

Cultured Marine Photosynthetic Ciliate *Mesodinium rubrum* as a potential live feed species for aquacultured animals

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Classification

□ Corliss (1979)

Phylum Ciliophora

Class Kinetophragminophorea

Order Haptorida

Family Didiniidae

Mesodinium rubrum (Lohmann, 1908)

Myrionecta rubra (Jankowski, 1976)

□ Lynn and Small (2002)

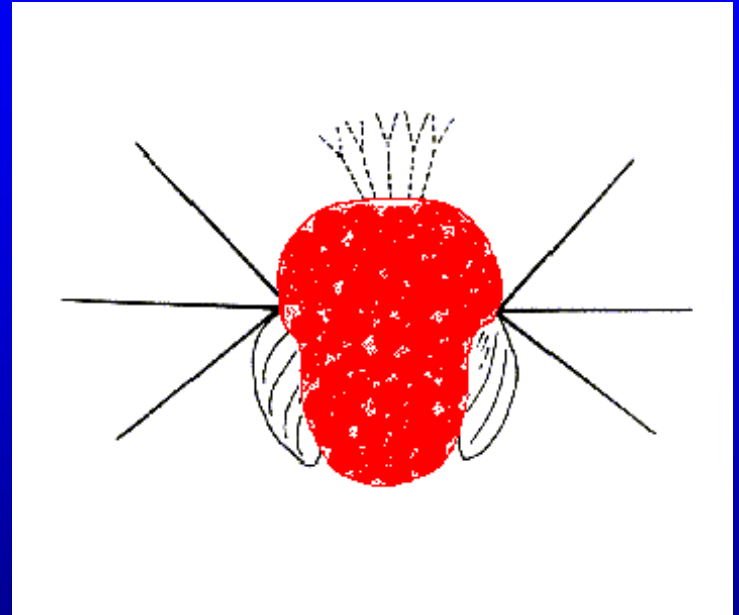
Class Litostomatea

Order Cyclotrichida

Family Mesodiniidae

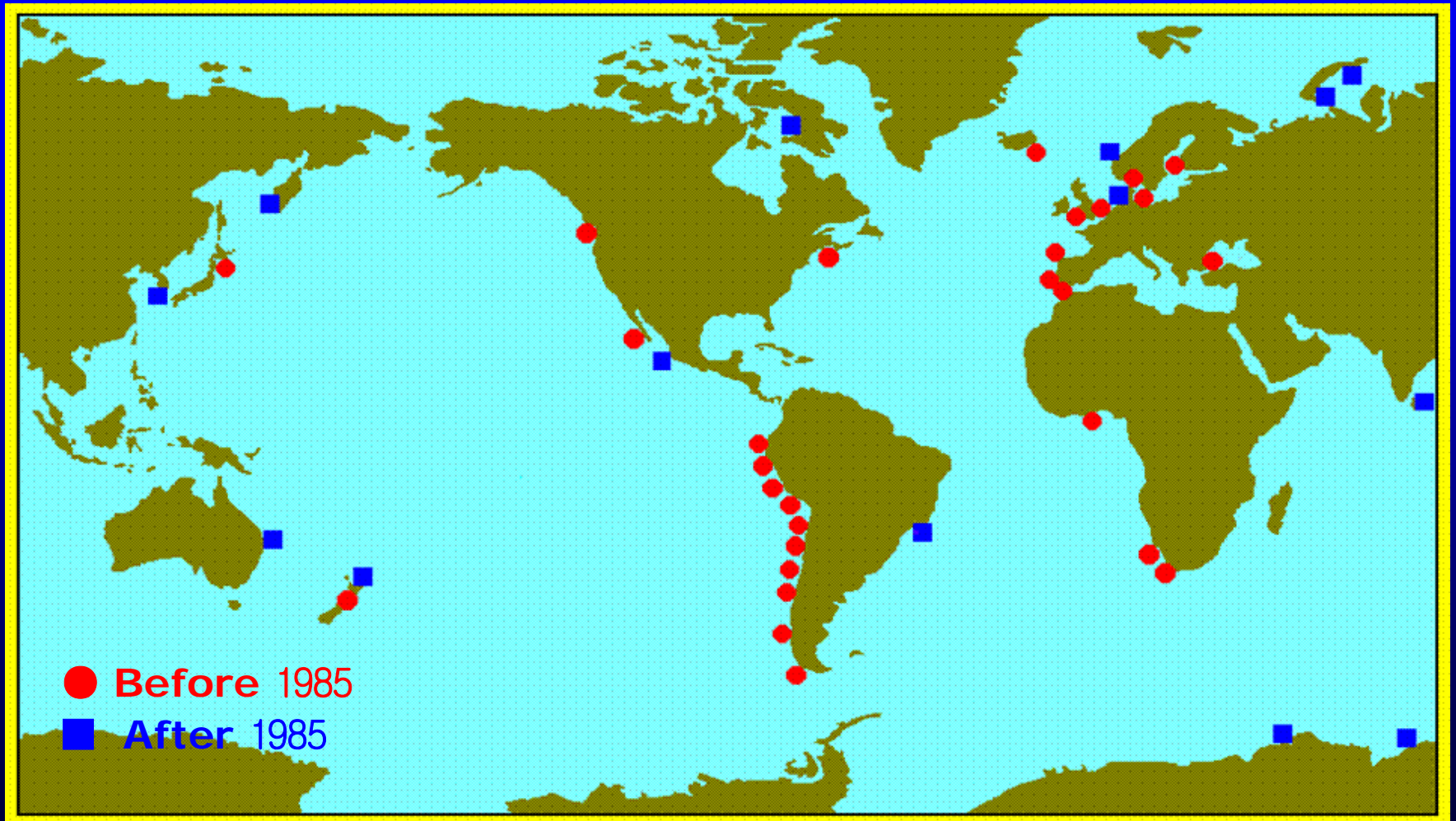
Mesodinium rubrum

- ❑ **Size** : 15 ~ 50 μm
- ❑ **Color** : dark brown
- ❑ **cell organelles** :
Oral tentacle, Cirri,
Equatorial ciliary belt
- ❑ **Motility** : Max. 5mm/sec
Vertical migration (>10m)
- ❑ **Pigments** :
chlorophyll a & c
 α -carotene, phycoerythrin, alloxanthin





