Zooplankton Grazing and Secondary Production in the Indian Ocean

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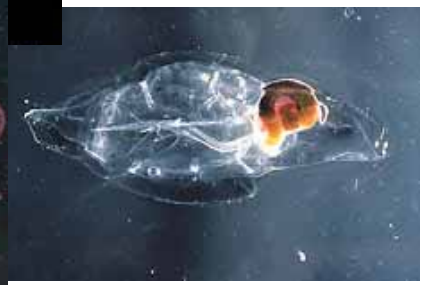
Zooplankton Diversity

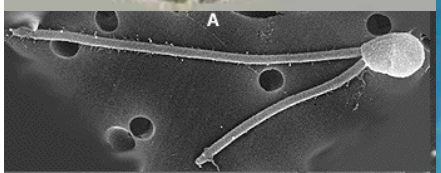
Omnivorous Suspension Feeders

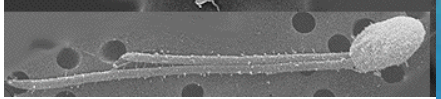


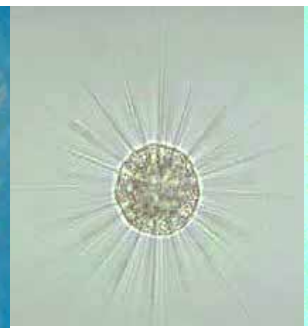
Carnivores

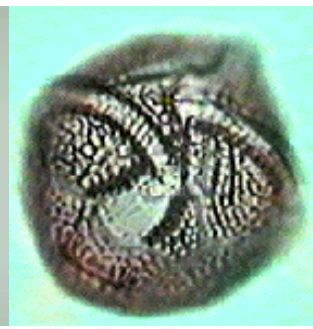
MesoZoo 200 µm

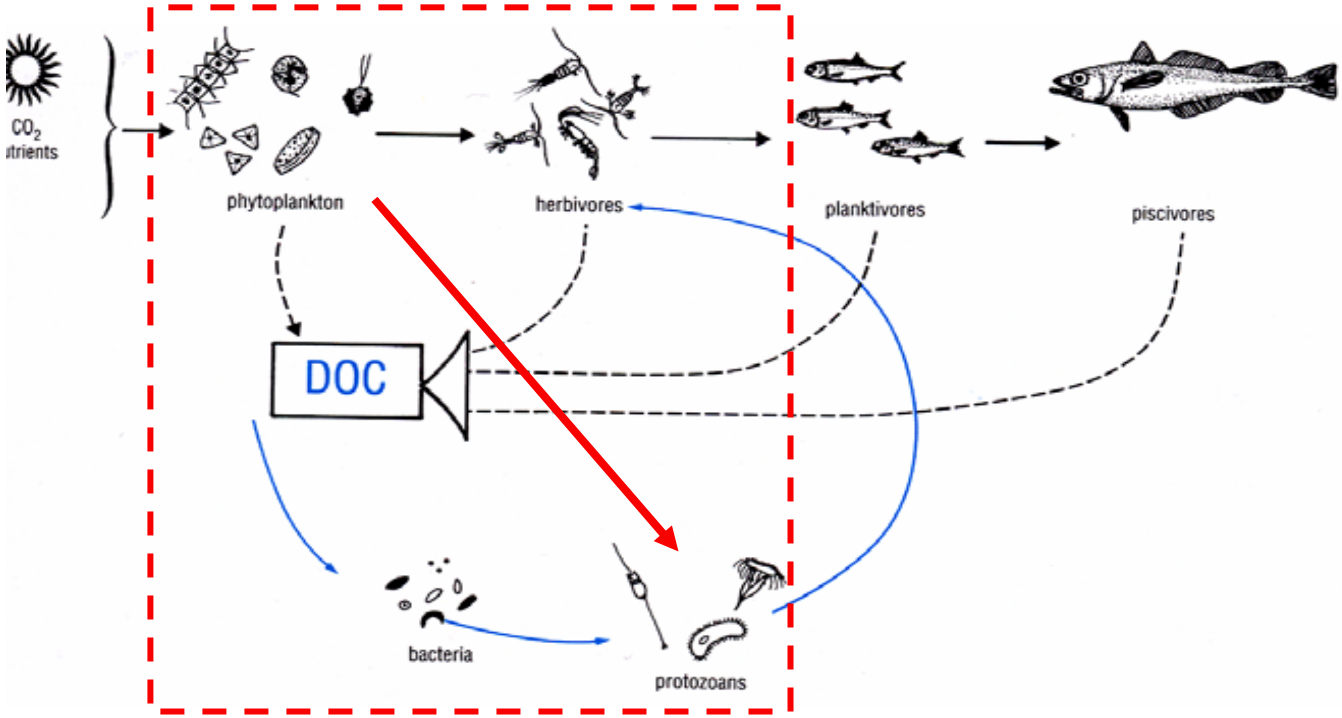
MicroZoo











Overview

Concepts, Methods & Relationships

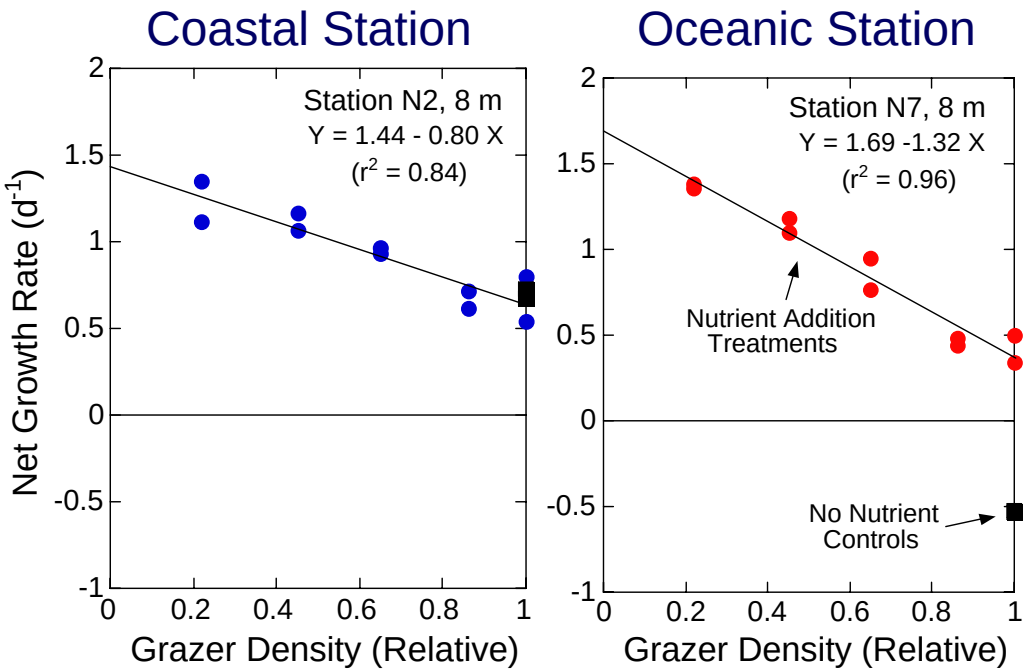
Microzooplankton Rate Overview

Mesozooplankton Rate Overview

Food-Web Flux Synthesis

Summary & Implications

MicroZoo Grazing - Dilution Method

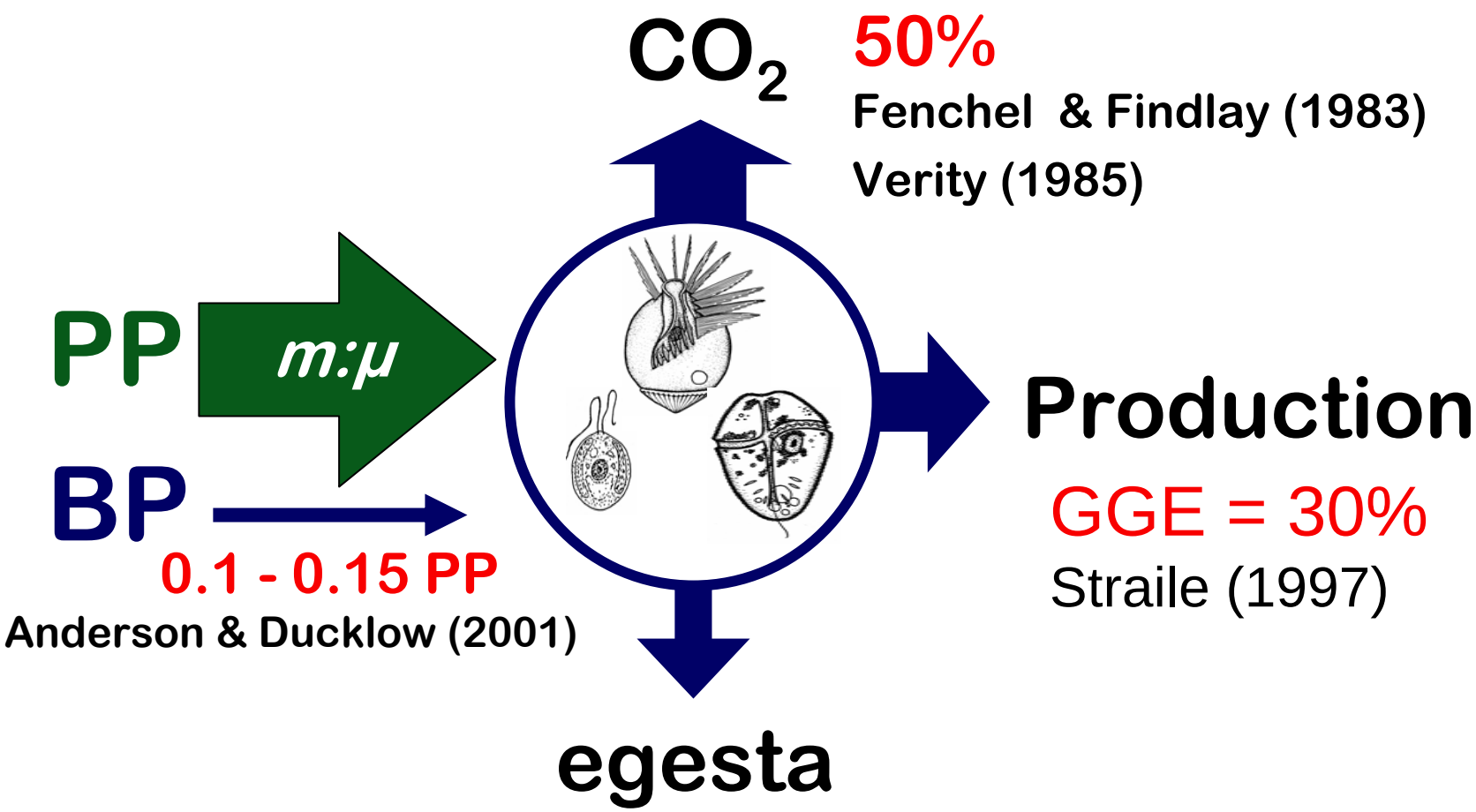


	Coast	Oceanic
Grazing, m (d^{-1})	0.8	1.3
Growth, μ_n (d^{-1})	1.4	1.7
Net Growth (d^{-1})	0.7	-0.5
Growth, μ_o (d^{-1}) m + net μ	1.4	0.8
% PP - m/μ_o	55	160
Nutr Limited μ μ_o/μ_n	1.0	0.5

Data Available:

		# Experiments
Reckman & Veldhuis (1997)	Arabian Sea	8
Landry et al. (1998)	Arabian Sea	61
Caron & Dennett (1999)	Arabian Sea	29
Edwards et al. (1999)	Arabian Sea	27
Brown et al. (2002)	Arabian Sea	(58) taxon-specific
Patterson et al. (in prep)	SW Australia	33
