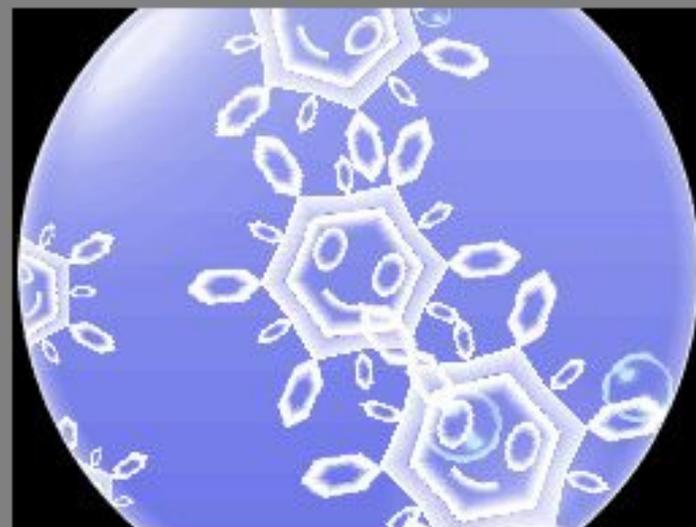
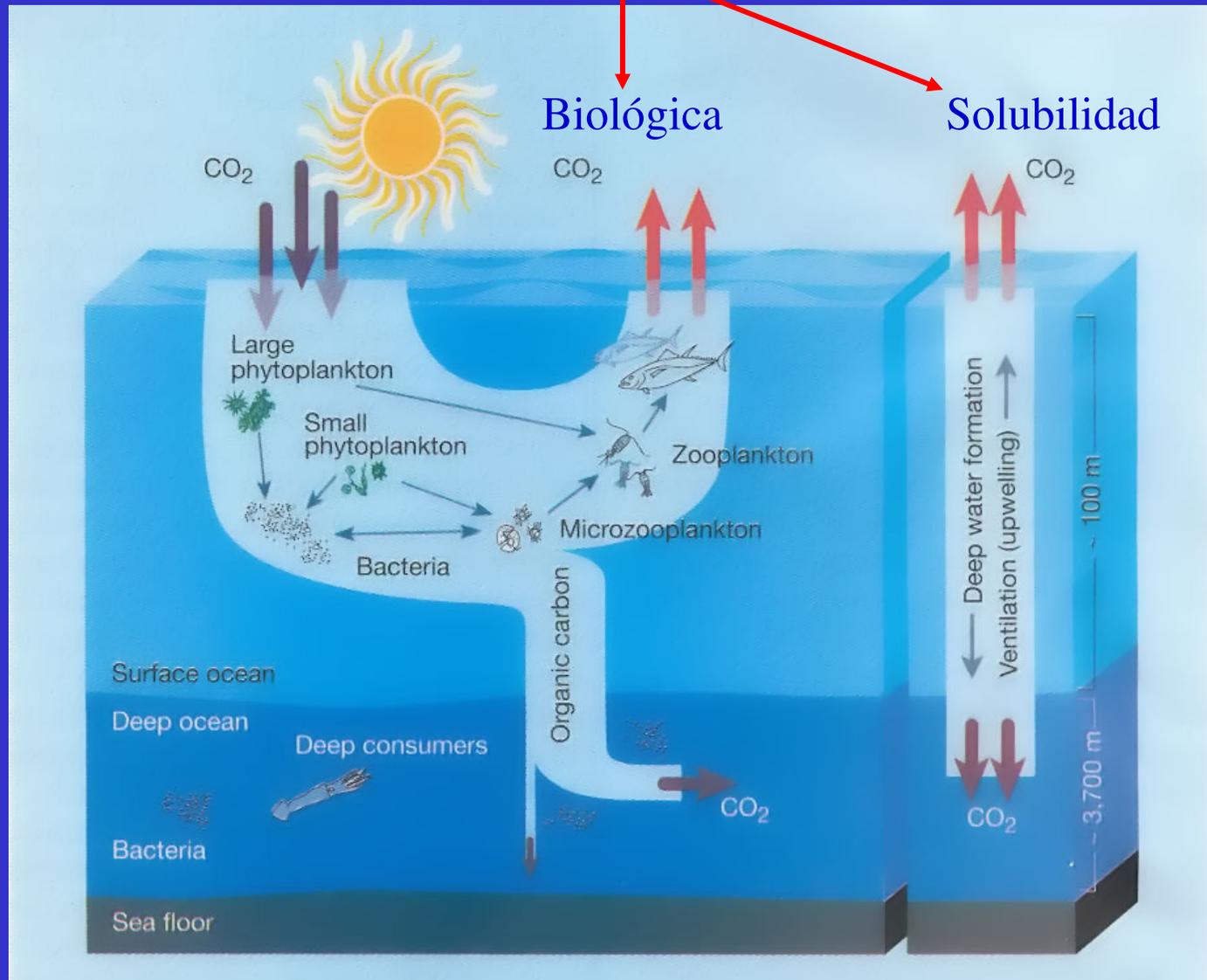