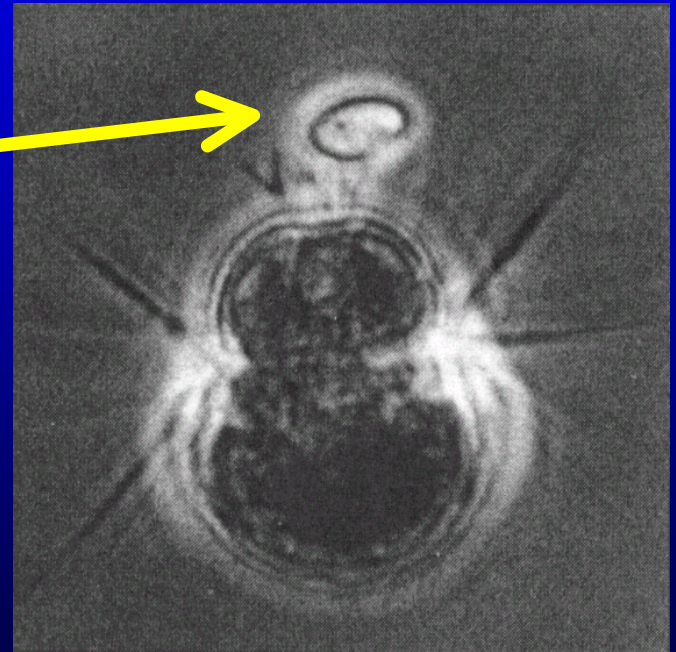
M. rubrum red tide

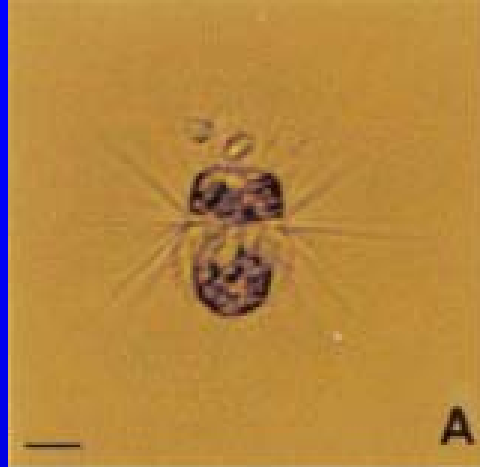


Confusion on Trophic Mode

- ❑ Phototrophy
- ❑ Phototrophy + phagotrophy(bacterioplankton)
- ❑ Uptake of amino acids
- ❑ Ingestion of particles
- ❑ Ingestion of cryptophyte cells ? (Hargraves, 1991)
- ❑ Phototrophy + Cryptophyte “feeding”