		158

MicroZoo Grazing & 2° Production



MesoZoo Grazing Methods

Gut Fluorescence: Uses gut "phaeopigments" (Ph) -- i.e., Chl a breakdown by-products -- as tracer of feeding on phytoplankton. Measured on individual spp. or mixed assemblages.

$$\text{Grazing} = [\text{Ph}]_{\text{gut}} * \text{Gut Turnover Rate}$$

Isotope Uptake: Measures uptake of ^{14}C and ^{3}H-labeled particles into the >200-µm size-fraction in short-term (1 h) incubations. Involves *in situ* incubations in special containers with mesh concentrated MesoZoo from 10-m depth range. Assumed to measure grazing on both phytoplankton (^{14}C) and detritus/heterotrophs (^{3}H).

Data Available:

No MesoZoo rate estimates in the US JGOFS database.

Extensive studies of net-collected abundance & biomass: JGOFS, IO

Roman et al. (2000) DSR II. Grazing was experimentally measured by the isotope technique at 6 stations on 2 cruises (NE Monsoon - January '95; Spring Intermonsoon - March '95) and extrapolated to grazing & production at all stations for all US JGOFS cruises/seasons (4).

MesoZoo Grazing & Production

Phyto

Biomass
Size Str

Growth or
P/B Model
(Hirst & Sheader 1997)

CO_2 (40%)