**Fluxo vertical de
partículas;**

**Degradação e
produção**

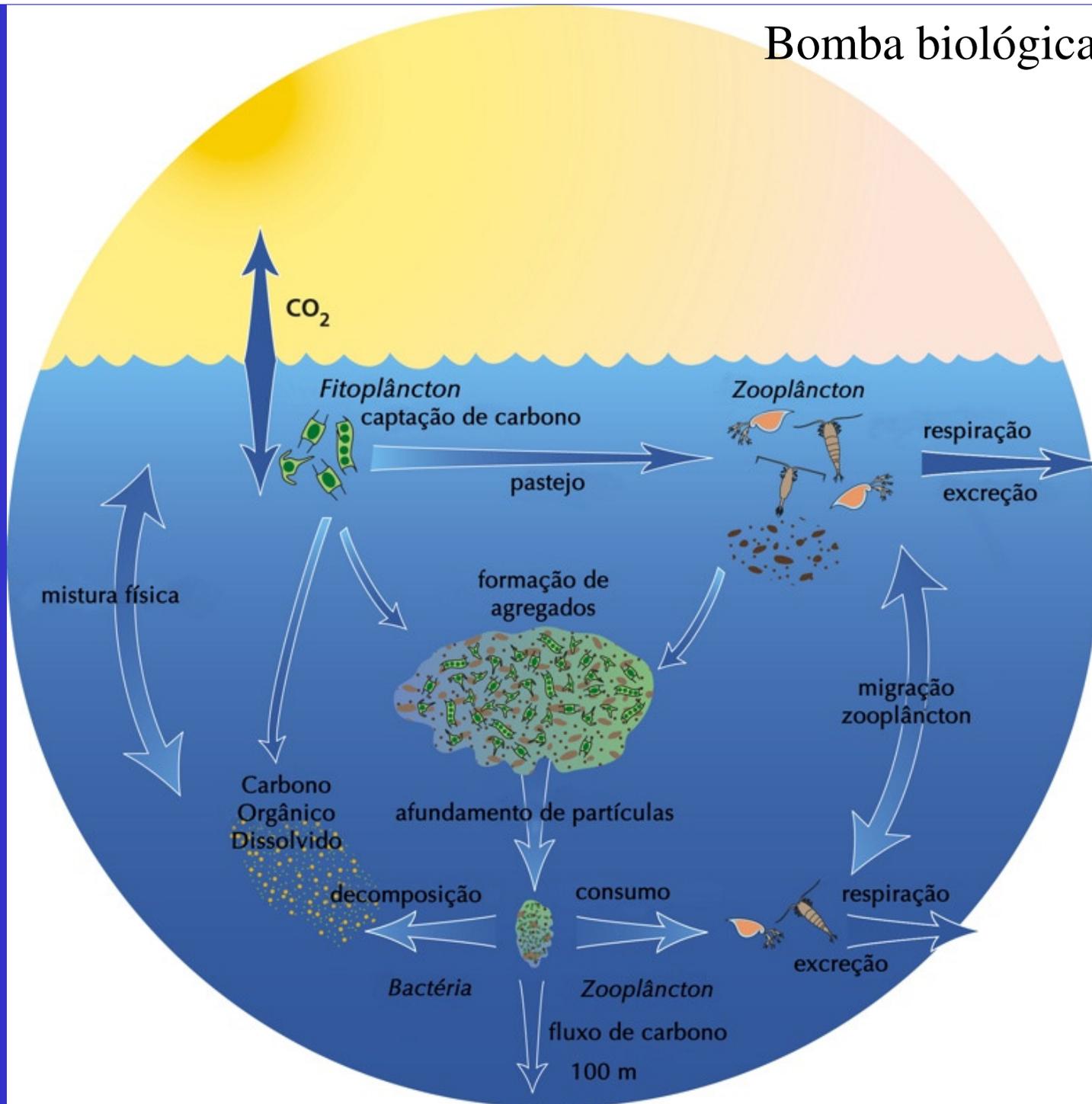


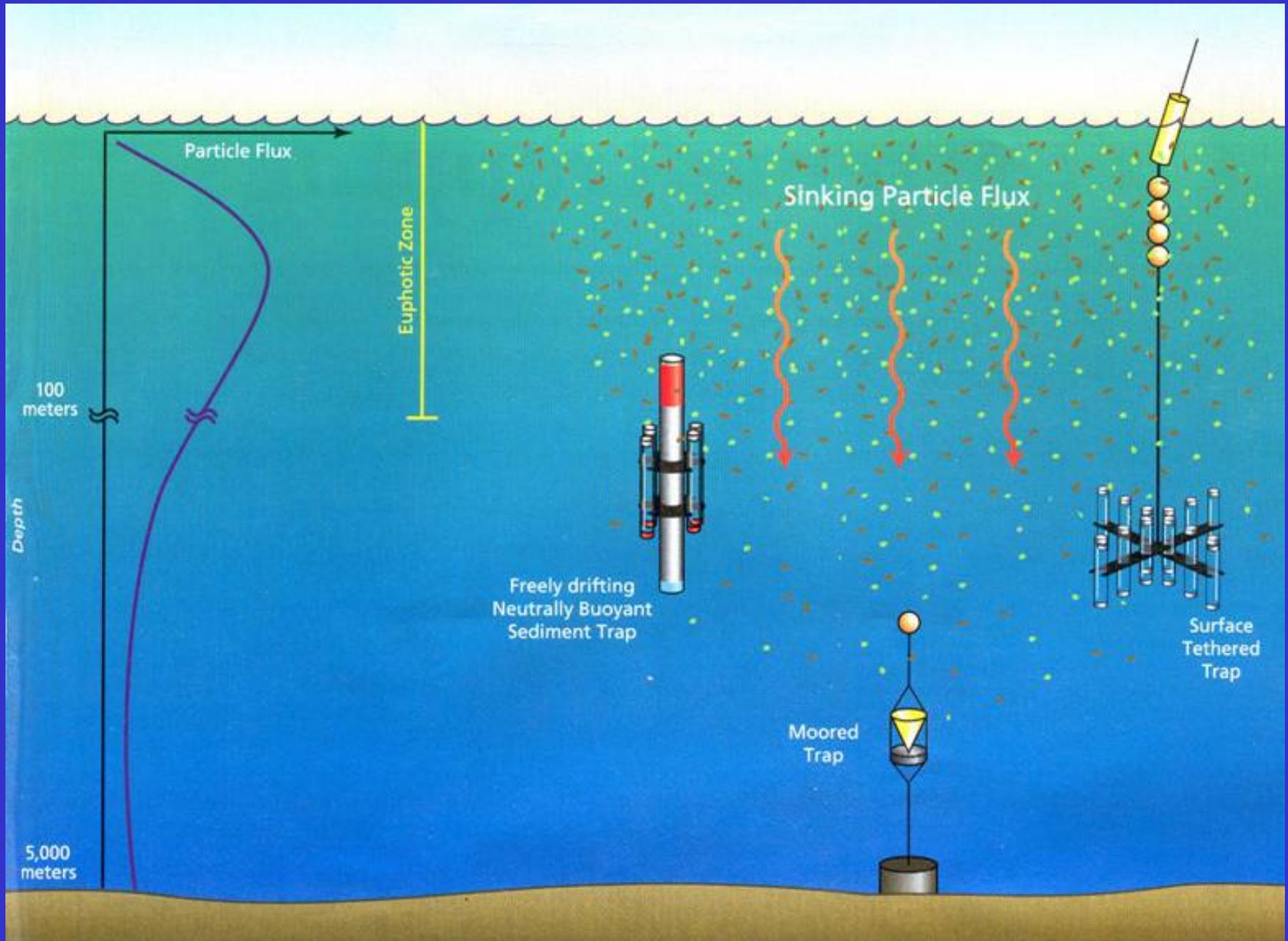
A bomba de carbono



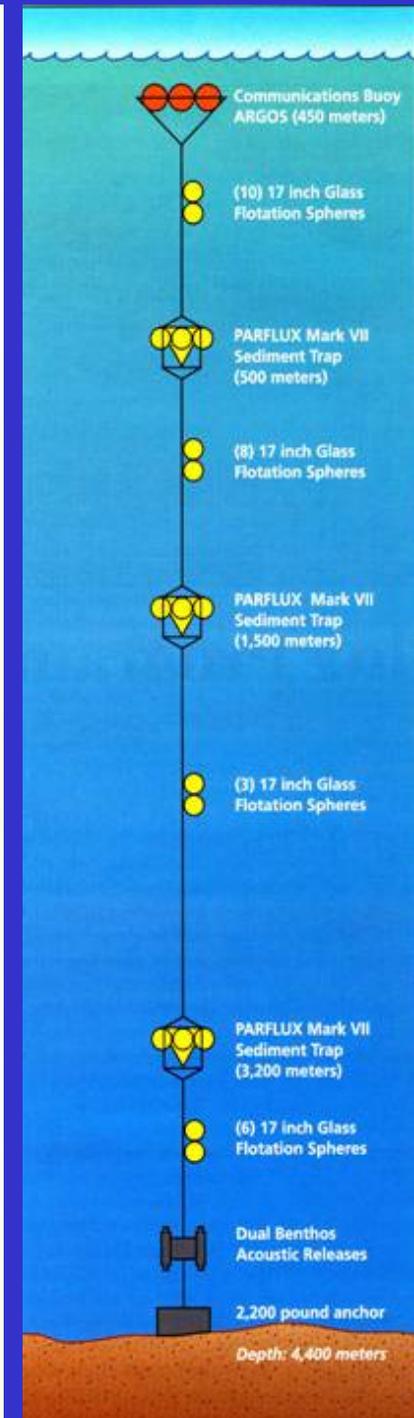
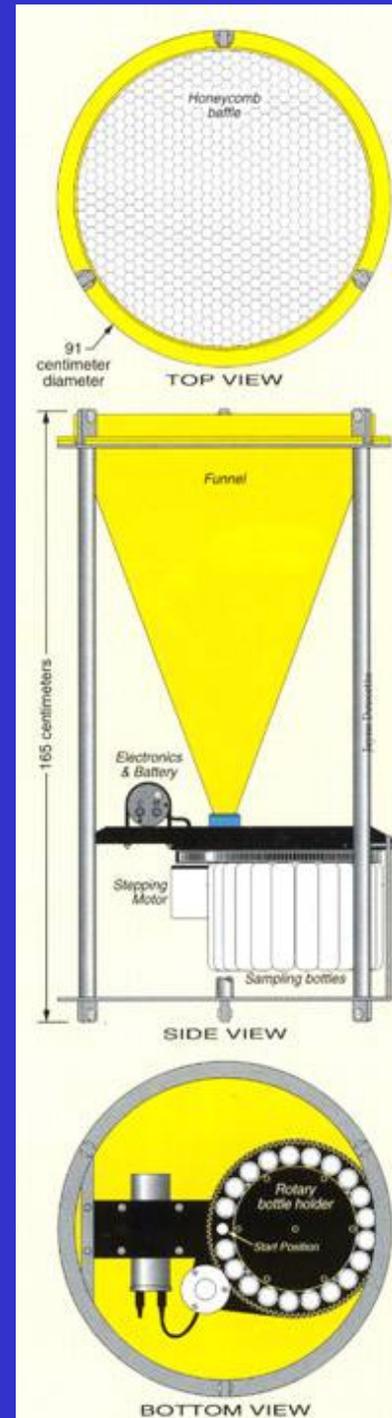
Chisholm (2000)

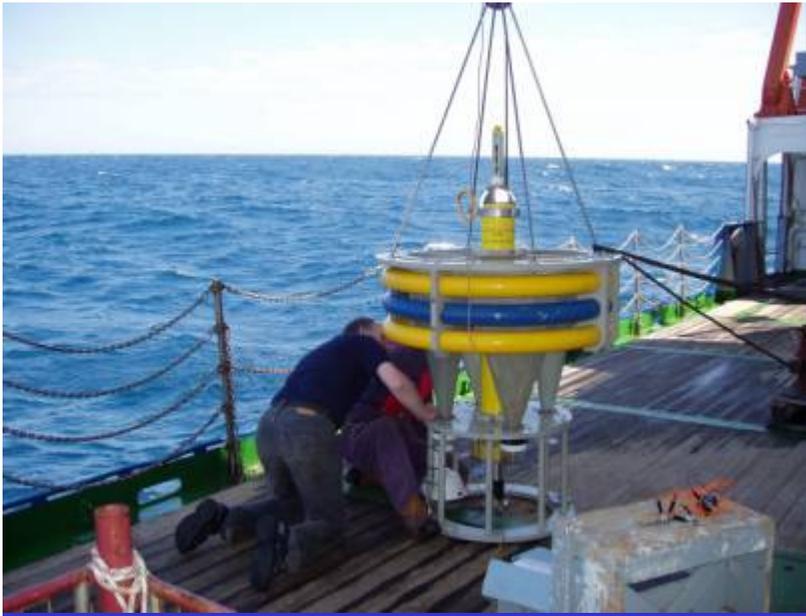
Bomba biológica





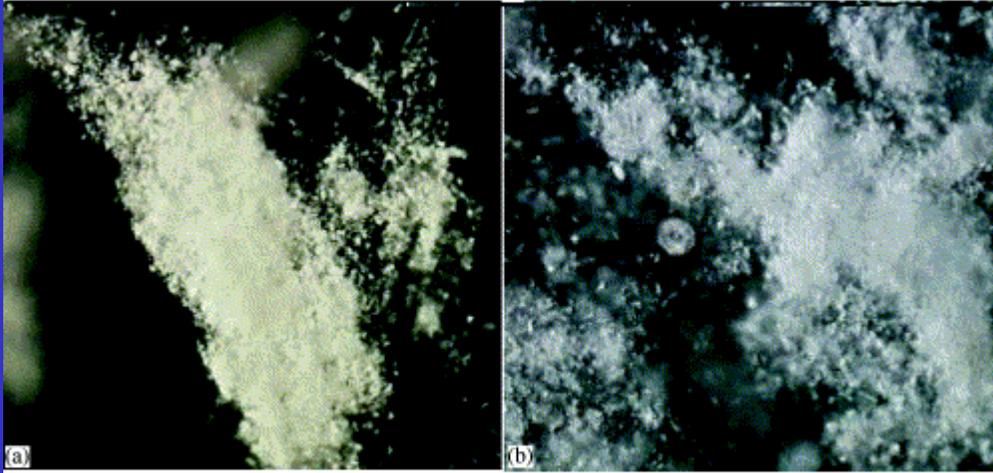
- Série temporal
- Atenuador tipo colméia
- Solução hipersalina + formol
- > 1 ano operante
- Correntógrafos, ADCPs etc







Marine Snow from the SOIREE experiment

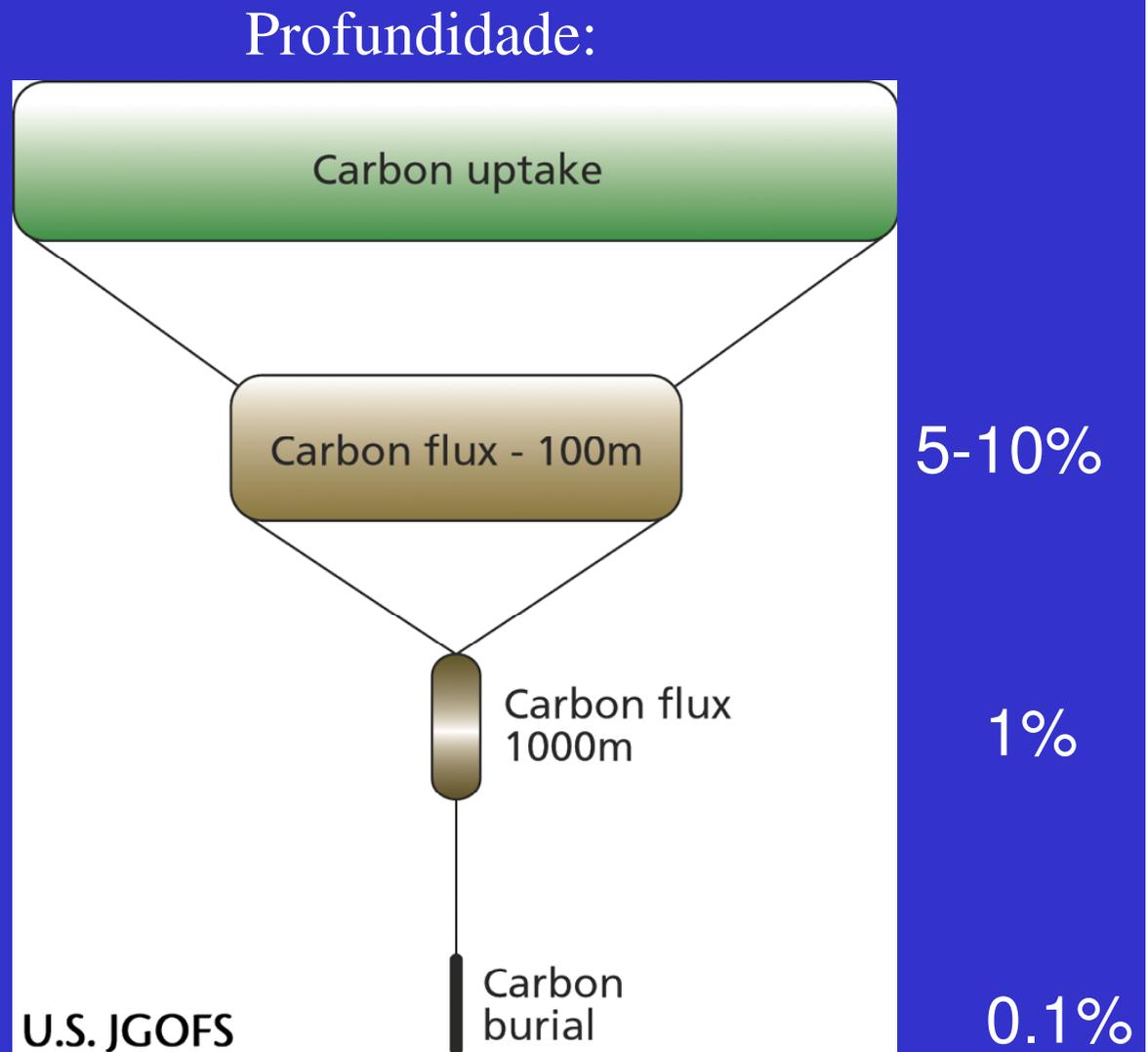


Escala acima – cada barra aprox. 1 mm



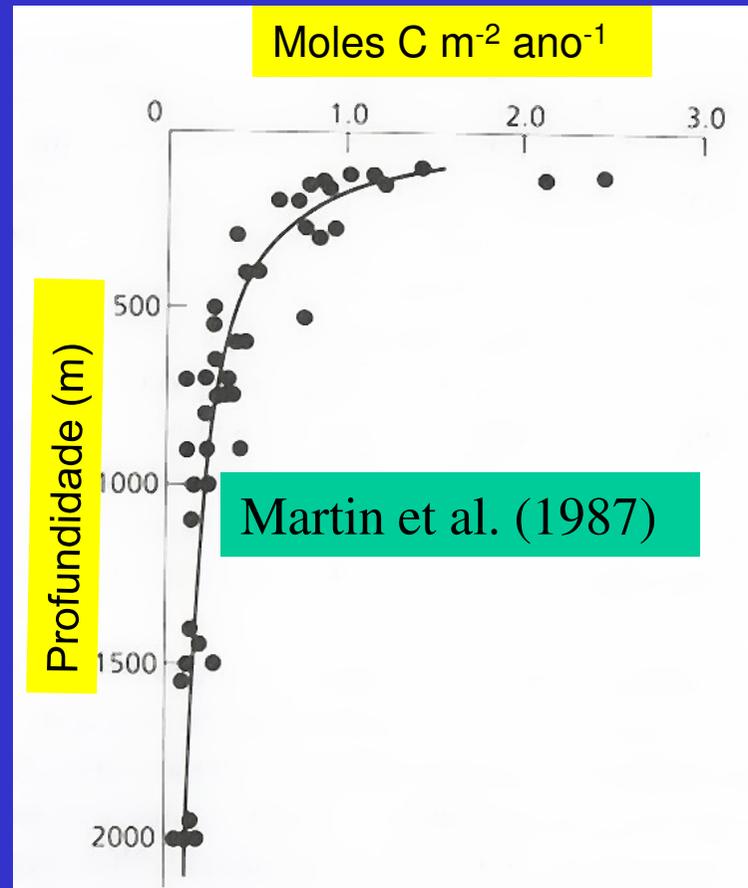
Alguns fatores que afetam o fluxo vertical:

- Profundidade da coluna d'água
- tipo de produção: nova ou regenerada
- tamanho das células – tipo de comunidade
- alça microbiana
- taxas de bioturbação no bentos