(Gustafson et al.,2000;
Kim, 2002)





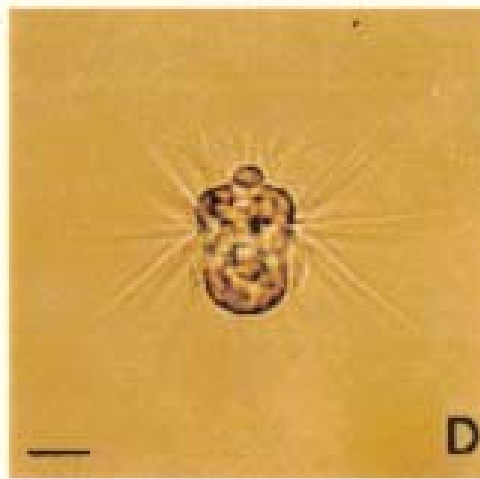
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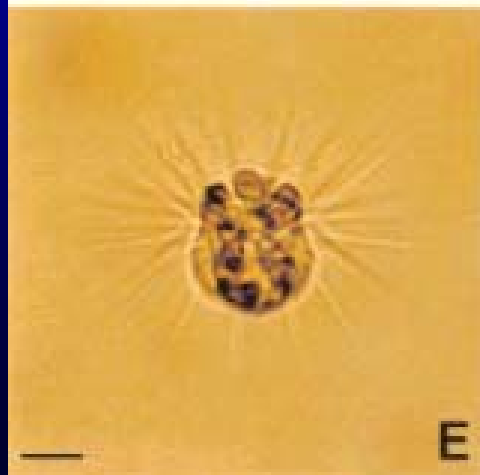
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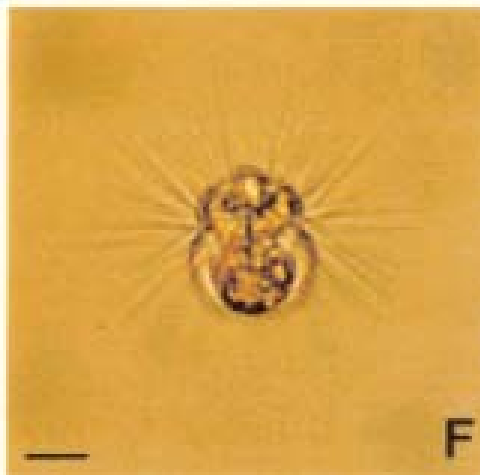
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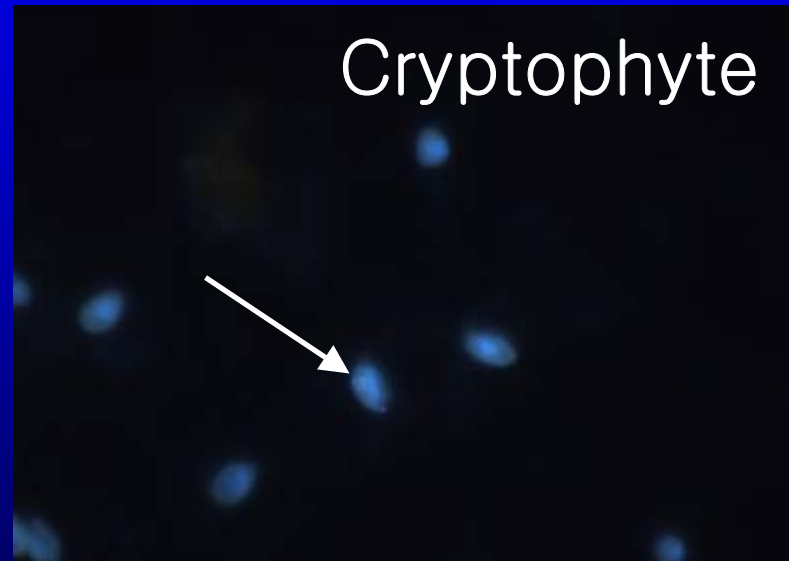