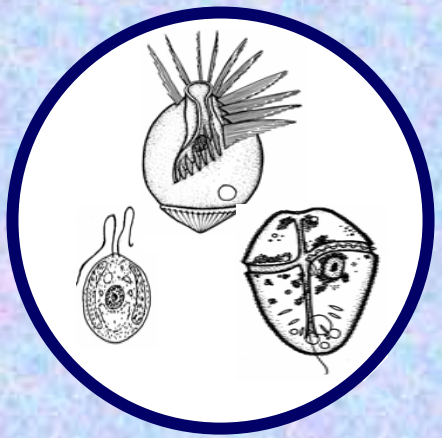
Phyto, MicroZoo
Detritus, & Carnivory

Total
Ingestion

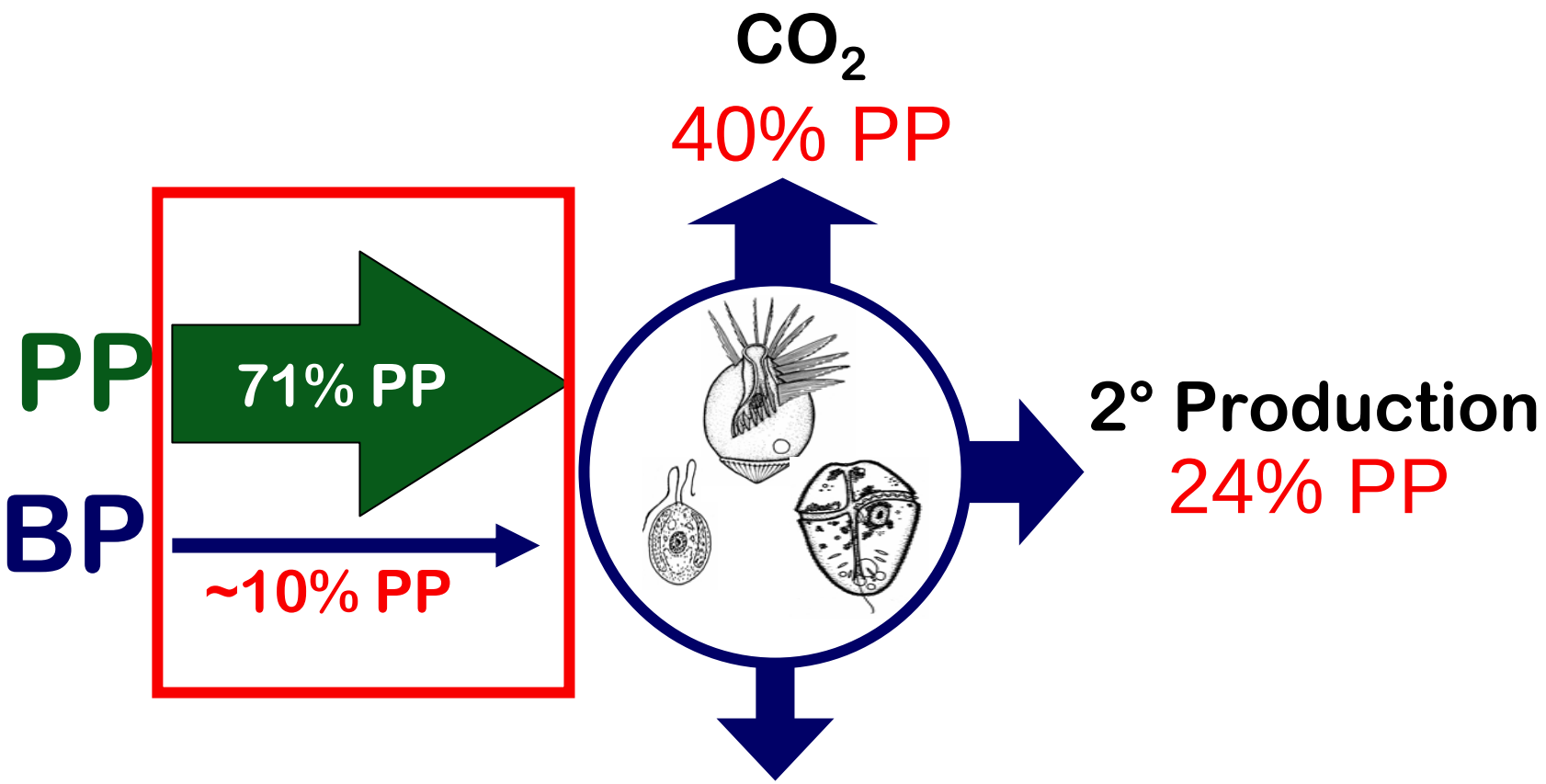
Estimated
Production
f (B, T°C, size)
GGE = 30%

Egesta (30%)

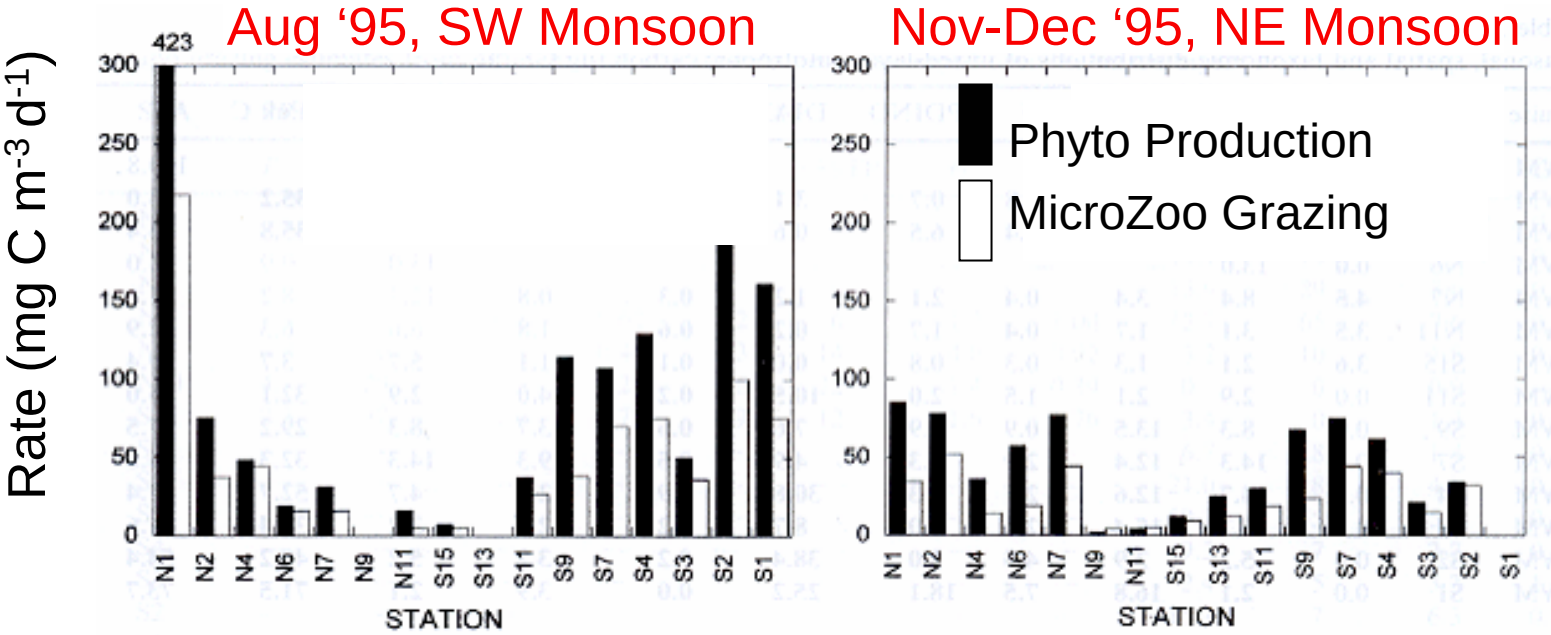
Grazing & Production by MicroZooplankton