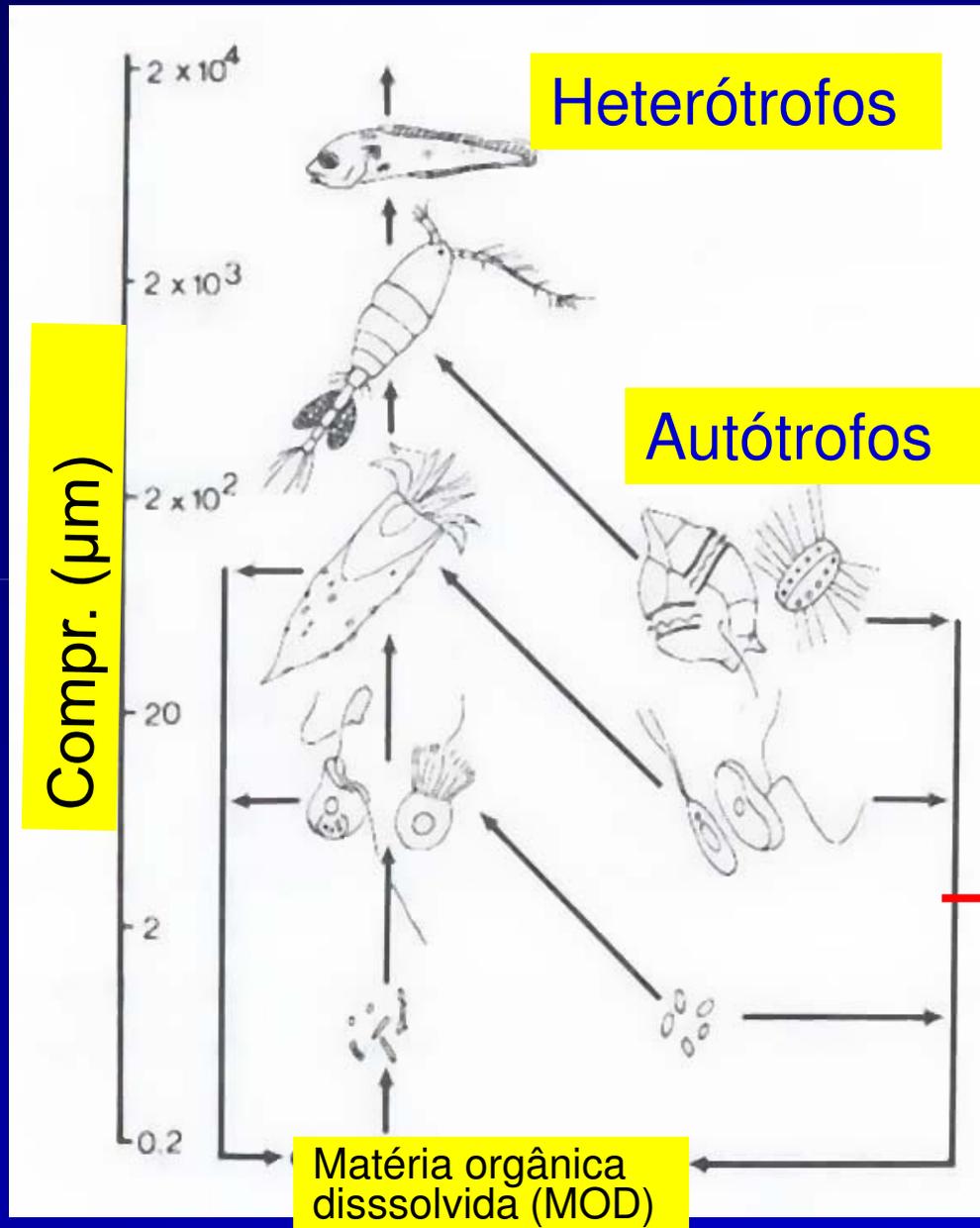


~20% exportado na forma de COD

Evidência de Intensa Reciclagem de Matéria Orgânica



Rede Trófica Pelágica

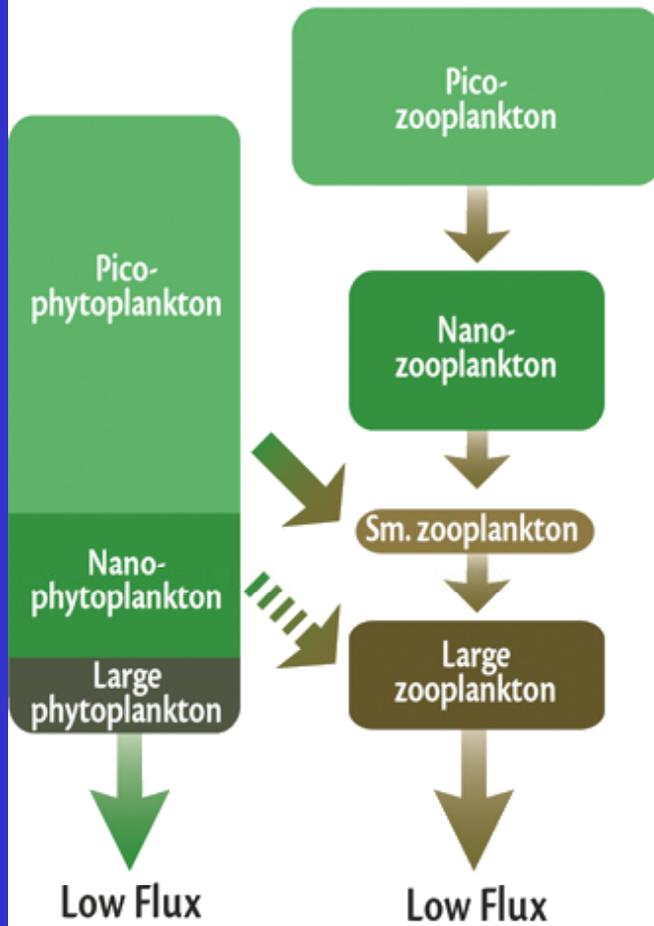


A composição da teia trófica afeta a eficiência da bomba de carbono

Alça microbiana

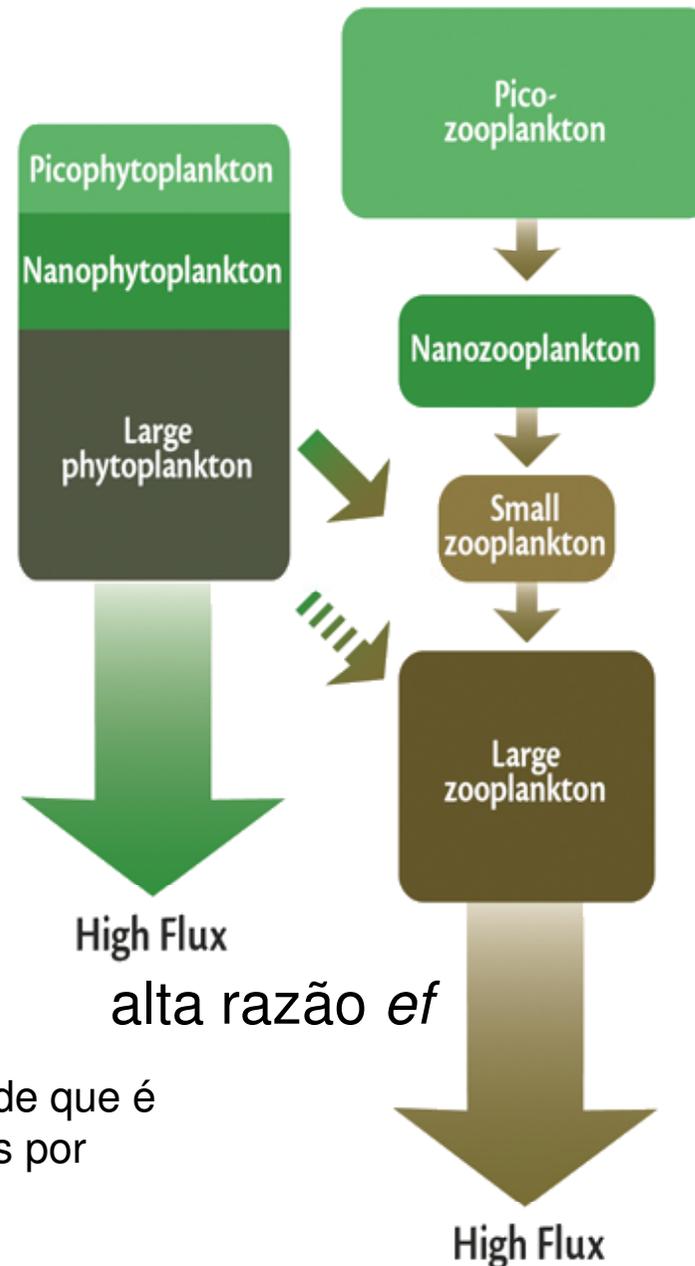
Figura de Fenchel (1987)

INTERMONSOON



baixa razão ef

MONSOON



High Flux
alta razão ef

razão ef = porção da produtividade que é suportada por nutrientes supridos por fontes externas

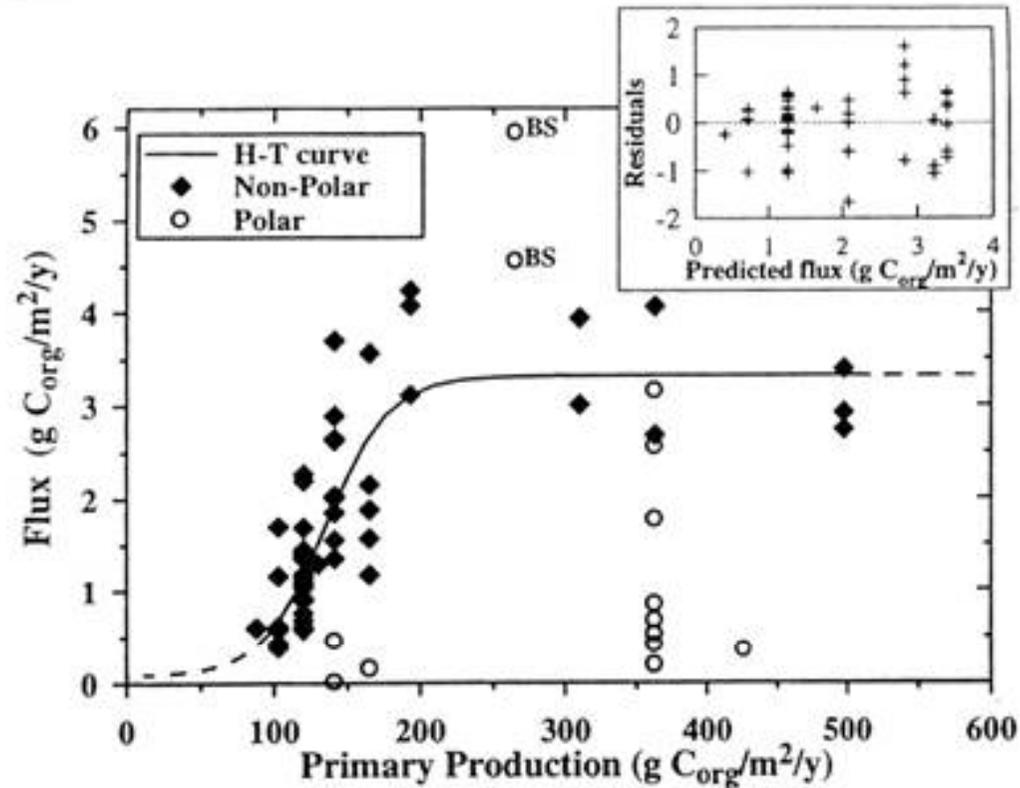
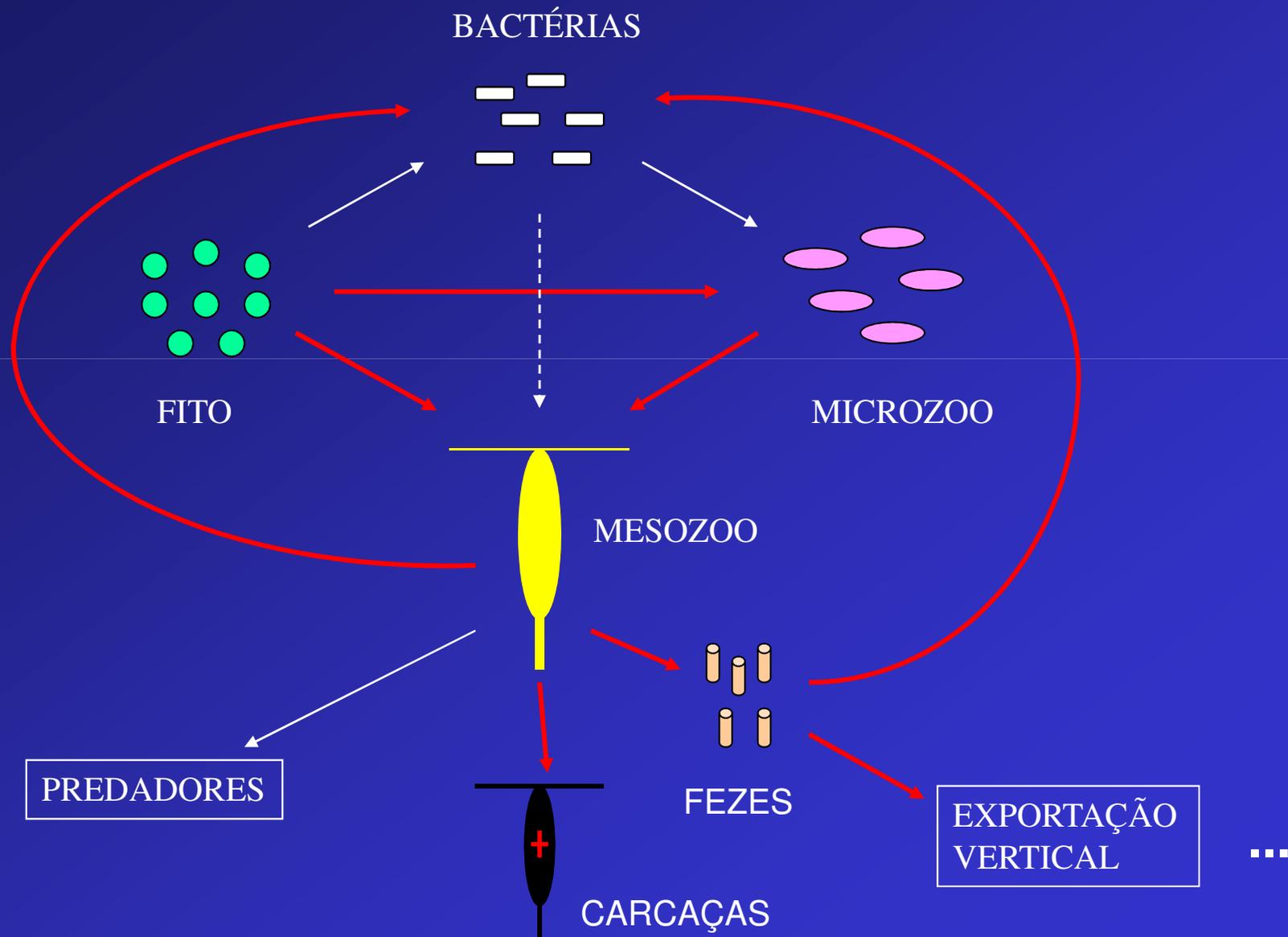


