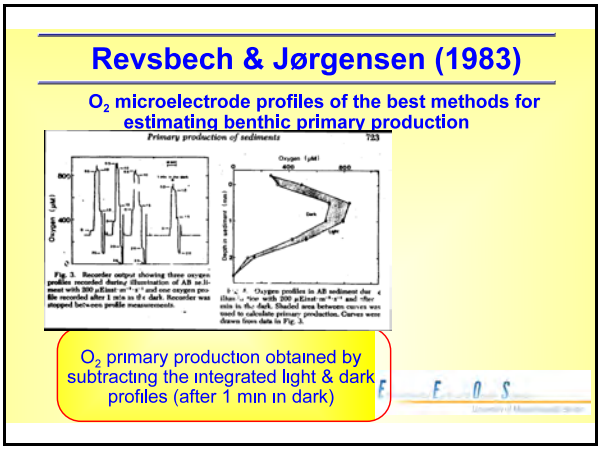
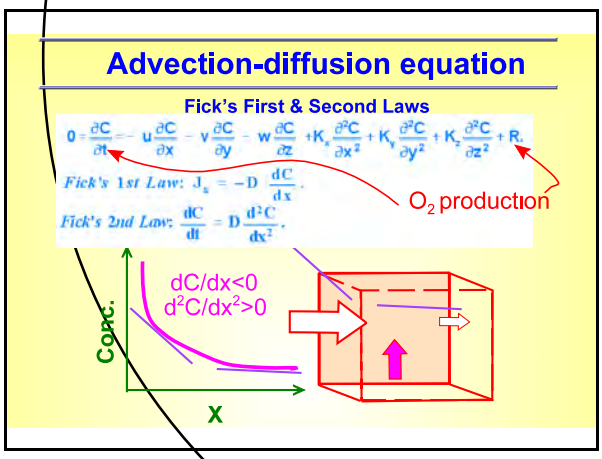


Slide 9 Revsbech & Jørgensen (1983)

NOTES:



Slide 10 Advection-diffusion equation

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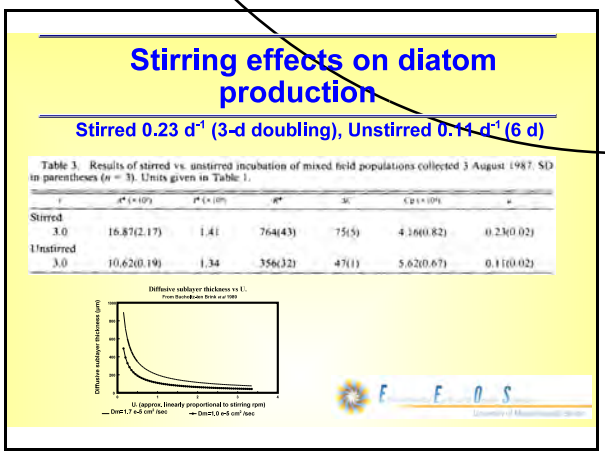

Slide 11 Stirring effects on diatom production

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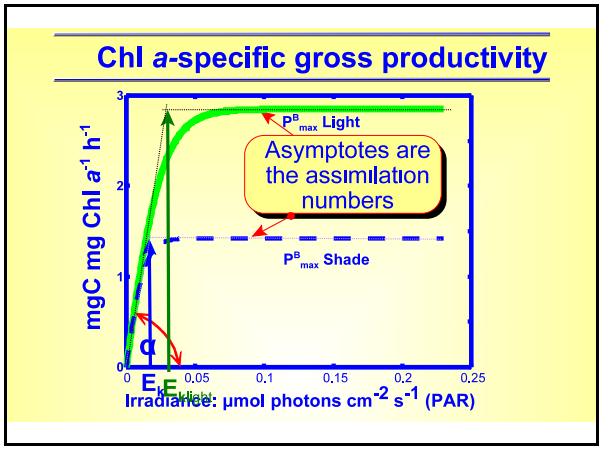