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Bacterivory of *M. rubrum* & Cryptophyte ?



M. rubrum



M. rubrum Food Web

Zooplankton



Bivalves



Fish larvae



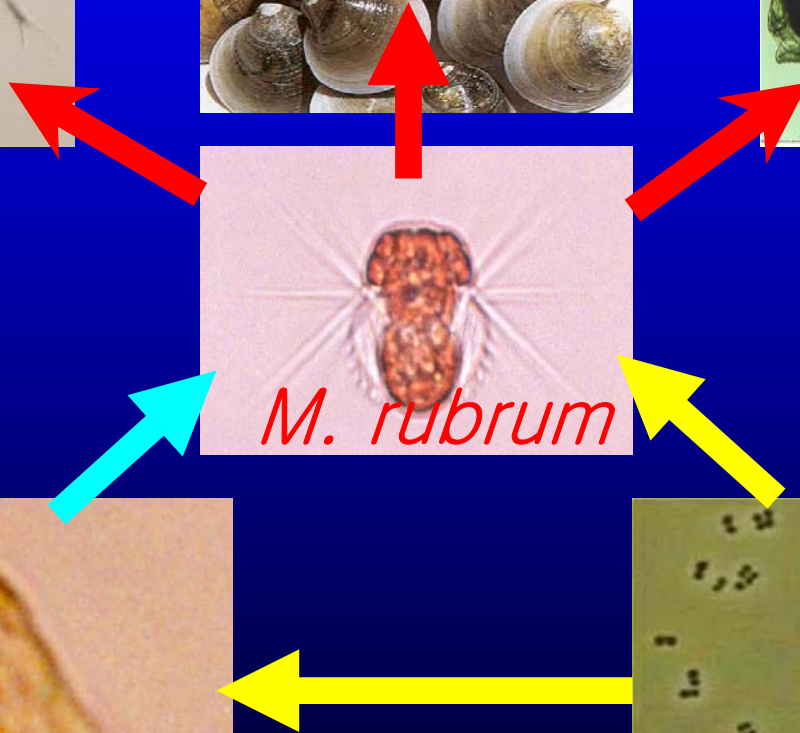
M. rubrum



Cryptophyte



Bacteria



Good live feed ?