Fig. 4. Relationship between primary production and organic carbon flux normalised to 2000 m depth for non-polar and polar environments. Data from the Bering Sea (BS) are identified as they invariably fall outside the range of other polar data (see below). The line represents the hyperbolic tangent fit described in the text. The insert shows the distribution of residuals about the line at each of the levels of predicted flux for non-polar regions.

- Relação linear < 200 gC m⁻² a⁻¹
- Constante a 3,5 gC m⁻² a⁻¹

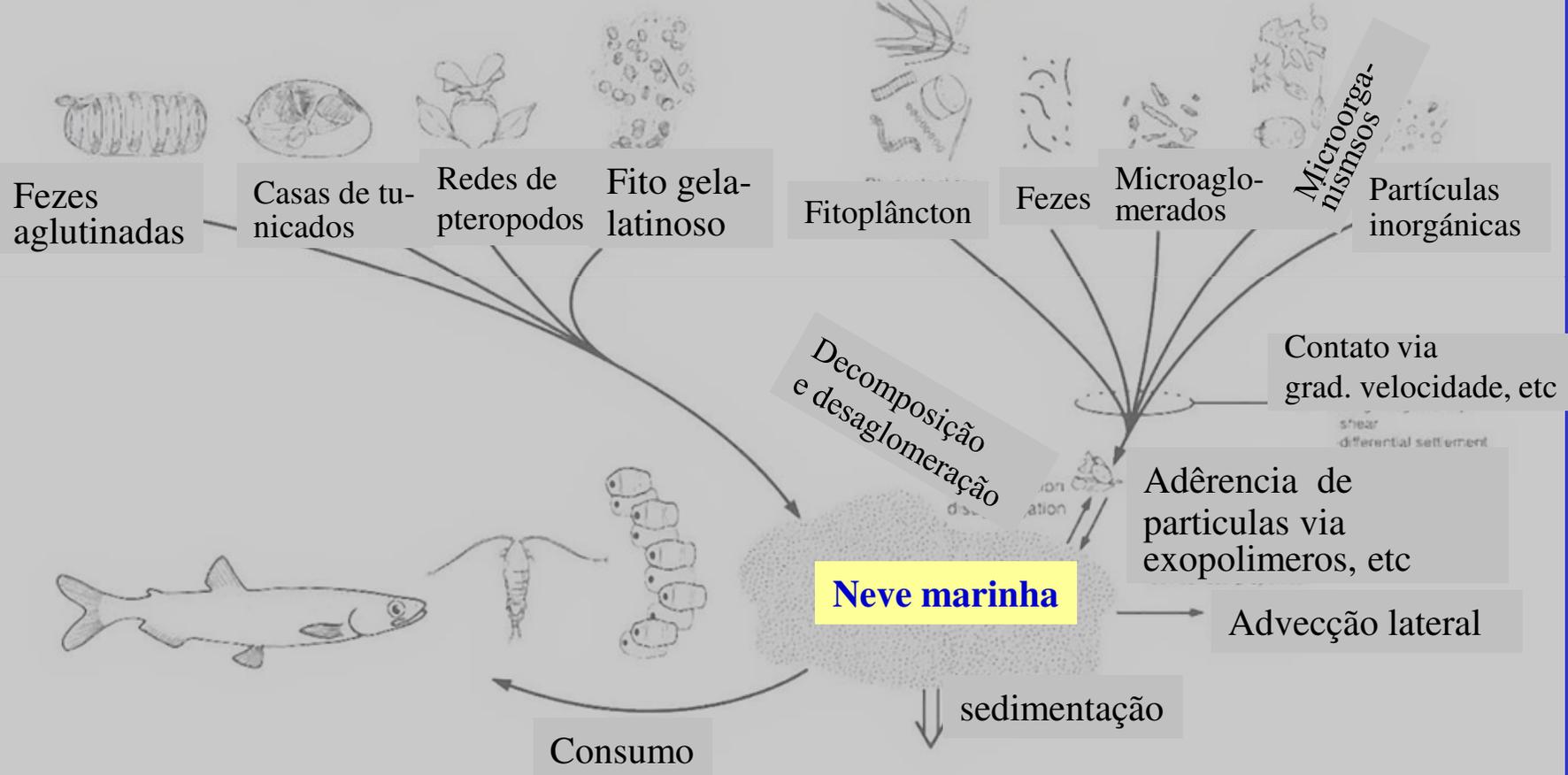
A alça microbiana ...



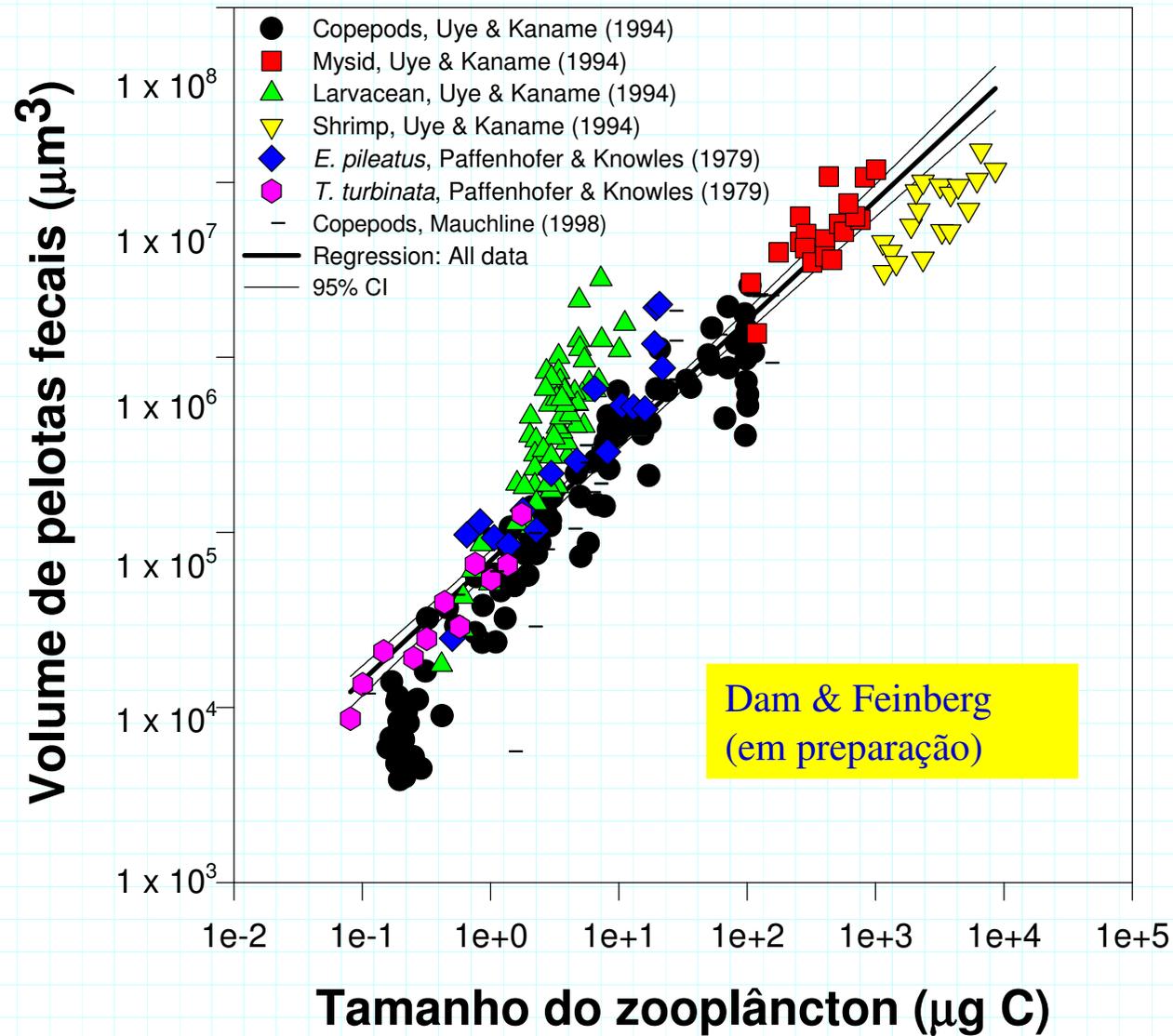
Dinâmica da neve marinha

Produção 'de novo' pelos organismos

Contribuição biológica da aglomeração física de partículas

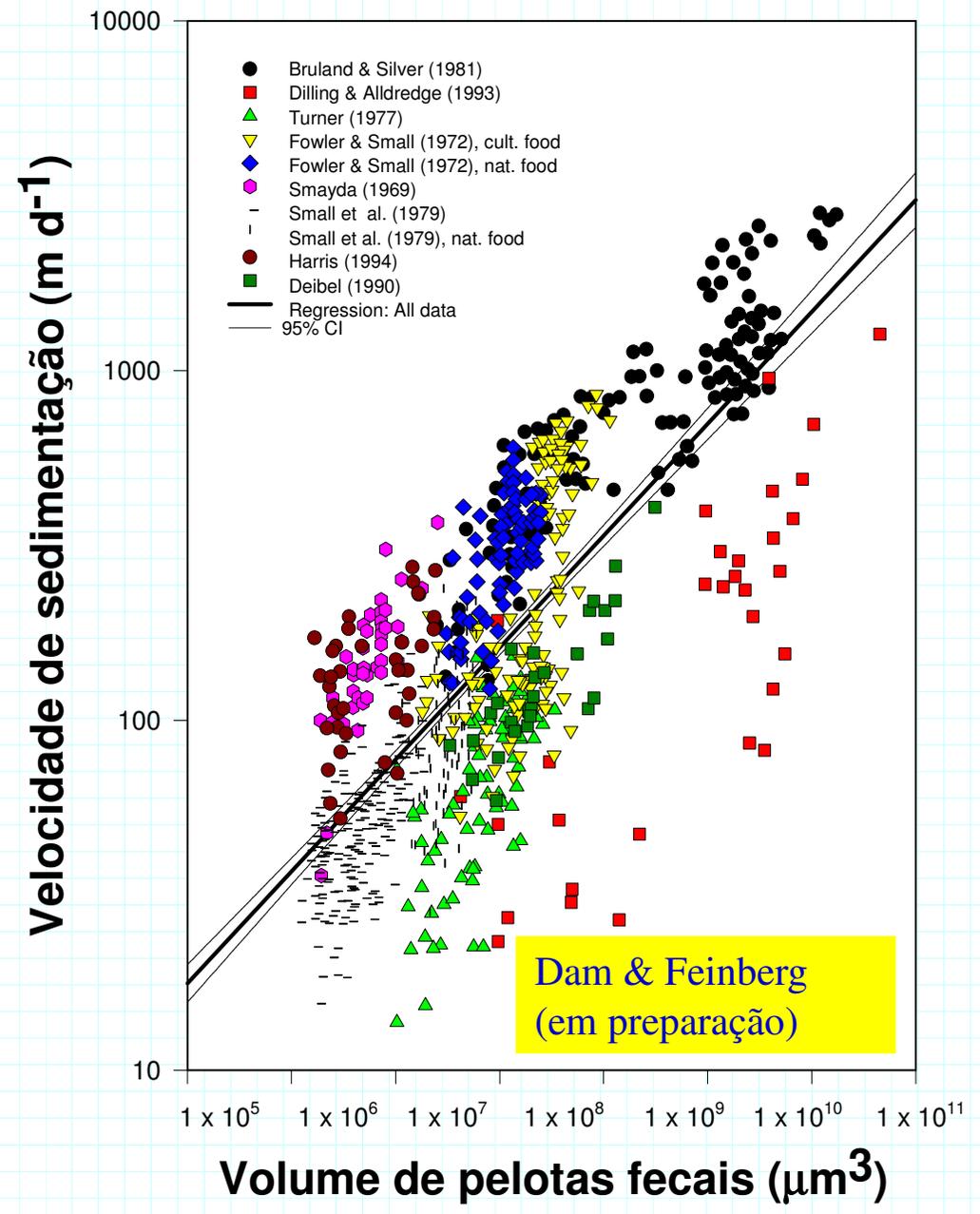


Aldredge & Silver (1988)