Slide 12

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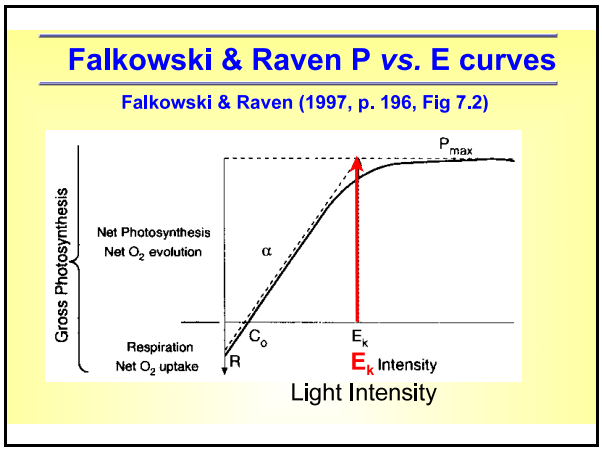

Slide 13 Falkowski & Raven P vs. E curves

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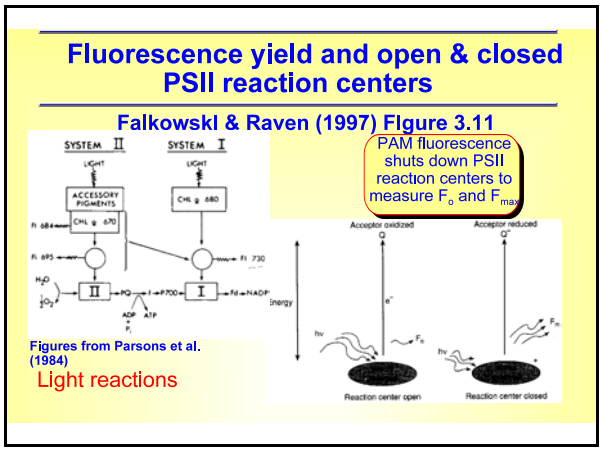

Slide 14 Fluorescence yield and open & closed PSII reaction centers

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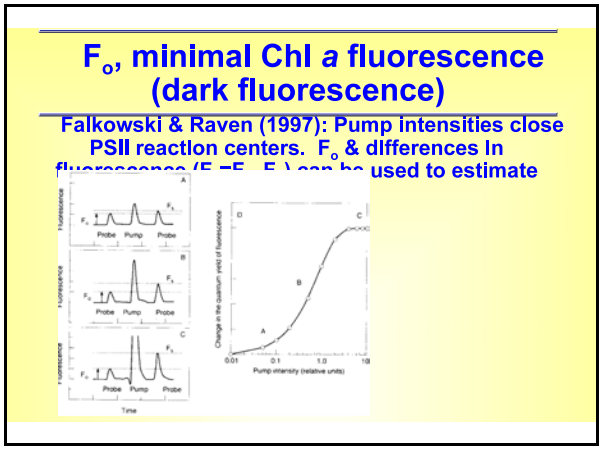
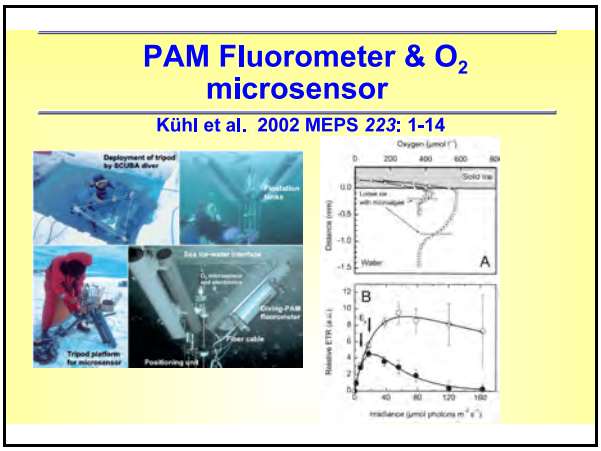


Slide 15 Fo, minimal Chl a fluorescence (dark fluorescence)

NOTES:



Slide 16 PAM Fluorometer & O2 microsensor

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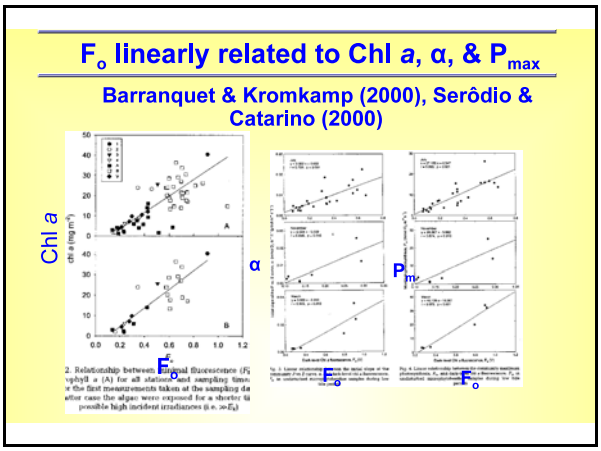

Slide 17 Fo linearly related to Chl a, α, & Pmax

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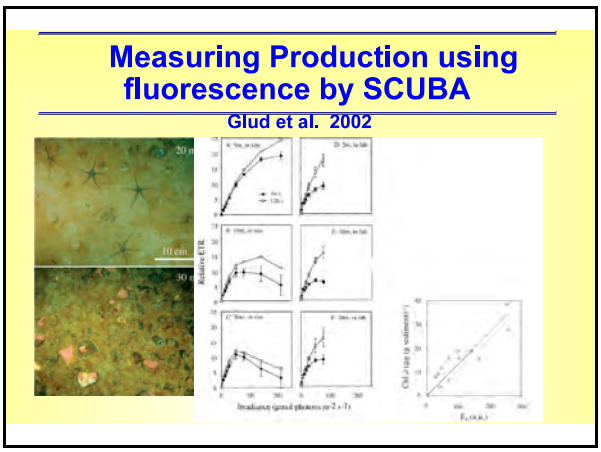

Slide 18 Measuring Production using fluorescence by SCUBA

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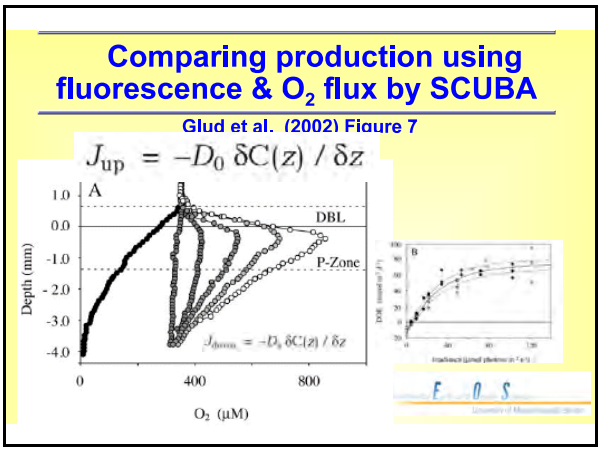
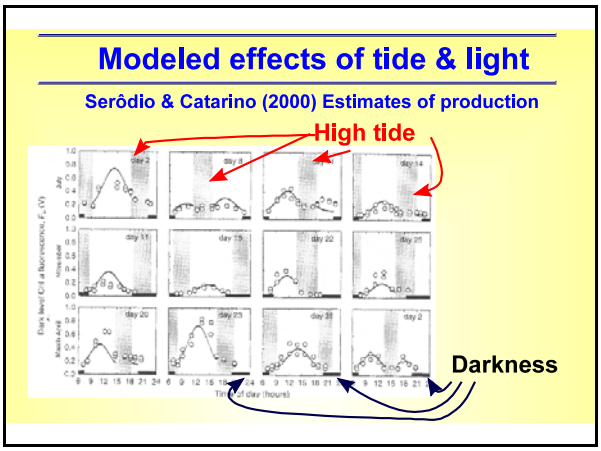