MicroZoo as “Primary” Consumers

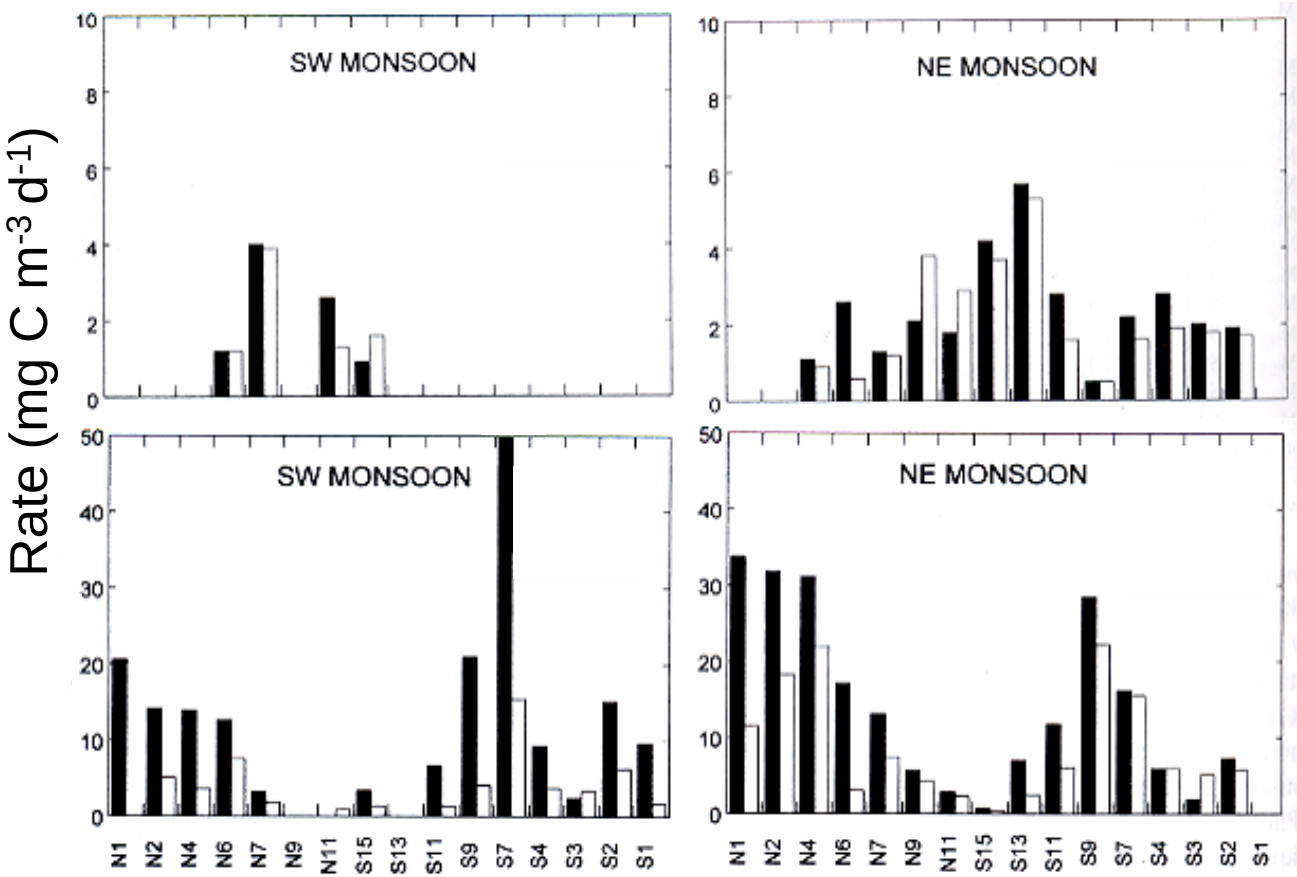


Spatial & Seasonal Variability



Brown et al. (2002)

Taxon-Specific Differences



Prochlorococcus

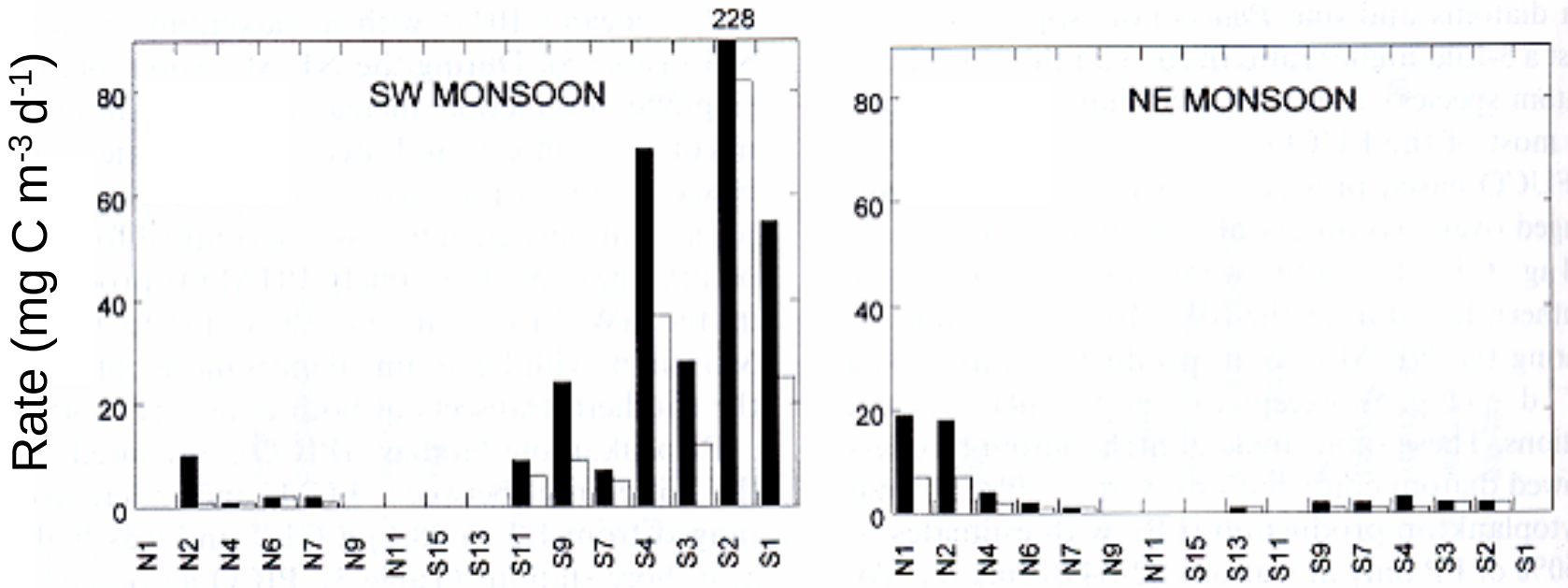
Synechococcus

Brown et al. (2002)

All Phytoplankton Taxa are Significantly Grazed by MicroZoo

Diatoms

Production Grazing



Brown et al. (2002)

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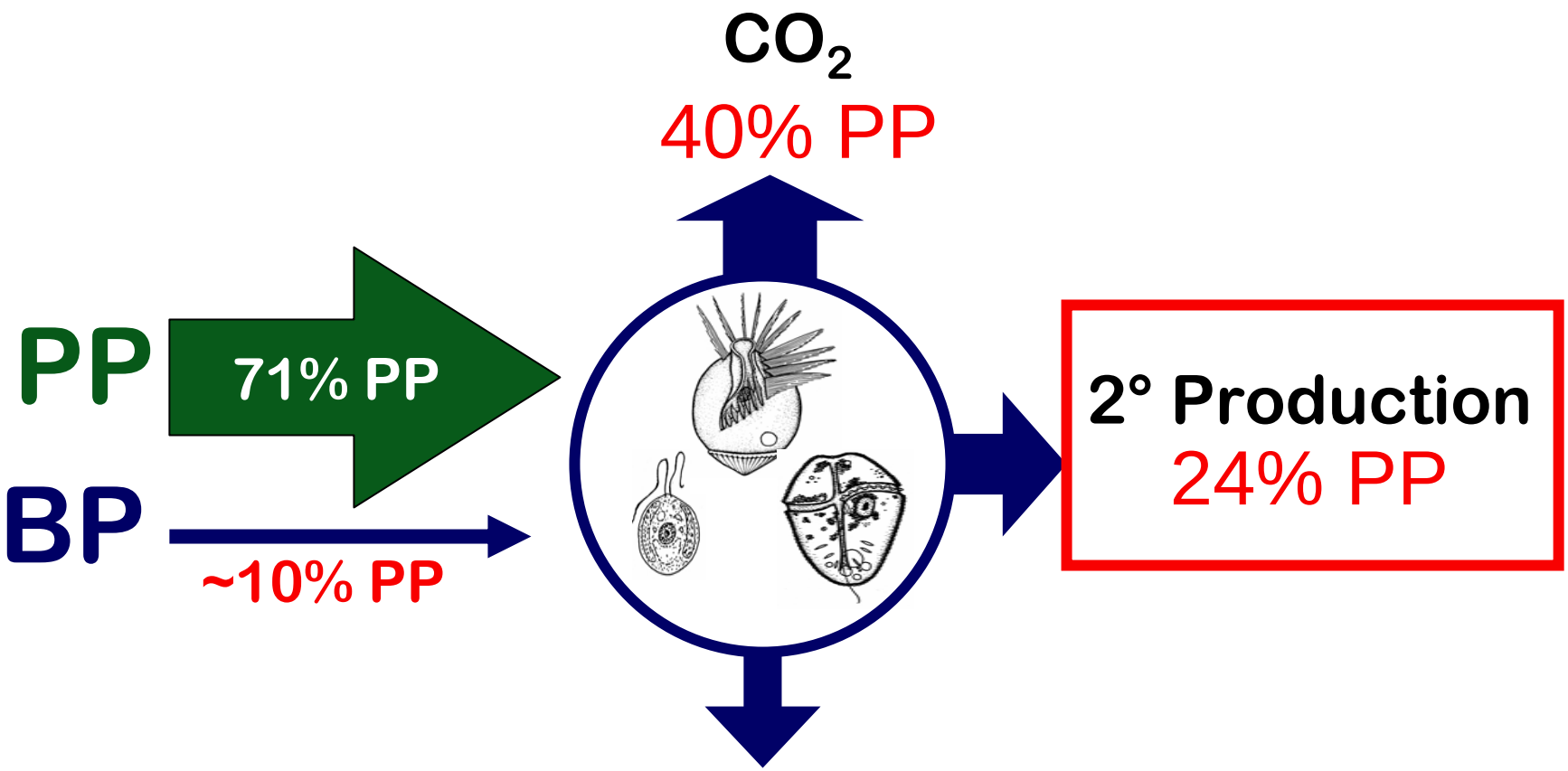
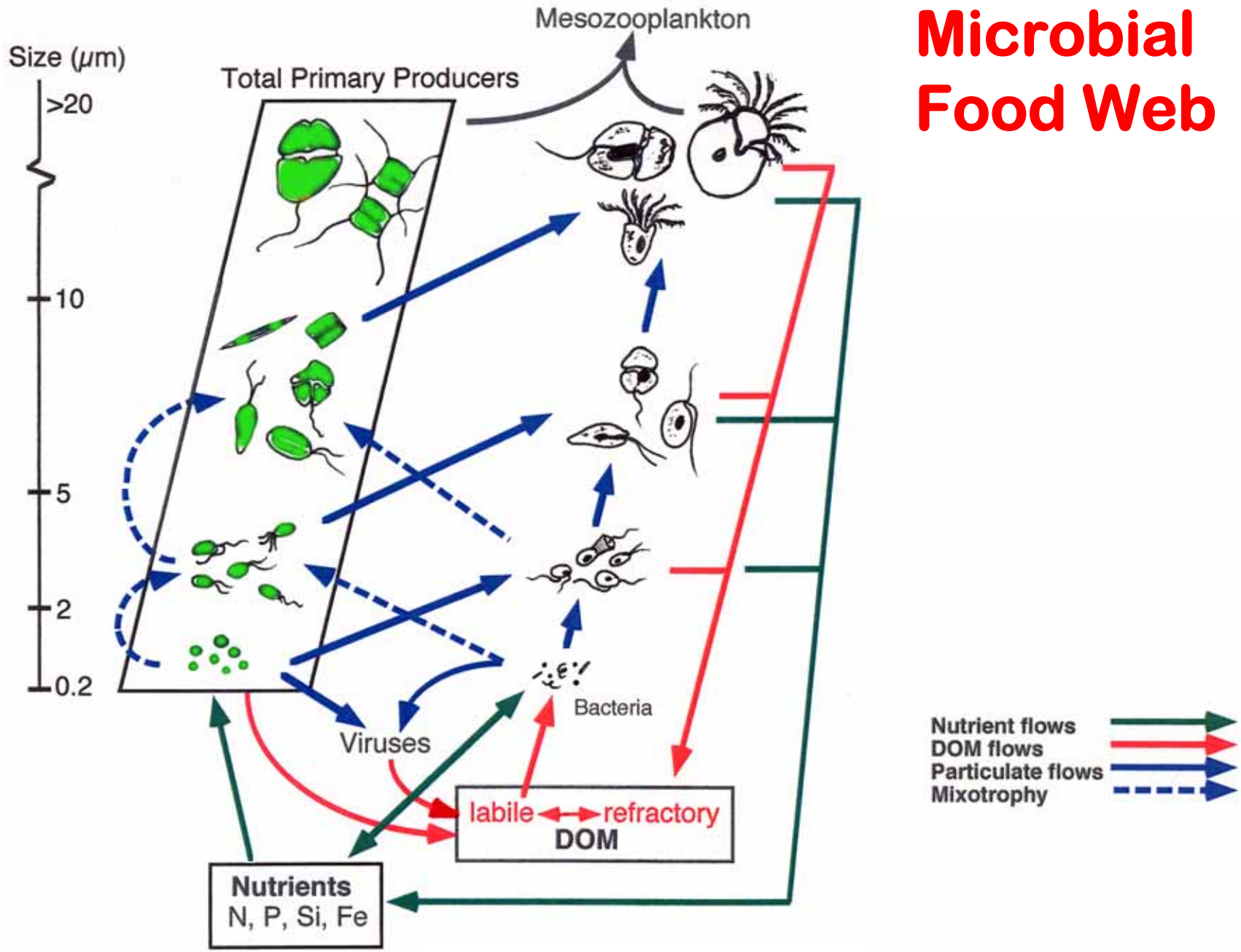


Microbial Food Web



Carbon Flows through MicroZoo

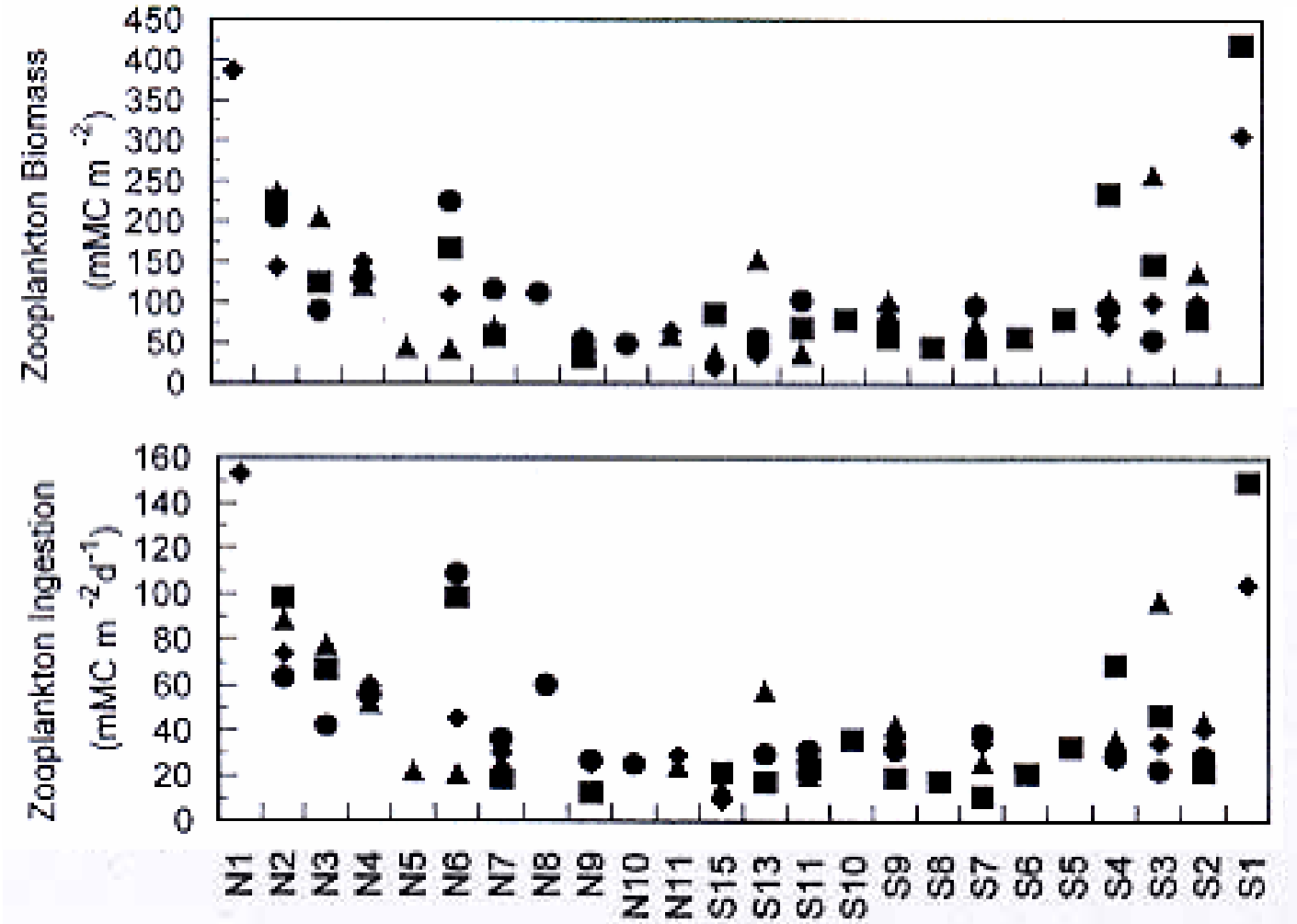
n	Cumulative Resp	Cumulative Prod	Trophic Transfer
1	40	24	24
2	53	32	7
3	56	34	2
4	57	34	1

n = mean # trophic steps before MesoZoo

All estimates as % of PrimProd

Grazing & Production by MesoZooplankton

Temporal & Spatial Variability in Biomass and Ingestion

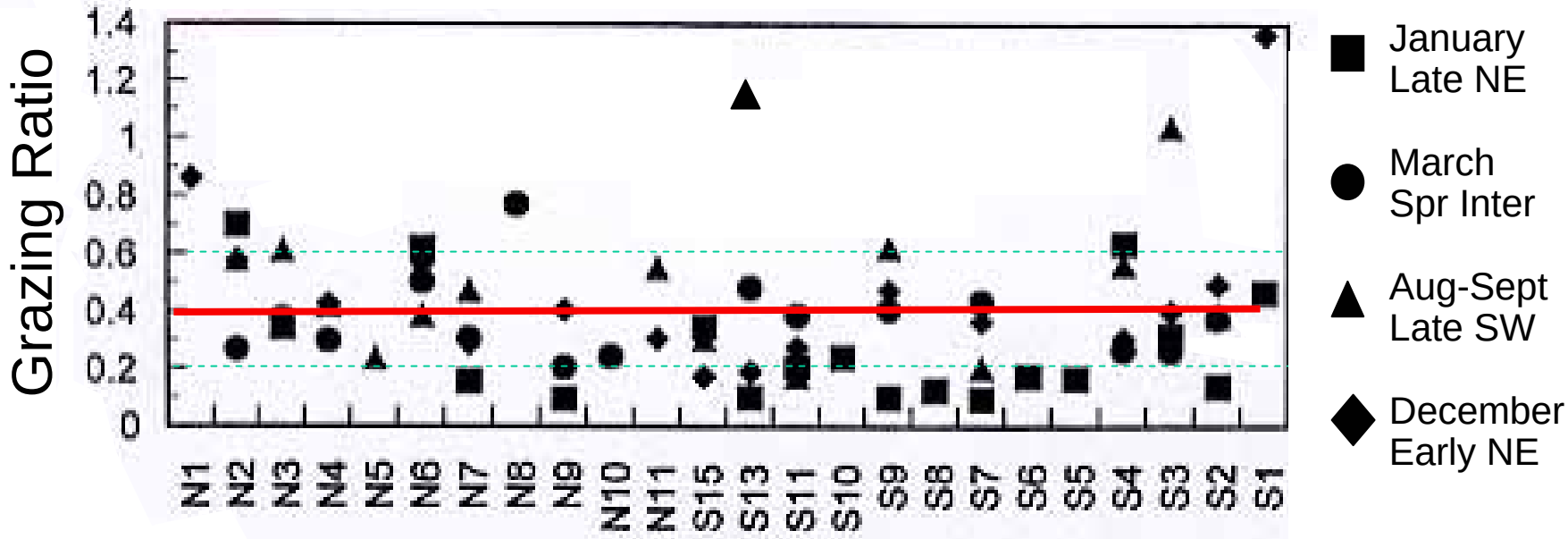


- January Late NE
- March Spr Inter
- Aug-Sept Late SW
- December Early NE

Roman et al. (2000)

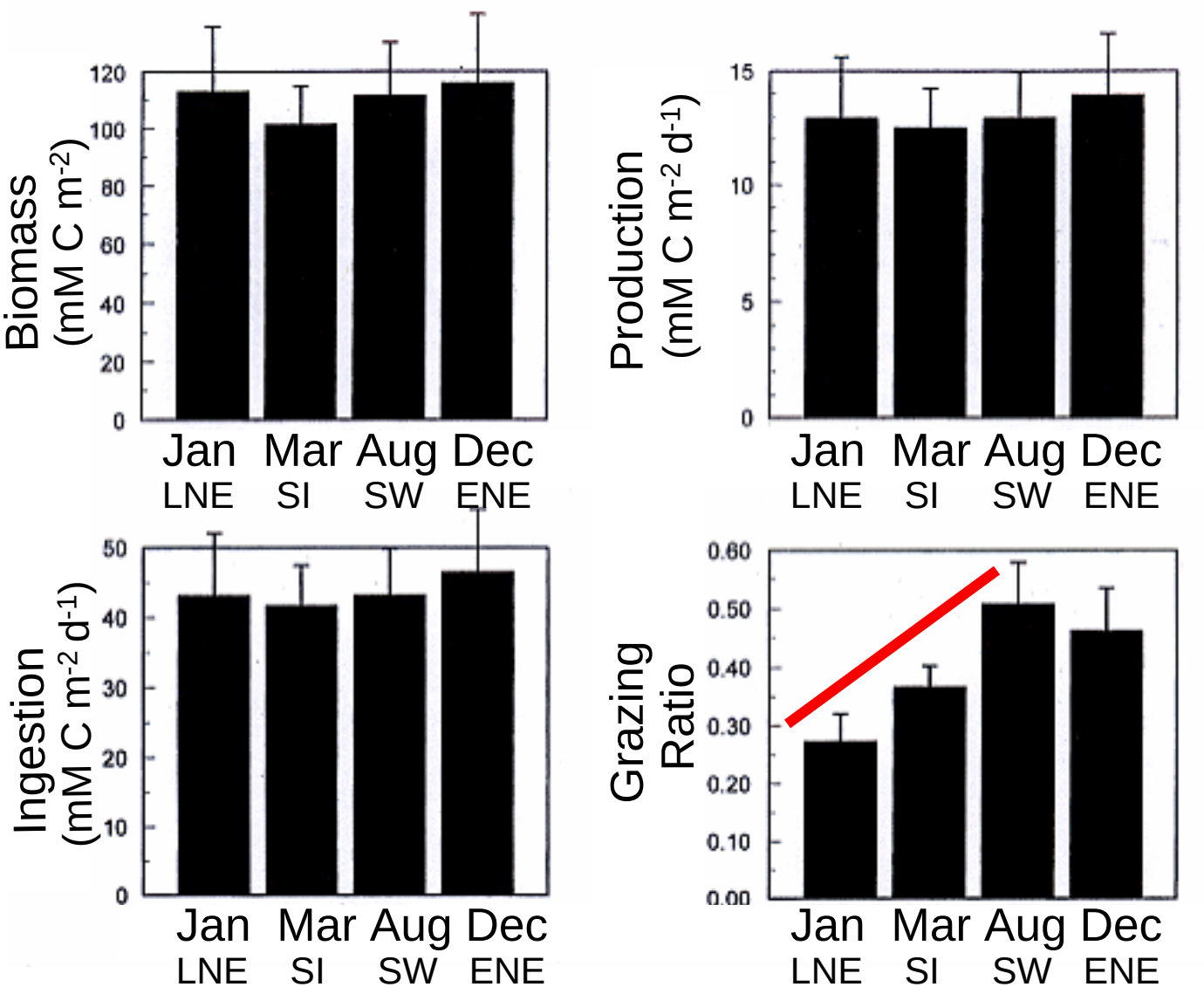
MesoZoo Ingestion vs. Primary Production

GRAZING RATIO
= Ingestion/Prim Prod



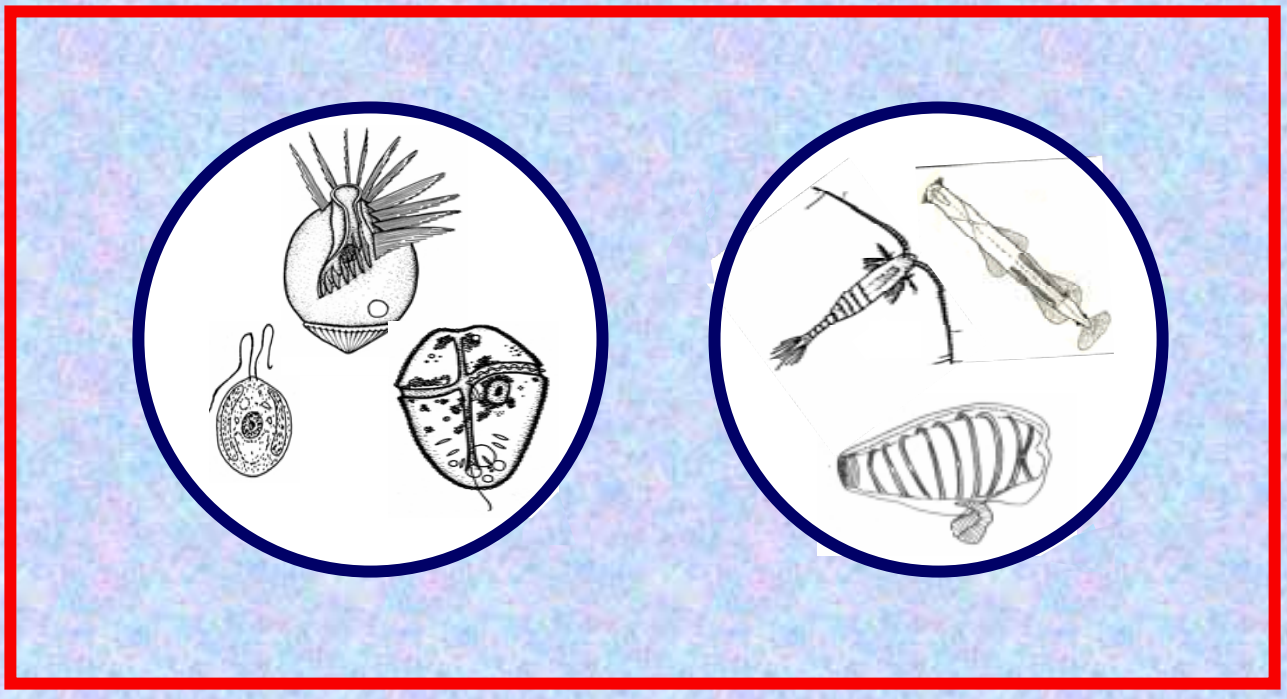
Roman et al. (2000)

Mean Estimates of MesoZoo Parameters



Roman et al. (2000)

A Food-Web Flux Analysis

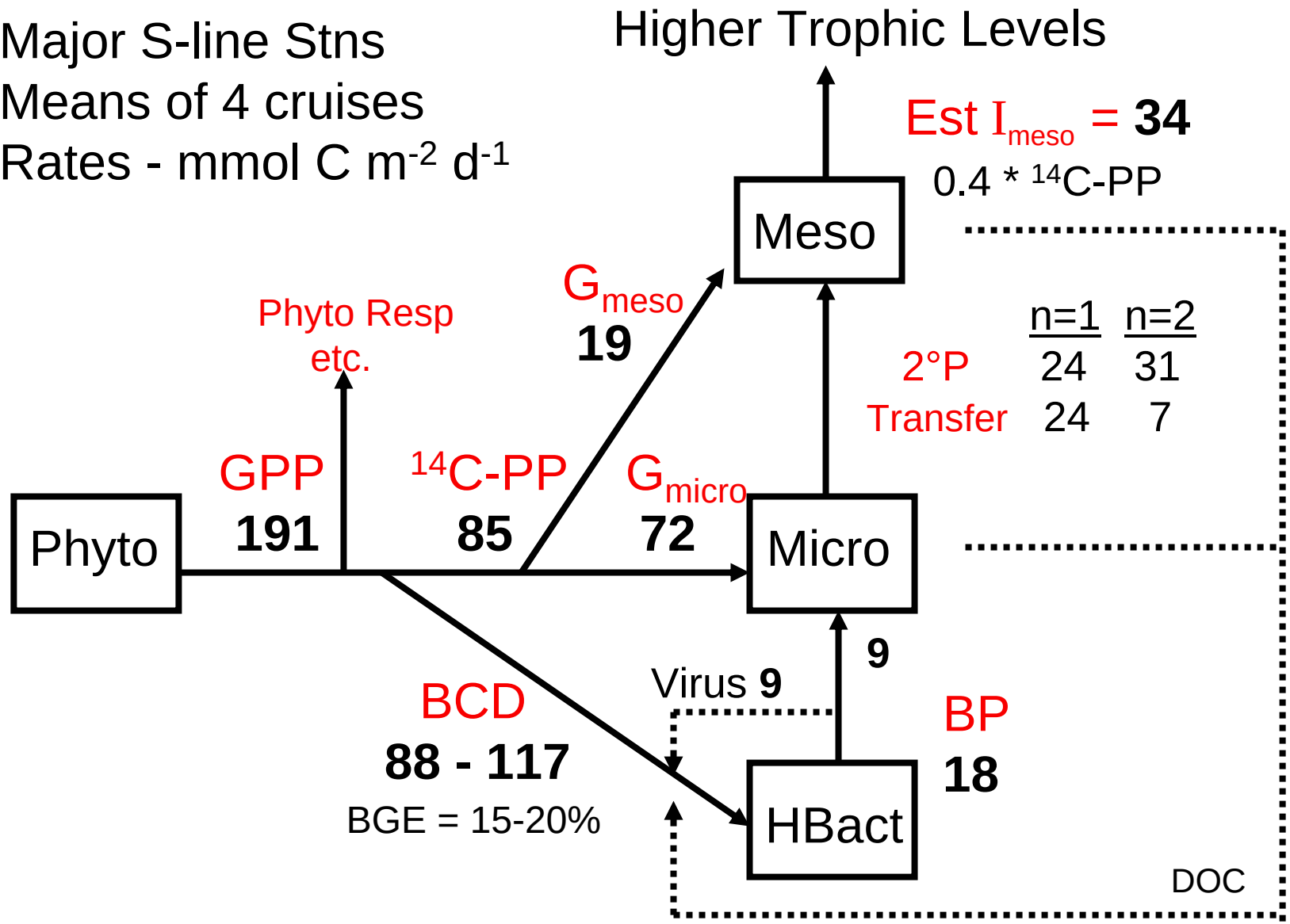


Sum of the Parts ...

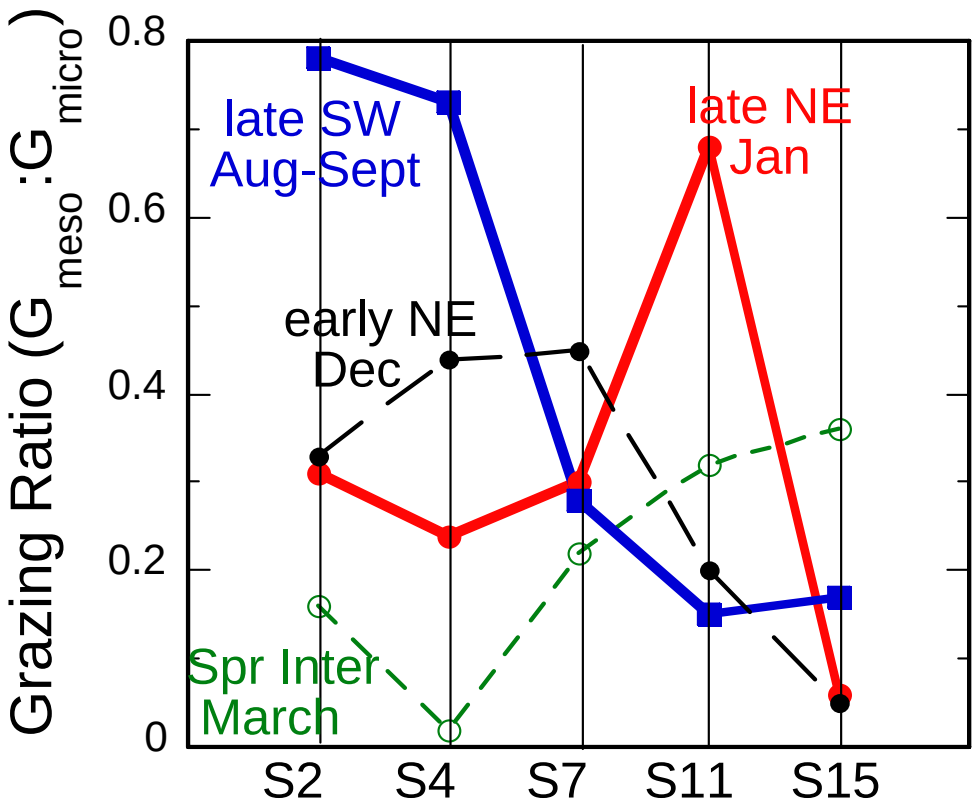
	% PrimProd
Feeding by MicroZoo	81
Feeding by MesoZoo	40
Bacterial Carbon Demand	~100
	> 200%

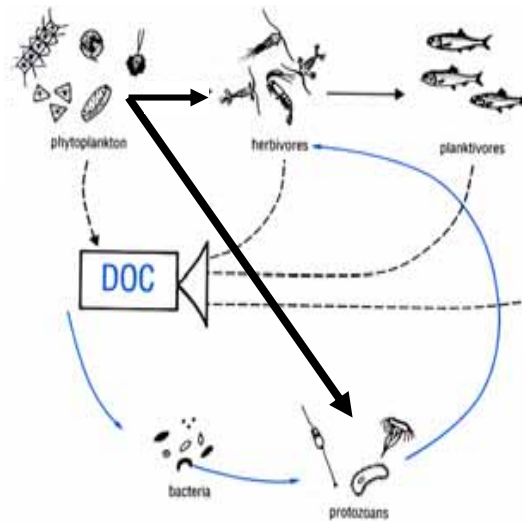
Trophic Fluxes in the Arabian Sea

Major S-line Stns
Means of 4 cruises
Rates - mmol C m^{-2} d^{-1}



Variable Partitioning of Grazing on Phytoplankton





Summary

Measured rates make sense in a food-web context

- Closed grazing balance
- Constrained fluxes

Dynamics: We know little about:

- Interannual & long-term trends
- Short-term community responses & transitions

Modeling:

- Explicit trophic connection between diatoms & dominant grazers (MicroZoo) - regulate Si:N utilization?
- Both Micro & MicroZoo are multi-level “boxes”
- Regulatory (top-down) role of MesoZoo ?