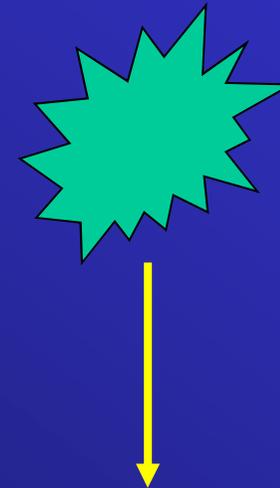
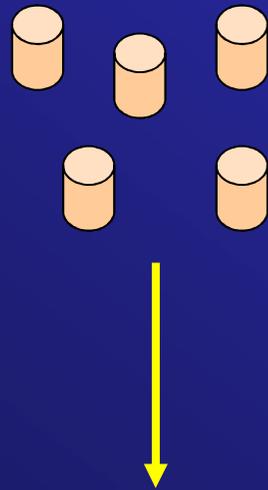
O tamanho é importante no fluxo vertical de material via fezes de zooplâncton

—Neve Marinha—

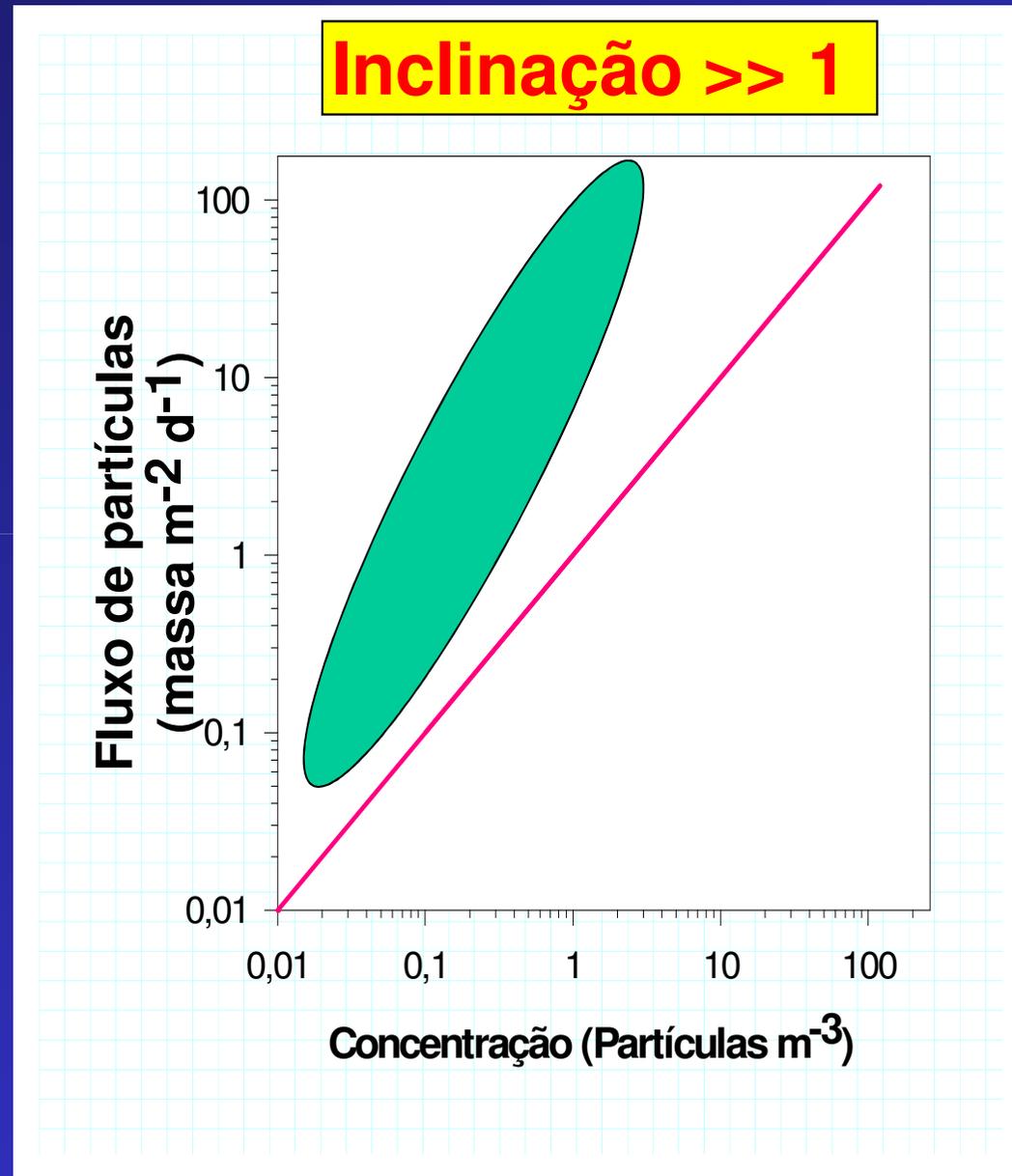
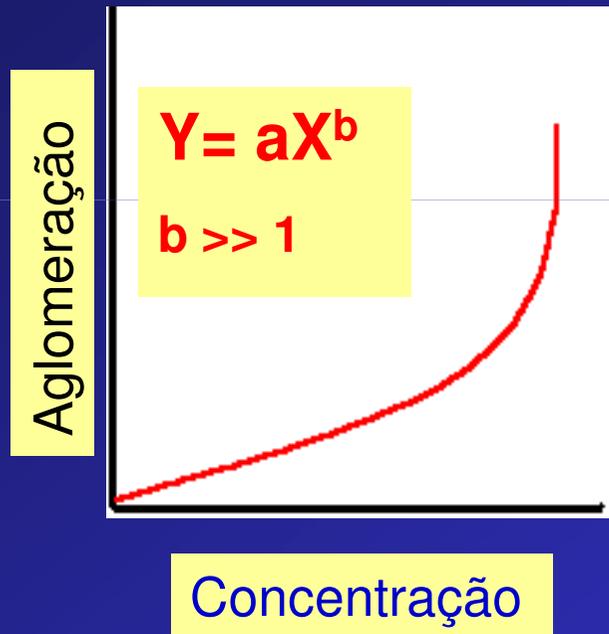


O destino das pelotas fecais é função da taxa de sedimentação

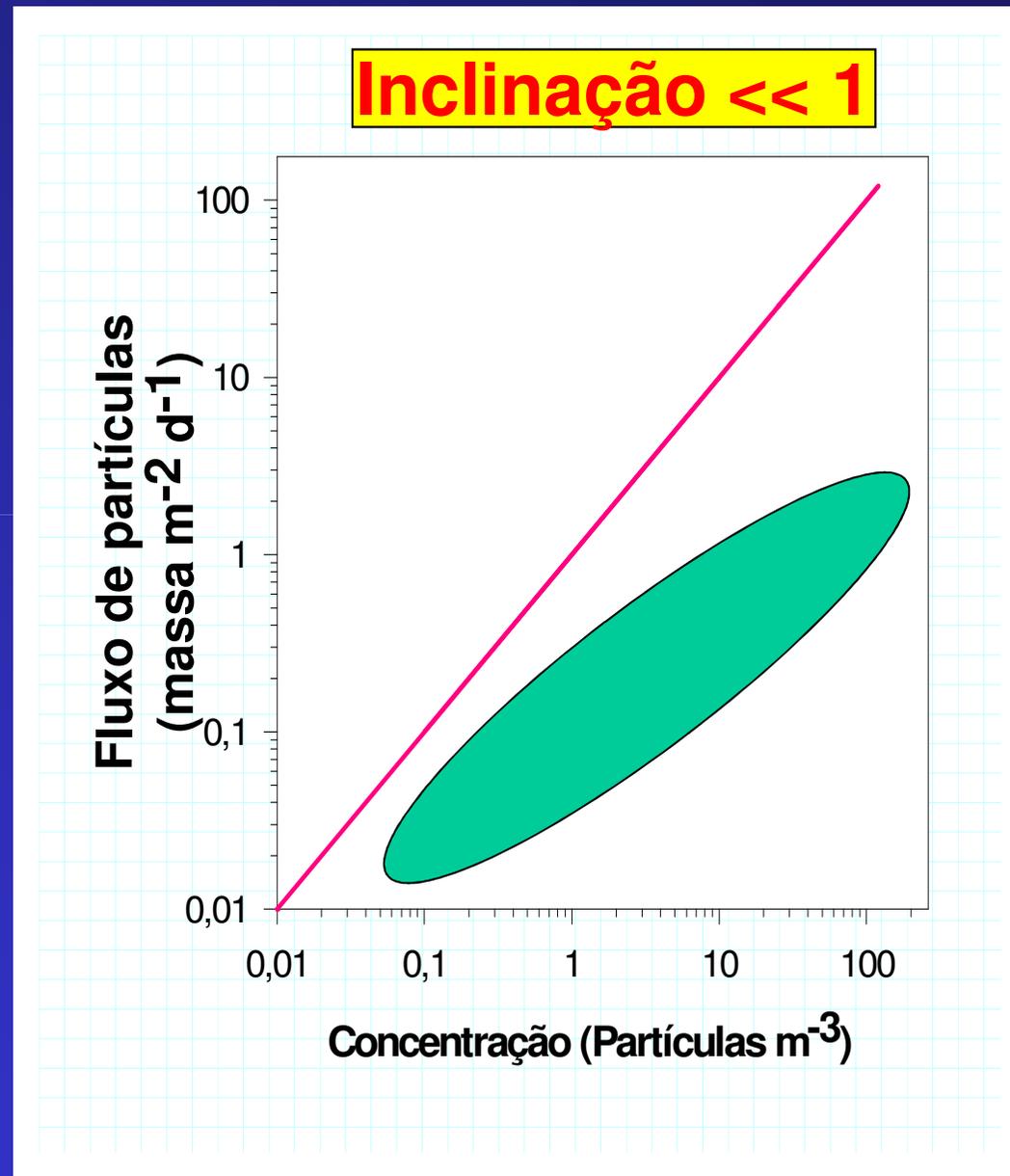
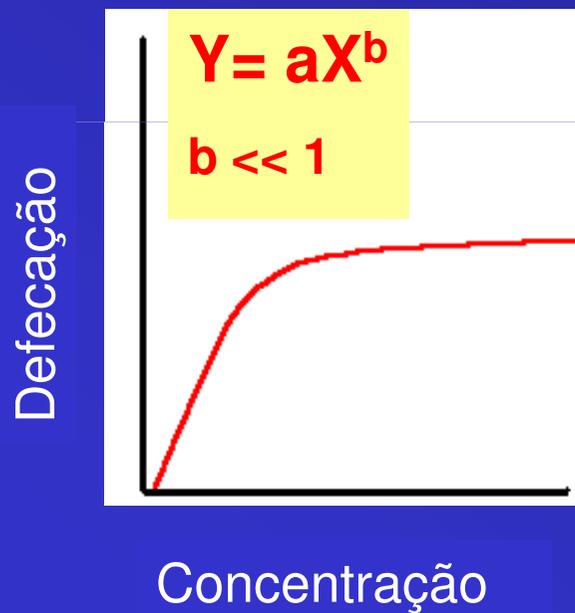
Controle do fluxo vertical: Fezes versus Aglomerados



Controle do fluxo vertical de partículas por aglomeração



Controle do fluxo vertical de partículas por **pelotas fecais**



Revisão Bibliográfica

Dam et al. (em preparação)

- 17 estudos: 14 marinhos; 3 água doce
- Armadilhas de sedimentos: 1-d a 2 semanas
- Escalas: “Blooms”-ciclo anual
- Localidades: Tropical-subpolar
- Faixa de 3-ordens de magnitude em biomassa & fluxo de fitoplâncton
- Regressão log/log de concentração versus fluxo gravitacional de pigmento

Dam et al.

(em preparação)

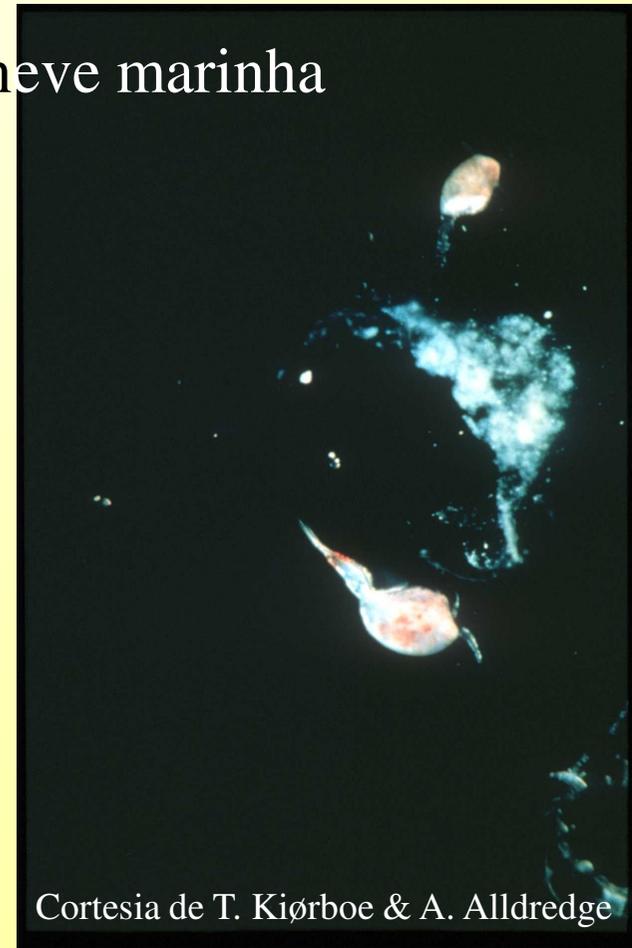
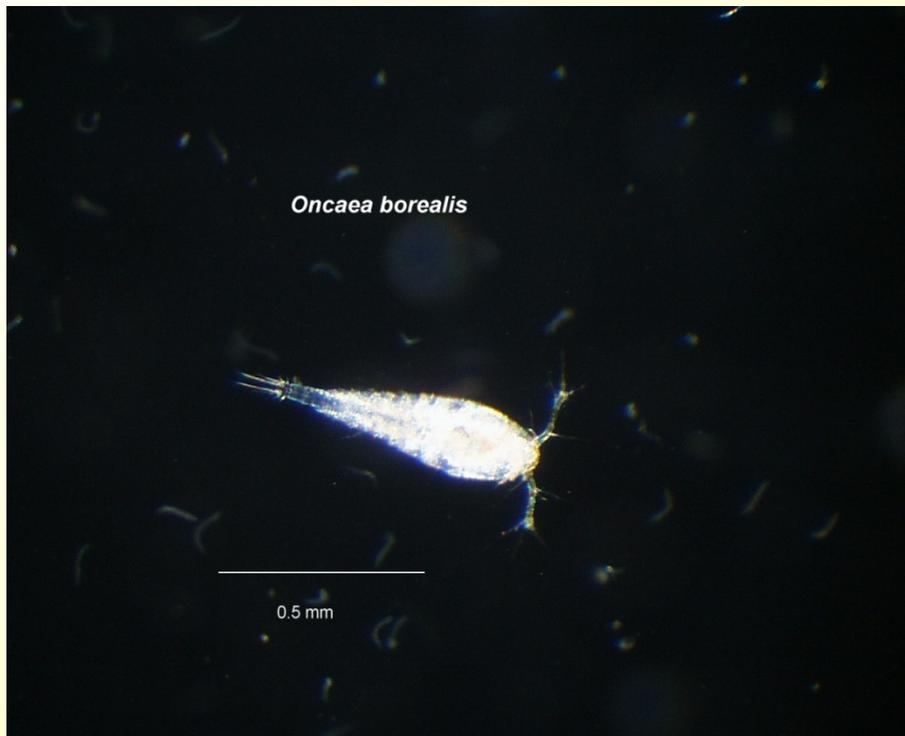
Referência	Localidade	<i>b</i>
Wassmann et al., 1990	Barents Sea, Northern Norway	2.02
Olesen, 1995 (March-May)	Kattegat, Denmark	1.82
Lignell et al., 1995; Uitto et al., 1995 & unpublished pigment flux data of Heiskanen from the same studies	Northern Baltic Sea, SW Finland	1.46
Kjørboe et al., 1994	Isefjorden, Denmark	1.36
Riebesell et al., 1995	Balsfjord, Northern Norway	1.10
Riebesell, 1989	MERL Tank, Rhode Island, USA	0.97
Reigstad & Wassmann, 1996	Balsfjord & Malangen, Northern Norway	0.93
Welschmeyer & Lorenzen, 1985	Dabob Bay, Washington, USA	0.88
Hargrave & Taguchi, 1978	Bedford basin, Halifax, Canada	0.77
Olesen, 1993	Kattegat, Denmark	0.71
Fallon & Brock, 1980 (1977 data)	Lake Mendota, Wisconsin, USA	0.68
Fallon & Brock, 1980 (1976+1977 data)	Lake Mendota, Wisconsin, USA	0.61
Olesen, 1995 (March-October)	Kattegat, Denmark	0.52*
Arfi & Guiral, 1994	Unnamed small pond, Layo, Ivory Coast	0.43
Sarnelle, 1992 & his unpublished pigment flux data from the same study	Zaca Lake, California	0.38
Fallon & Brock, 1980 (1976 data)	Lake Mendota, Wisconsin, USA	0.27*
Kjørboe et al., 1996	East Sound, Washington, USA	0.17*
Olesen, 1995 (June-Oct)	Kattegat, Denmark	0.15*
Dam, 1989	Long Island Sound, New York, USA	0.14*
Tremblay et al., 1989	Hudson Bay, Canada	0.13*
Kjørboe et al., 1998	St. Helena Bay, South Africa	-0.72*

Redução do Fluxo Vertical: Consumo de Aglomerados

Zooplâncton coloniza neve marinha

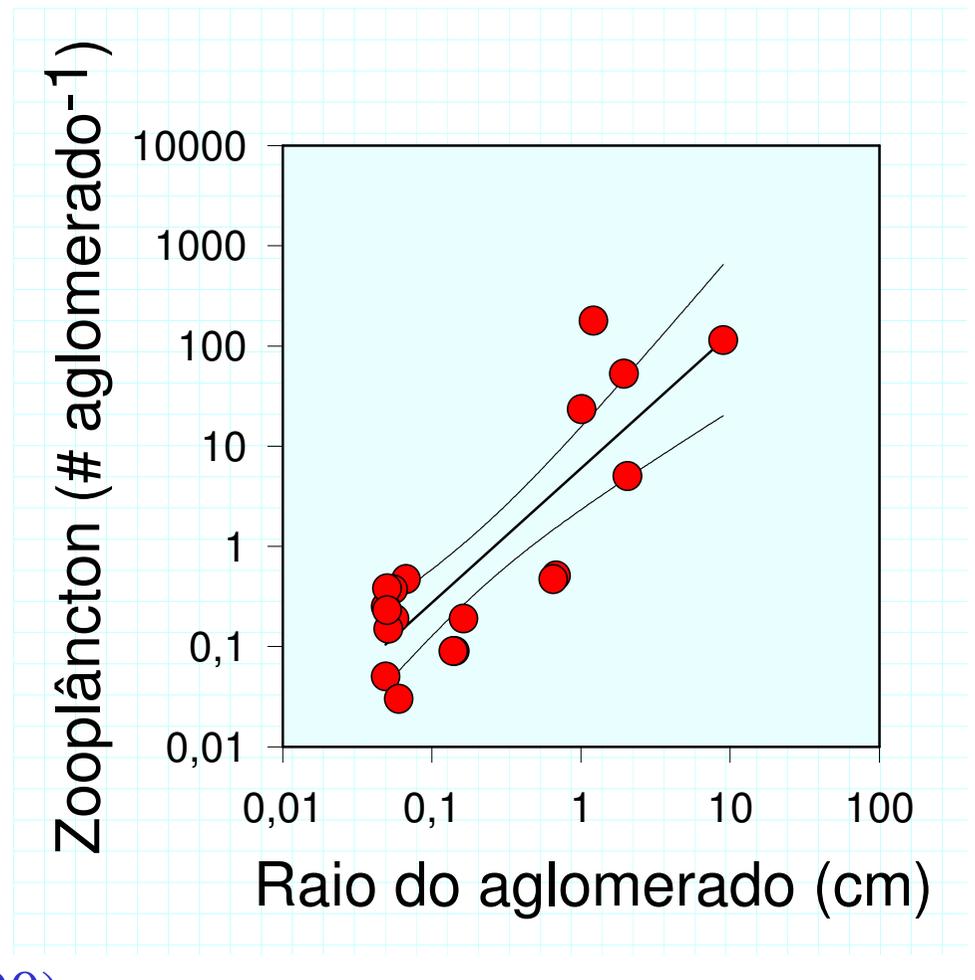
Oncaea sp. consumindo neve marinha

Oncaea borealis



Cortesia de T. Kiørboe & A. Aldredge

Grande abundância de zooplâncton em neve marinha



Zooplâncton causa rápida decomposição da neve marinha

Raio do agregado, cm	C do agregado, μg	Abundância do zoop. por agregado	Taxa de ingestão, $\mu\text{g C d}^{-1}$	Tempo de reposição, d
0.1	2	0.44	0.48	4.2
1.0	76	81	88	0.87

Kjørboe (2000)

Como o zooplâncton localiza a neve marinha?

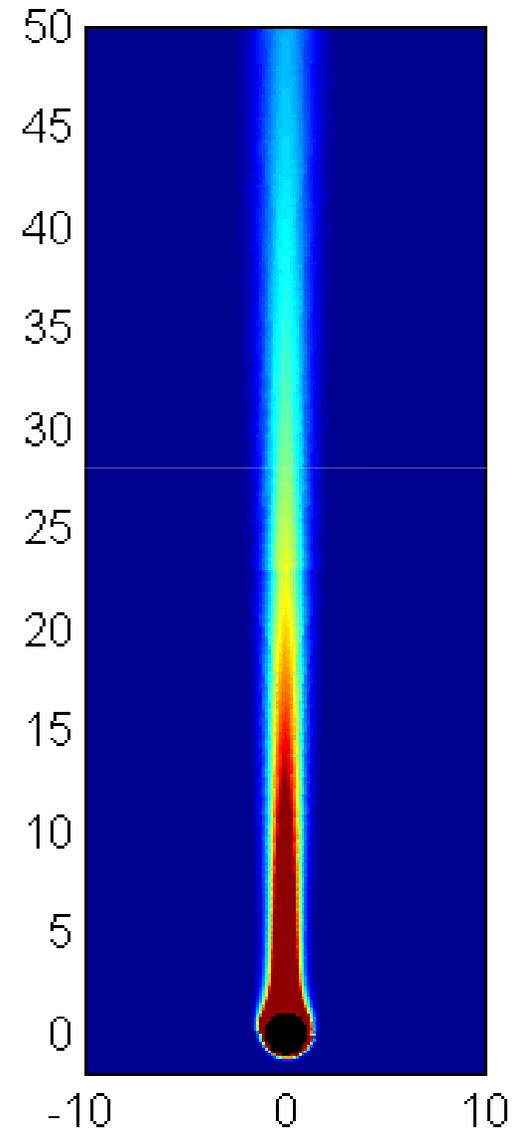
Pistas hidromecânicas?

Pistas químicas?