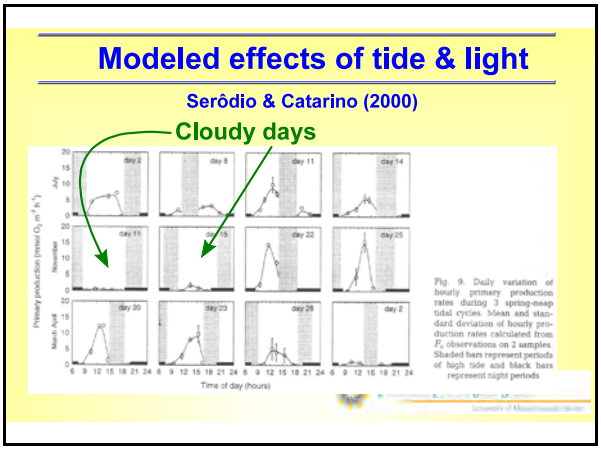
Slide 19 Comparing production using fluorescence & O2 flux by SCUBA

NOTES:



Slide 20 Modeled effects of tide & light

NOTES:



Slide 21 Modeled effects of tide & light

NOTES:

Rates of diatom production

Epipelic: about 100-200 $gCm^{-2}y^{-1}$

Location/Source	Technique	g C/m²/yr[a]	Author
Benthic microalgae:			
Georgia salt marsh	O_2, CO_2	200	Pomeroy (1959)
Delaware salt marsh	O_2	38–99	Gallagher and Daiber (1973)
California salt marsh	O_2	217–400	Zedler (1980)
Massachusetts salt marsh	^{14}C (shaded)	106	Van Raalte *et al.* (1976)
	(unshaded)	165	
Intertidal sandflat	O_2	143–226	Pamatmat (1968)
Intertidal sandflat	O_2	0–325	Riznyk and Phinney (1972)
Intertidal sandflat	^{14}C	4–9	Steele and Baird (1968)
Intertidal mudflat	^{14}C	31	Leach (1970)
Estuarine subtidal	^{14}C	116	Gronived (1960)
	^{14}C	90	Marshall (1970)
	^{14}C	180	Joint (1978)
Wadden Sea sand flat	^{14}C	58–177	Cadée (1980)
Sea and marsh grasses:			
Thalassia beds	O_2	520–640	Westlake (1963)
Spartina (Georgia)	O_2	257–897	Teal (1962)
(North Carolina to Nova Scotia)	cropping	130–256	Mann (1972b)
(Massachusetts)	cropping	1100–2300[b]	Valiela *et al.* (1976)
Mangrove swamps:			
Florida (net prod.)	O_2 (+ litter)	400	Mann (1972b)
Kelps:			
Laminaria (Nova Scotia)	cropping	1900	Westlake (1963)
(England)	cropping	1225	Bellamy *et al.* (1968)
(Nova Scotia)	blade renewal	1750	Mann (1972b)
Macrocystis	cropping	400–820	Clendenning (1972)
Littoral seaweeds:			
Fucus	O_2	<3000[c]	Kanwisher (1966)

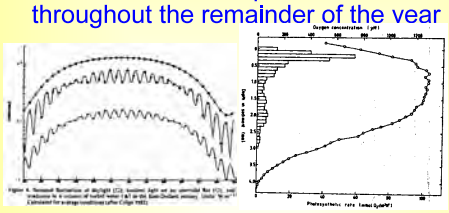
Slide 22 Rates of diatom production

NOTES:

What limits benthic production?

LIght In wInter, DIC In summer

- Production limited by light in winter
- Production may be limited by inorganic carbon in North temperate mudflats throughout the remainder of the year

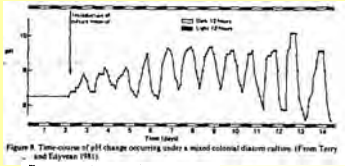


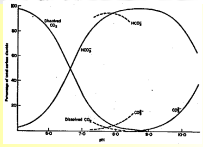
Slide 23 What limits benthic production?