- ❑ Manageable & novel **laboratory strain**, (MR-MAL01), from temperate waters
- ❑ Remarkable tolerance to T & S (0~24°C, 3~40psu)
- ❑ Non-toxic red tide species
- ❑ High N:C cellular composition (=high protein content)

Feeding experiments

1. As live feed for young bivalves



Materials & Methods

- Predator bivalve
 - Scallop (*Chlamys farreri*)
3.3±0.2cm
 - Manila clam (*Ruditapes philippinarum*)
3.2±0.1cm
- Experimental density: 0, 2, 5 & 10 ind. L⁻¹
- Initial prey density: 3,500 ~ 4,000 cells ml⁻¹
- Culture conditions
 - Scallop (15°C, 30psu)
 - Manila clam (20°C, 30psu)
 - 2 days of acclimation

M. rubrum strain

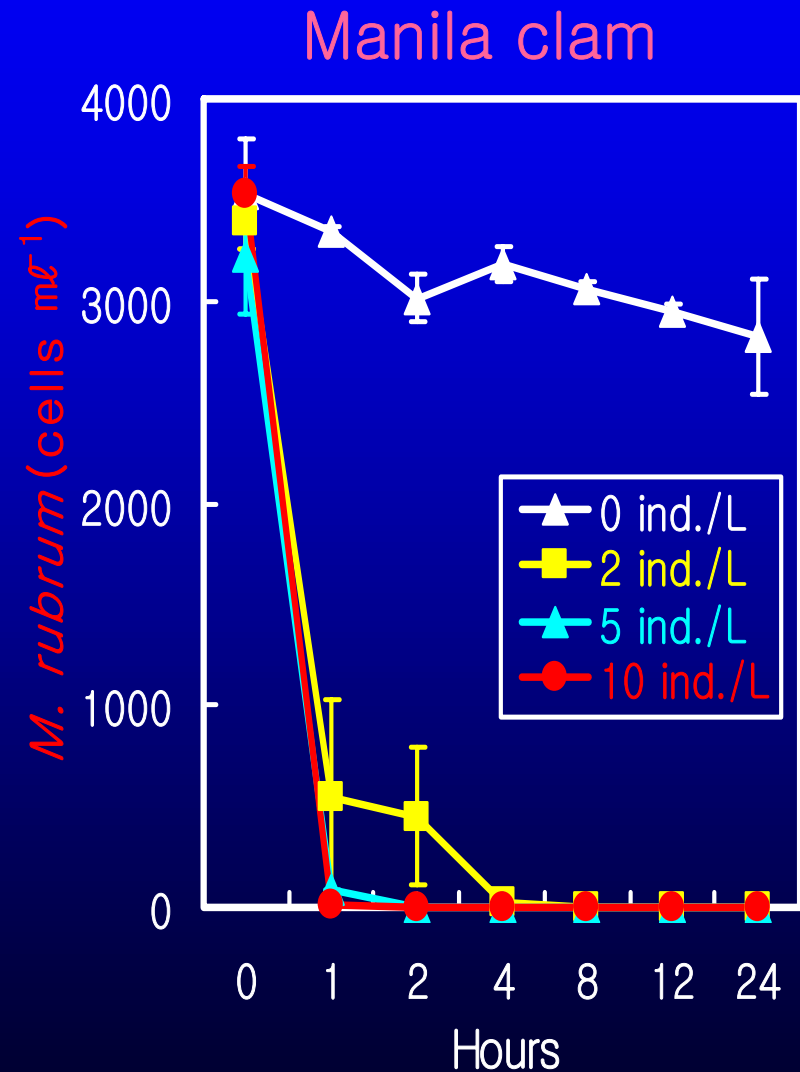
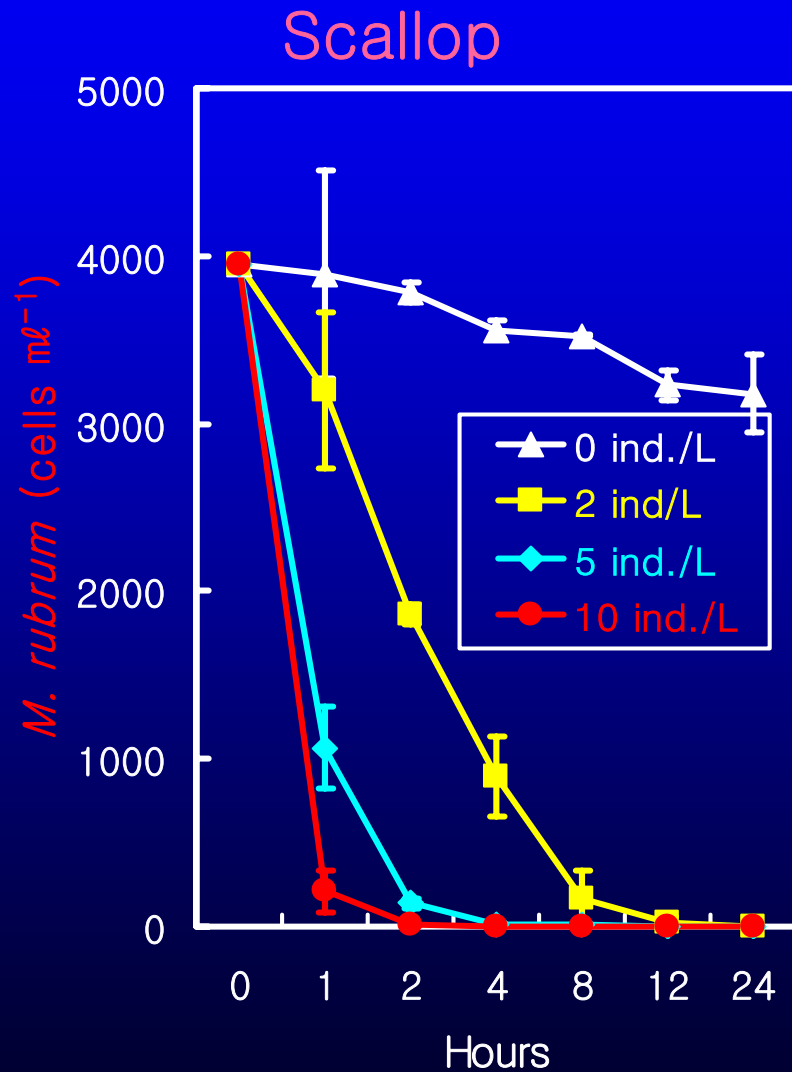
Species	Strain	MSD* ($\mu\text{m} \pm \text{SE}$)	Volume ² ($\mu\text{m}^3 \pm \text{SE}$)
<i>M. rubrum</i>	MR- MAL01 ¹	20.8 \pm 0.34	4,095 \pm 244.4

¹ MAL : Marine Algal Laboratory,
Kunsan National University

² Coulter Multisizer II (Coulter Co., USA)

* MSD: mean spherical diameter

Ingestion of *M. rubrum* prey



Maximum ingestion rates

Predator	Max. ingestion rate (cells predator ⁻¹ min. ⁻¹)	Temperature (°C)
Scallop	9.4	15
Manila clam	22.2	20

M. rubrum
85,400 cells ml⁻¹



2 hr



M. rubrum
28,800 cells ml⁻¹

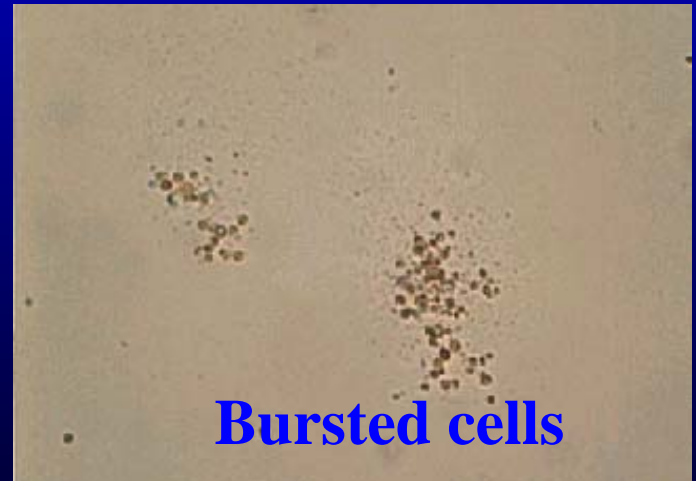




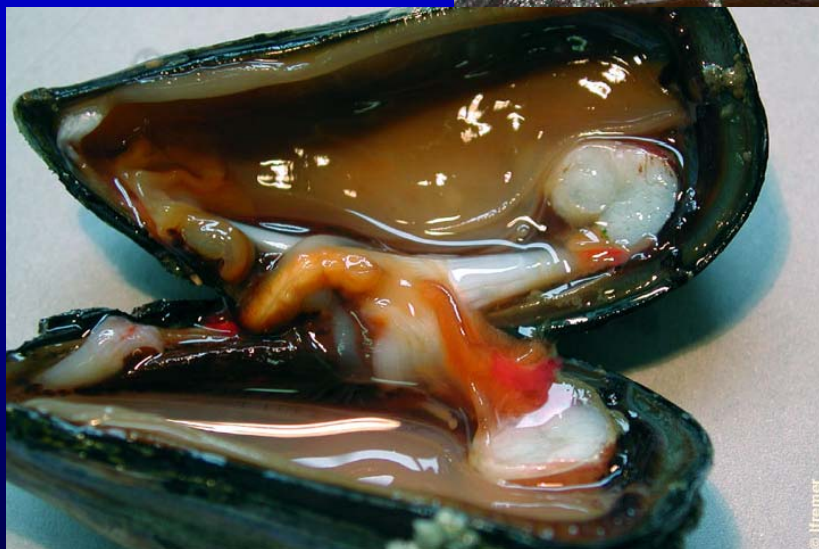
Gut (part)



Gut contents



Bursting cells



from a French *M. rubrum* bloom site
(<http://www.ifremer.fr/envlit/photos/Archive/200103/index.htm>)

Feeding experiments

2. As live feed for bivalve spat



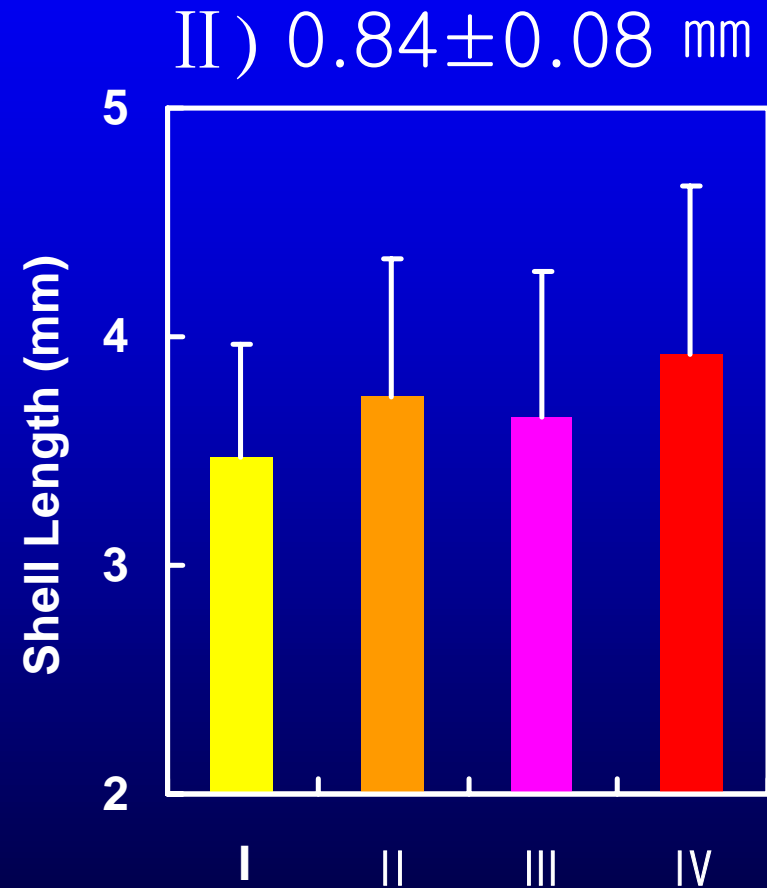
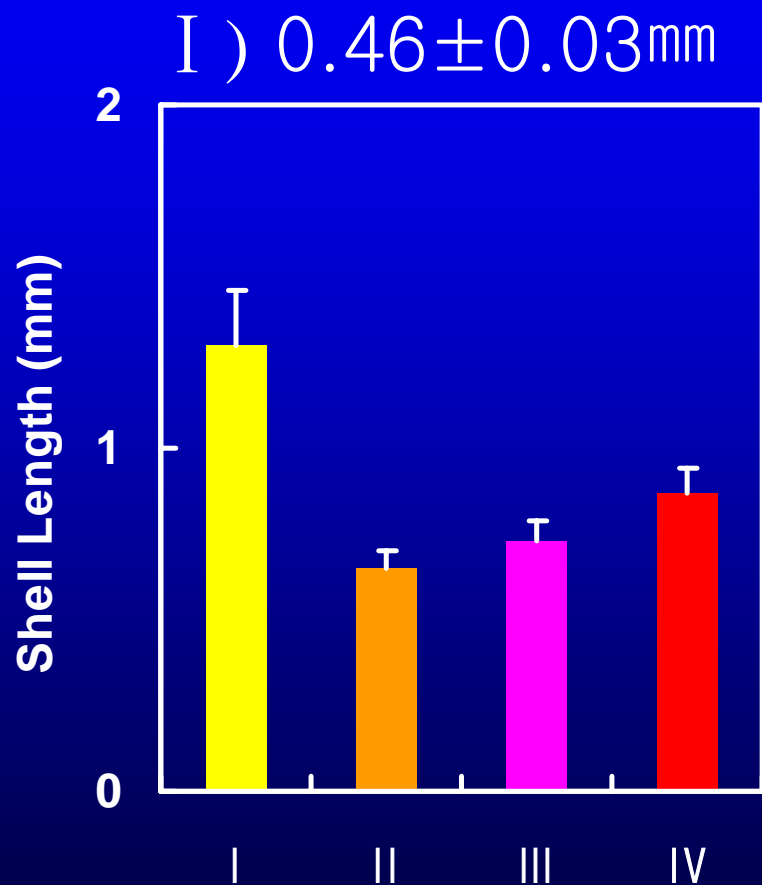
Materials & Methods

- Predator shellfish spat
 - Manila clam (*Ruditapes philippinarum*)
 - Size : I) 0.46 ± 0.03 mm, II) 0.84 ± 0.08 mm

- Experimental prey & density
 - *Isochrysis galbana* : 1×10^5 cells ml⁻¹
 - *M. rubrum* : 1×10^2 , 1×10^3 , 1×10^4 cells ml⁻¹
 - constant prey concentration

- Culture conditions & experimental periods
 - 20°C, 30psu
 - 28 days (replaced with new water every 4d)

Growth of Manila clam spat



I : *I. galbana* (1×10^5 cells l^{-1}), II : *M. rubrum* (1×10^2 cells l^{-1})
II : *M. rubrum* (1×10^3 cells l^{-1}), IV : *M. rubrum* (1×10^4 cells l^{-1})

Experimental Test (live feed for aquatic animals?)

	Predator	Stage/Size	Result
Bivalve	Manila clam	< SL 0.5mm	X
		> SL 0.5mm	○
	Scallop	3.3 cm	○
Shrimp	Flesh prawn	Zoea	X
Fish	Mudskipper	Post-larvae	○
	Skewband grunt	"	○
	Flounder	"	X

Centrifuge-harvested *M. rubrum* (MR-MAL01)



Marine aquacultural applications

1. Live feed for ranching animal

- spat & broodstock of bivalve
- fish larvae with small mouth
(Black scraper
Dotted gizzard shad
Seven-banded grouper etc.)



2. Enrichment of feed organism for seedling production

- Rotifer, Artemia

3. Natural coloring agent

- Salmon, Carp etc.