Trilha de MOD em aglomerados

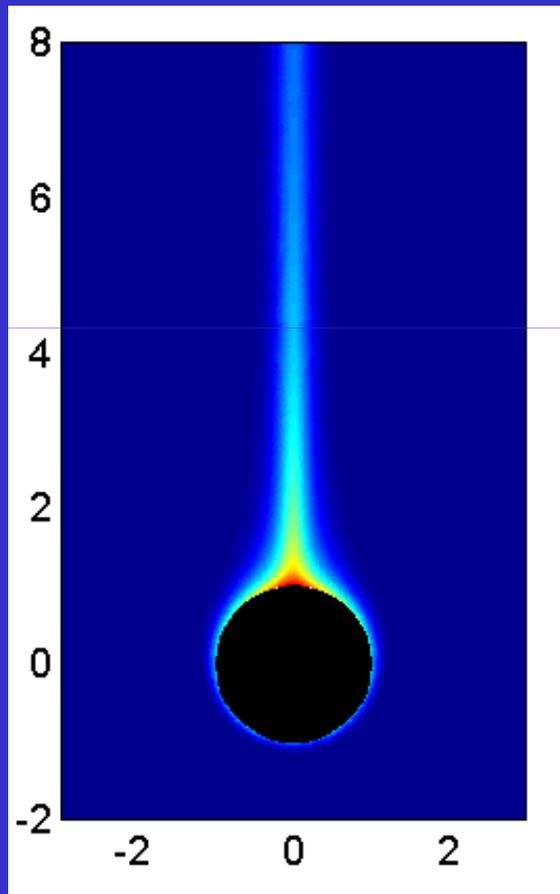
Aglomerados deixam uma trilha de MOD em seu caminho.

O zooplâncton pode utilizar esta trilha?

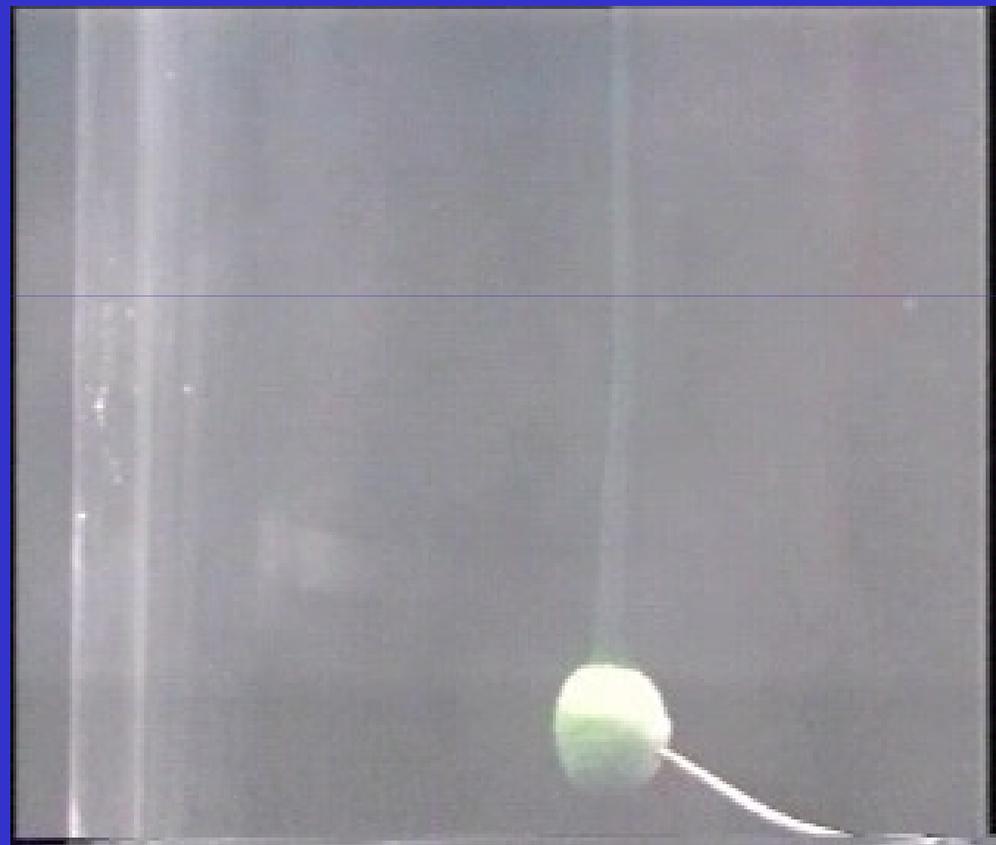


A trilha invisível visualizada

Modelo matemático

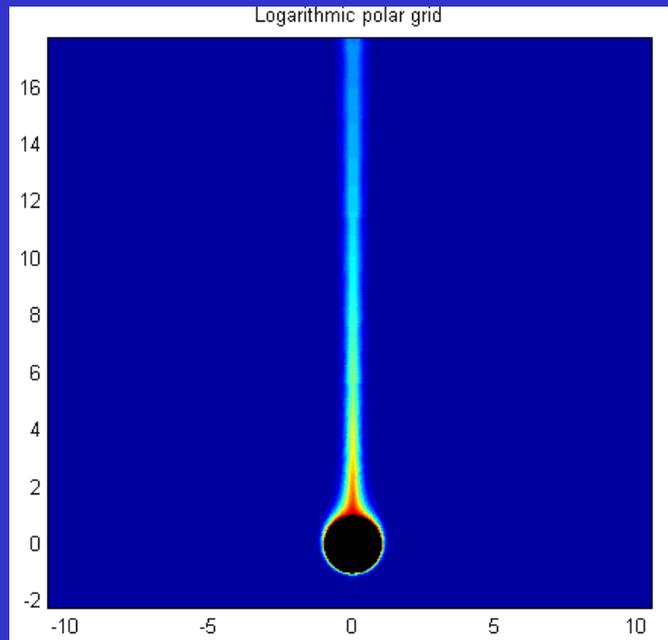


Modelo físico

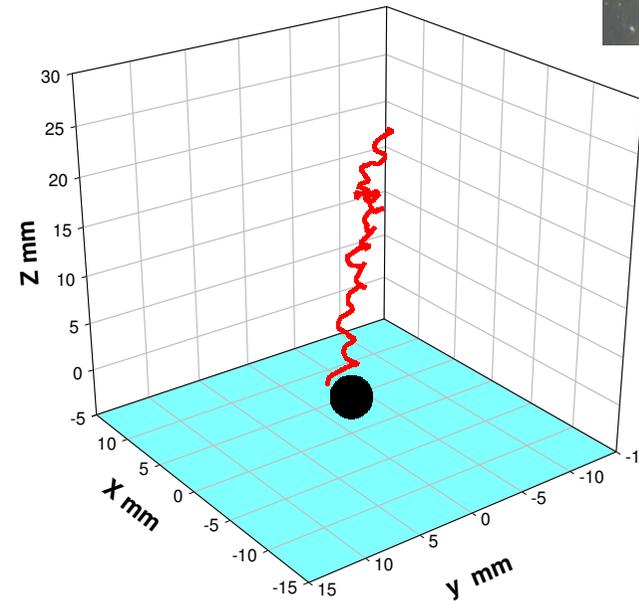


Kjørboe et al. (2001)

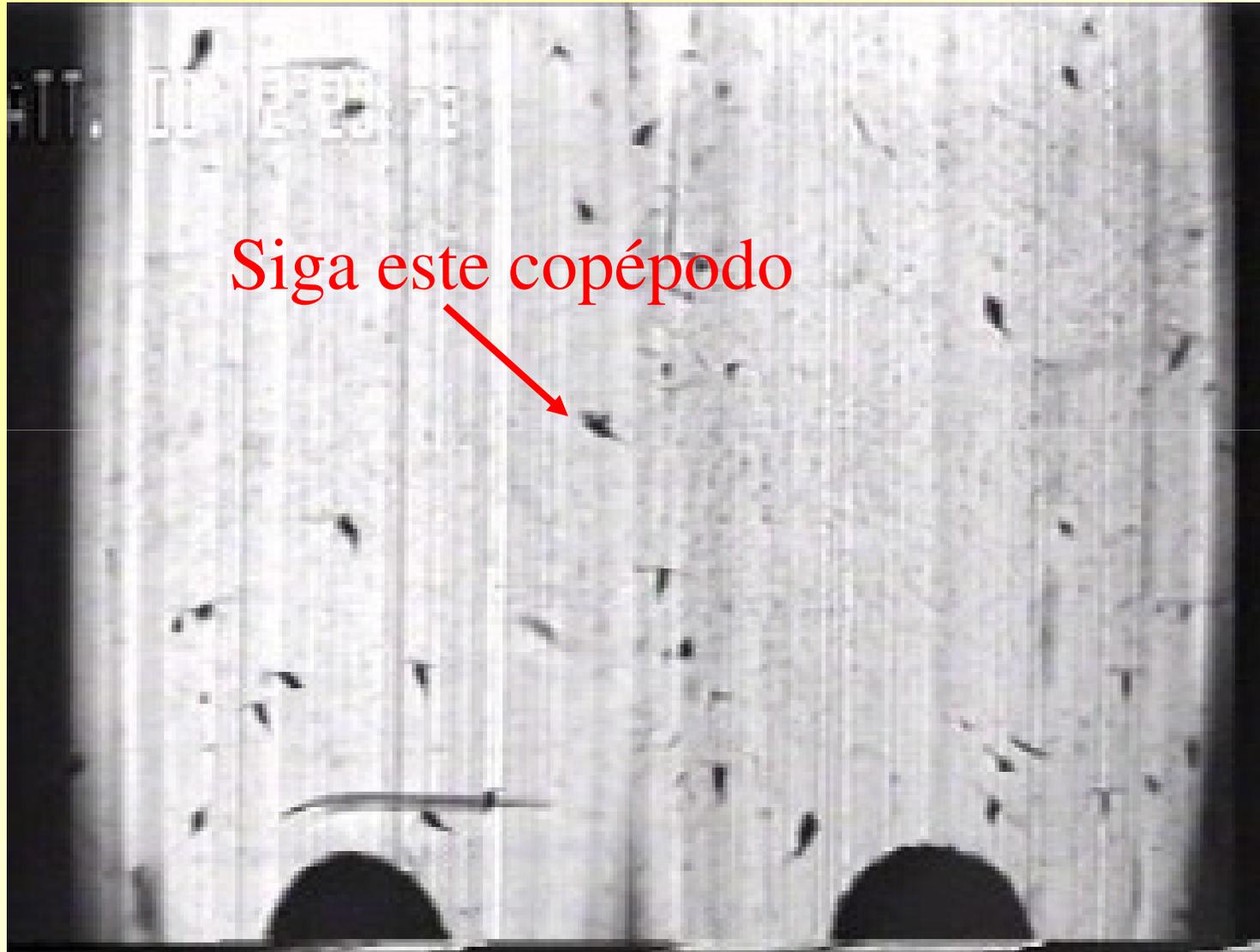
Copépode rastreando trilha de aminoácido da partícula em afundamento



Temora tracking amino acid trail from sinking particle



Rastreando a trilha

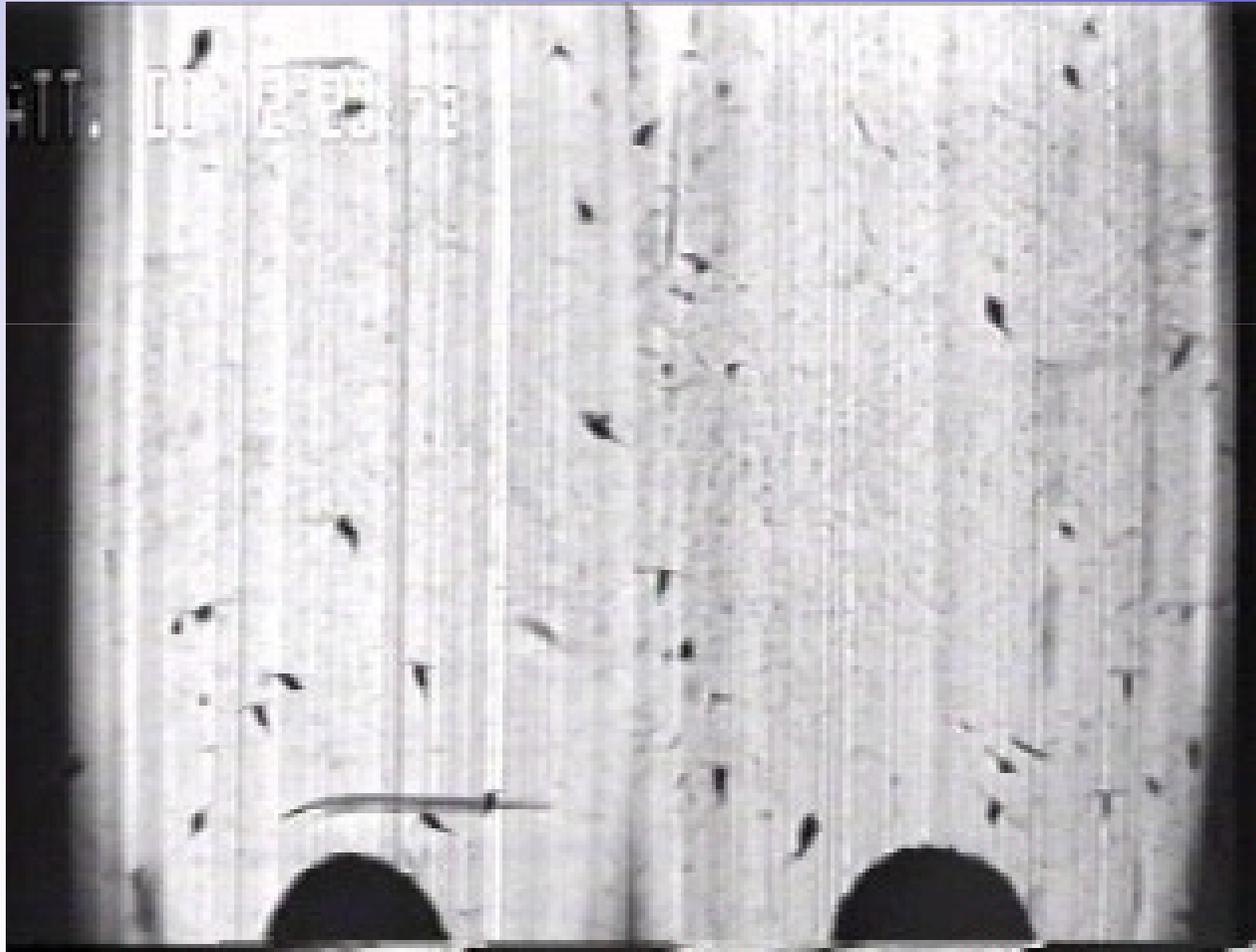


Kjørboe et al. (2001)

A trilha invisível

vista de dois lados

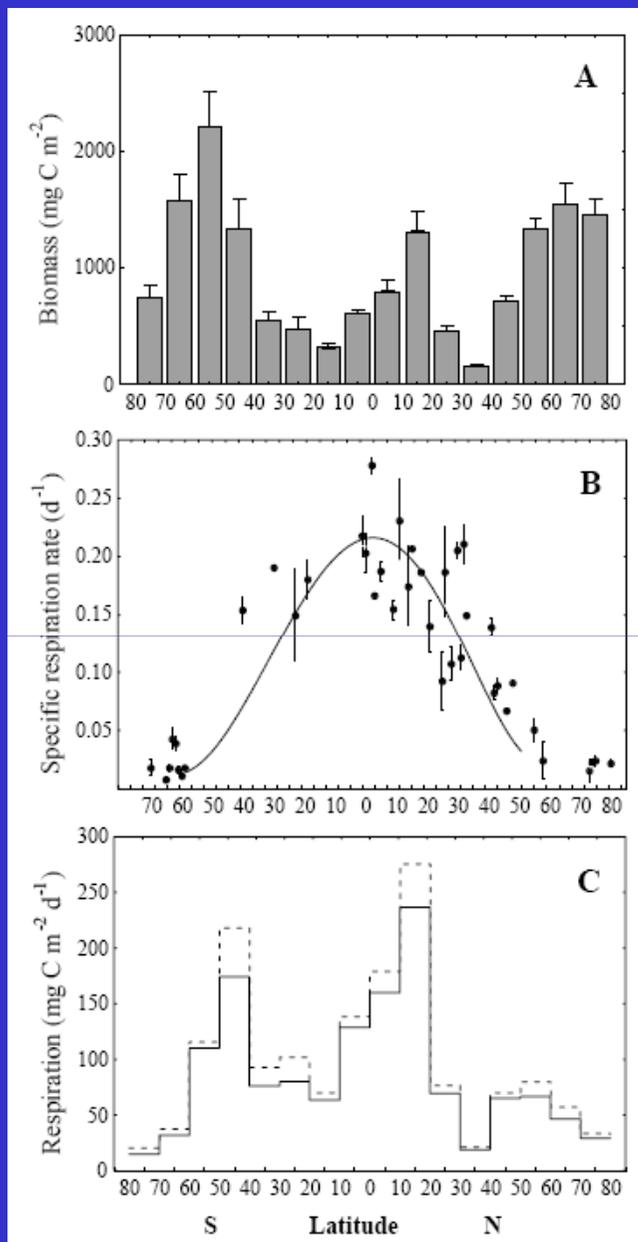
Kjørboe et al. (2001)



O Fluxo Ativo (Metabólico)

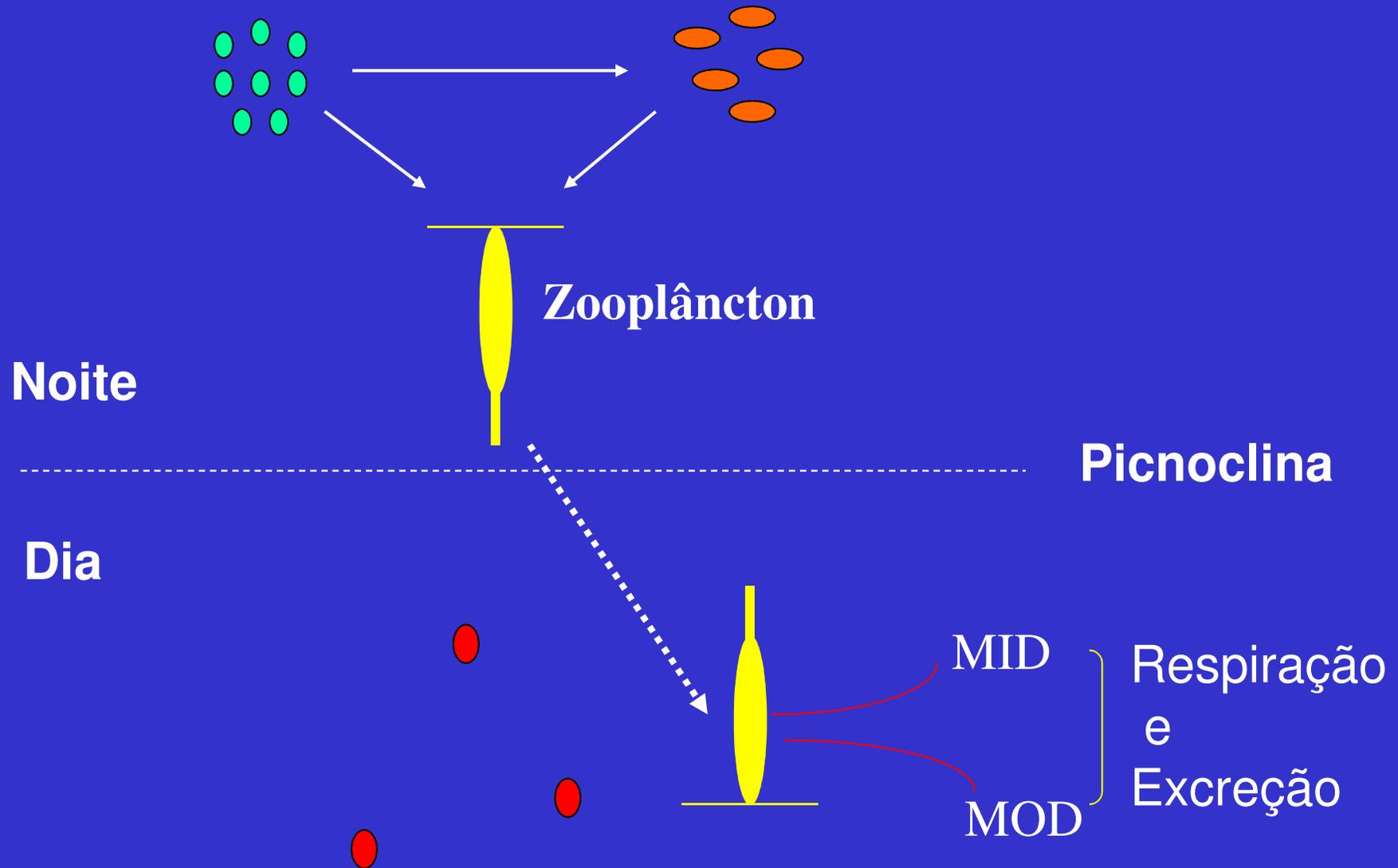
- O zooplâncton controla parcialmente a eficiência da bomba biológica: **transporte ativo**.

Respiração Global do Zooplâncton



Prof	Resp. (GTC Y ⁻¹)	%PP
< 200	10.4	13-25
200-1000	2.2	3-5
1000	0.4	0.5-1
Total		17-32

Consequências do Fluxo Ativo Via Migração Vertical



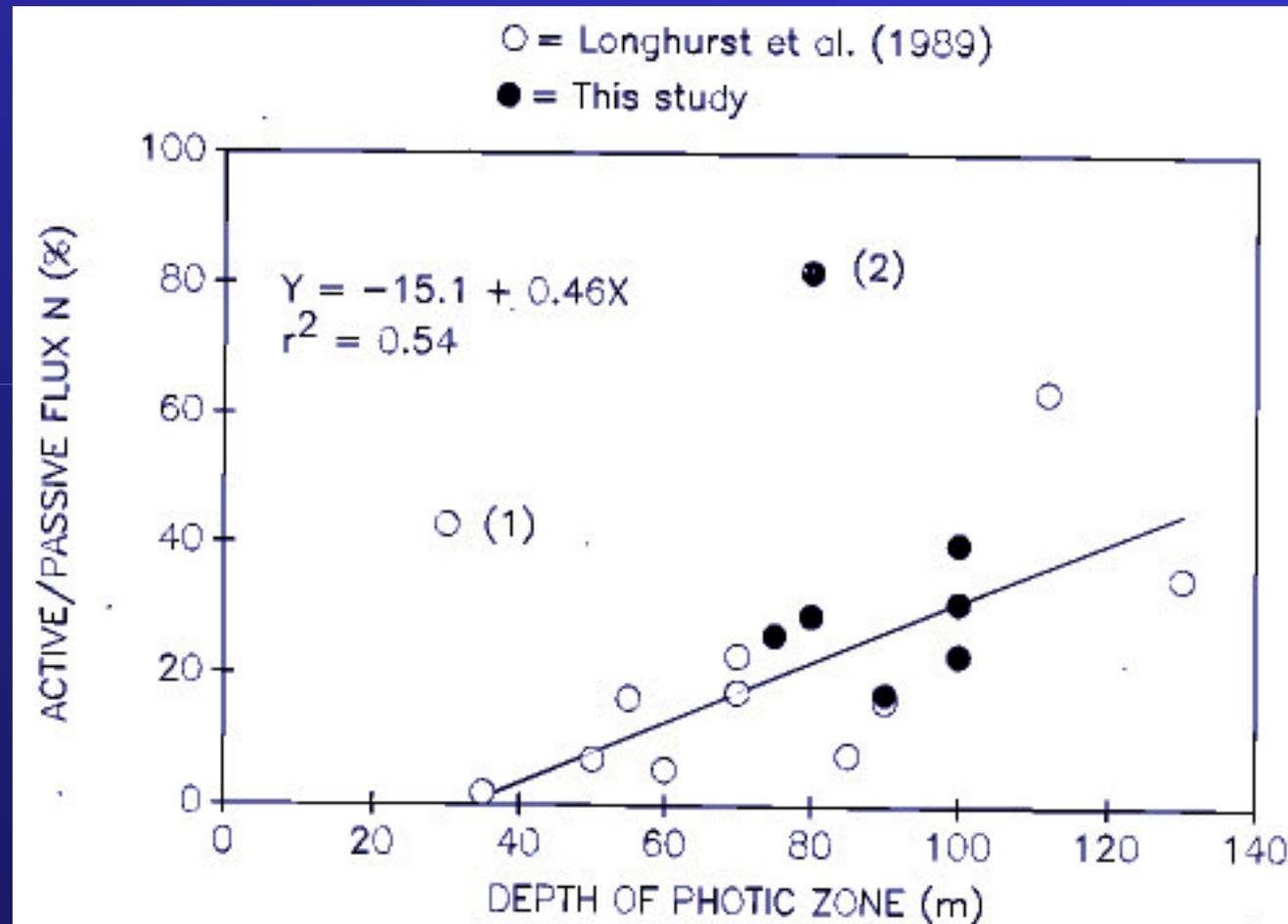
Resumo de Medição do Fluxo Ativo

Steinberg et al. (2000)

Location of study and time of year	Migrating biomass (mg C m ⁻²)	Migratory flux (mg C m ⁻² d ⁻¹)	% of mean POC flux	Reference
BATS (year-round)	50 (0-123)	2.0 (0-9.9) ^a	8 (0-39)	(this study)
Subtropical and tropical Atlantic – several stations (September)	–	5.5 (2.8-8.8) ^b	6 (4-14)	Longhurst et al. (1990)
BATS (March/April)	191 (82-536)	14.5 (6.2-40.6)	34 (18-70)	Dam et al. (1995)
Equatorial Pacific (March/April)	96	4.2 ^c	18	Zhang and Dam (1997)
(October)	155	7.3 ^c	25	
Equatorial Pacific Oligotrophic HNLC area (September/October)	47 ^d 53 ^d	3.8 ^{b,e} 7.9 ^{b,e}	8 ^e 4 ^e	Le Borgne and Rodier (1997), and Rodier and Le Borgne (1997)

Media = 14%

O valor relativo do fluxo ativo aumenta quanto mais oligotrófico é o sistema



Dam et al. (1995a)