NOTES:

DIC limitation in diatoms mats

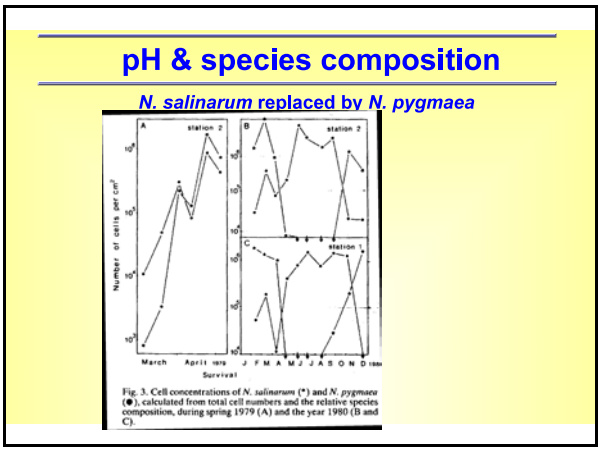
pH from Terry & Edyvean (1981)





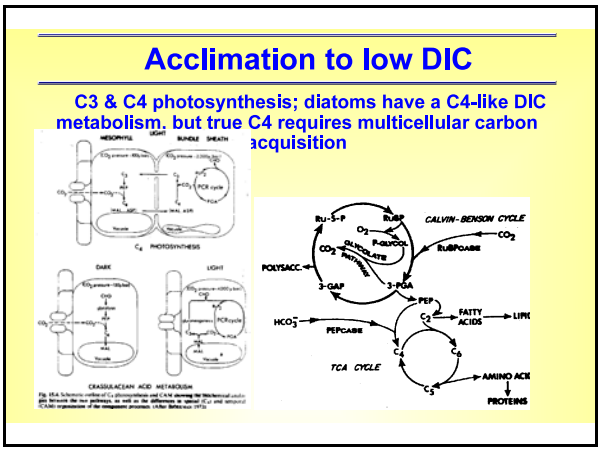
Slide 24 DIC limitation in diatoms mats

NOTES:



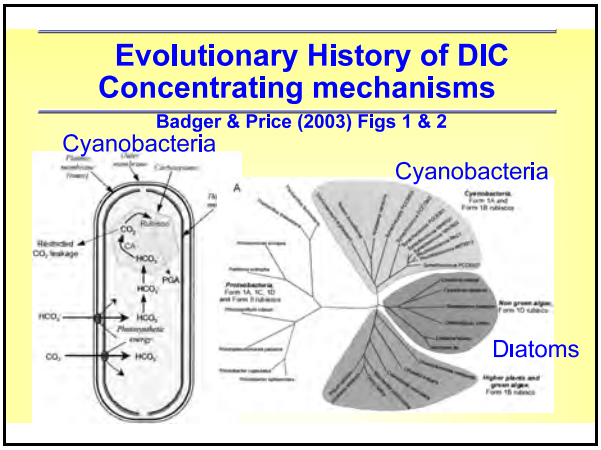
Slide 25 pH & species composition

NOTES:



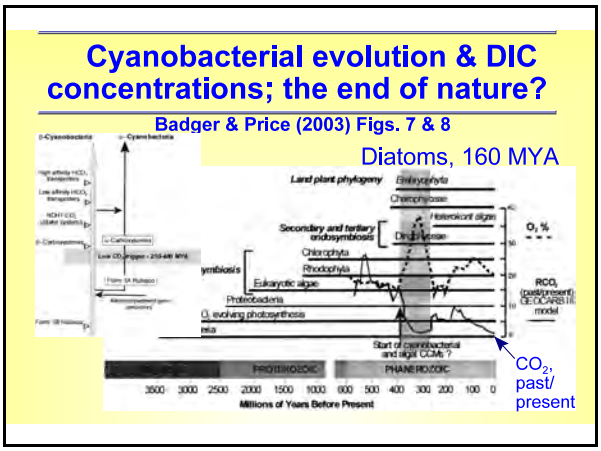
Slide 26 Acclimation to low DIC

NOTES:



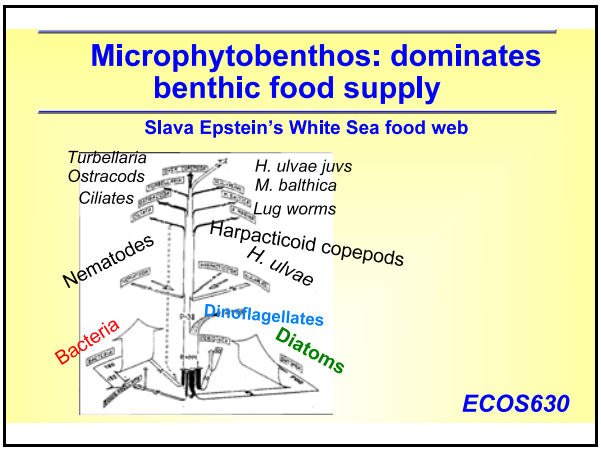
Slide 27 Evolutionary History of DIC Concentrating mechanisms

NOTES:



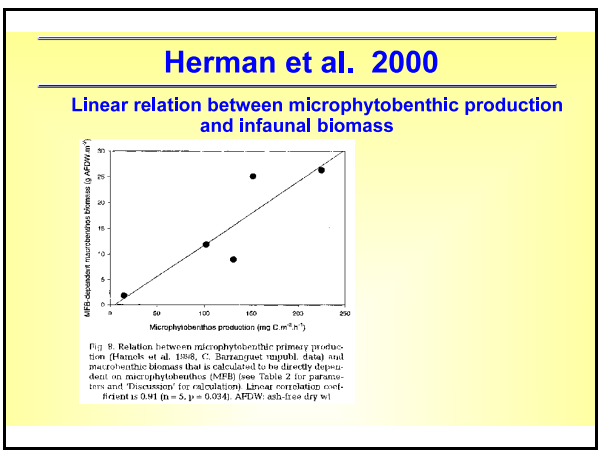
Slide 28 Cyanobacterial evolution & DIC concentrations; the end of nature?

NOTES:



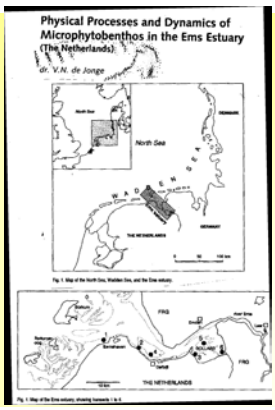
Slide 29 Microphytobenthos: dominates benthic food supply

NOTES:



Slide 30 Herman et al. 2000

NOTES:



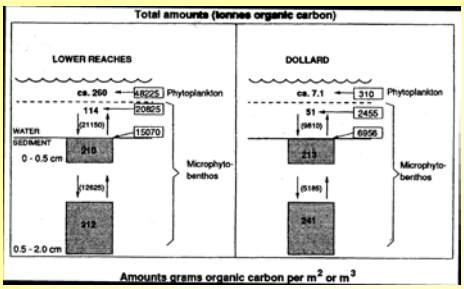
ECOS630

Slide 31

NOTES:

Photoautotrophic standing stock

From de Jonge (1994)

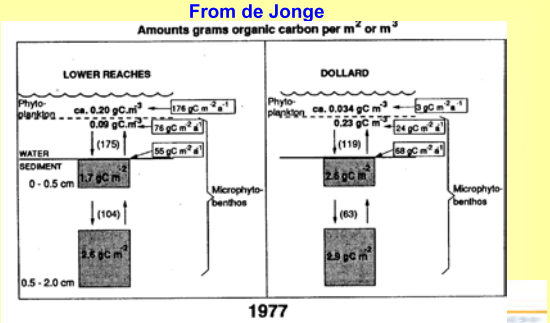


Slide 32 Photoautotrophic standing stock

NOTES:

Photoautotrophic production

From de Jonge



Slide 33 Photoautotrophic production

NOTES:

Microphytobenthos & phytoplankton

- Ems Dollard
  - Microphytobenthic production 60-250 mgC m^{-2} d^{-1}
  - 30% of phytoplankton are resuspended microphytobenthos
- Dollard (about 1 m deep)
  - 92% of Chl *a* from microphytobenthos
  - Production
    - 25% of total production from resuspended benthic diatoms
    - 53% from true phytoplankton
    - 22% from tidal flat production

Slide 34 Microphytobenthos & phytoplankton

NOTES: