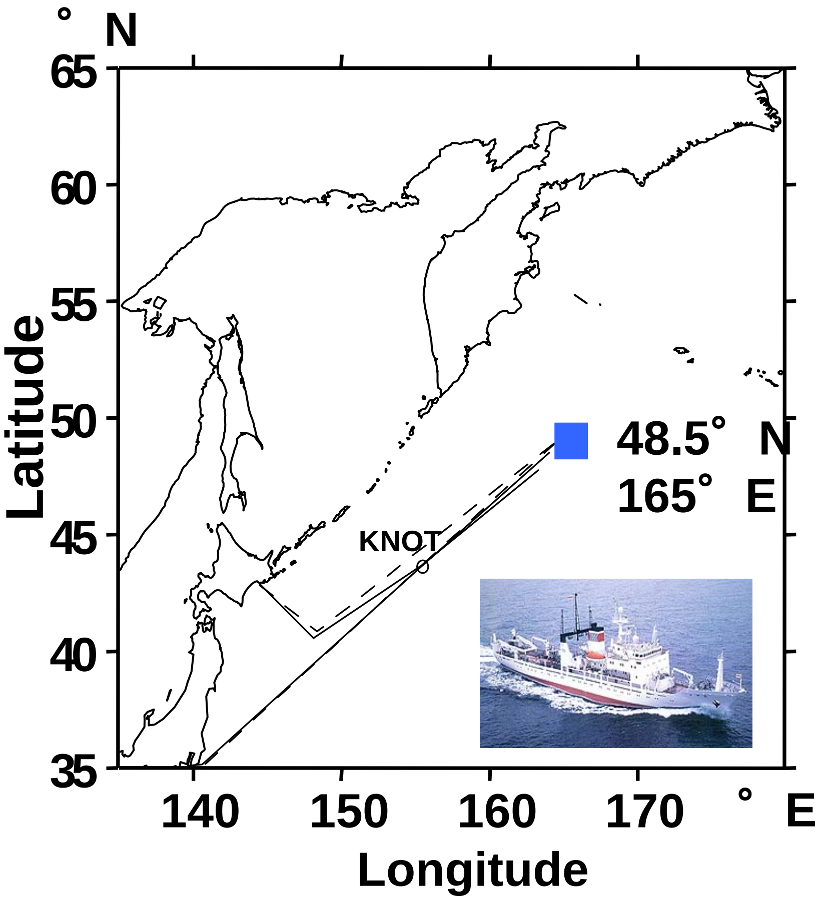
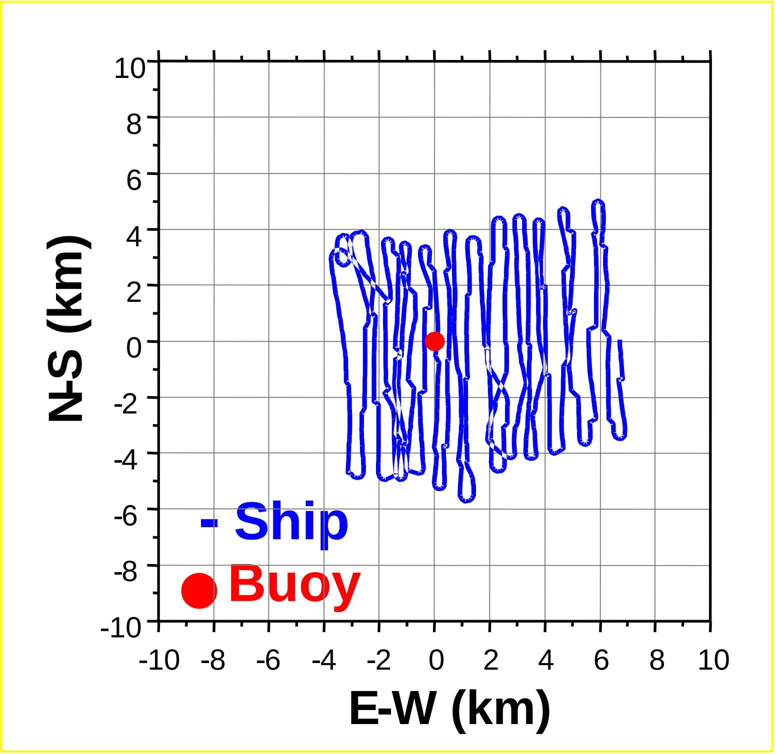
# Role of Heterotrophic Dinoflagellate *Gyrodinium* sp. in Biogeochemical Cycles

Hiroaki Saito, Takashi Ota, Koji Suzuki,
Jun Nishioka & Atsushi Tsuda

# SEEDS: Iron-enrichment exp. in the HNLC subarctic Pacific



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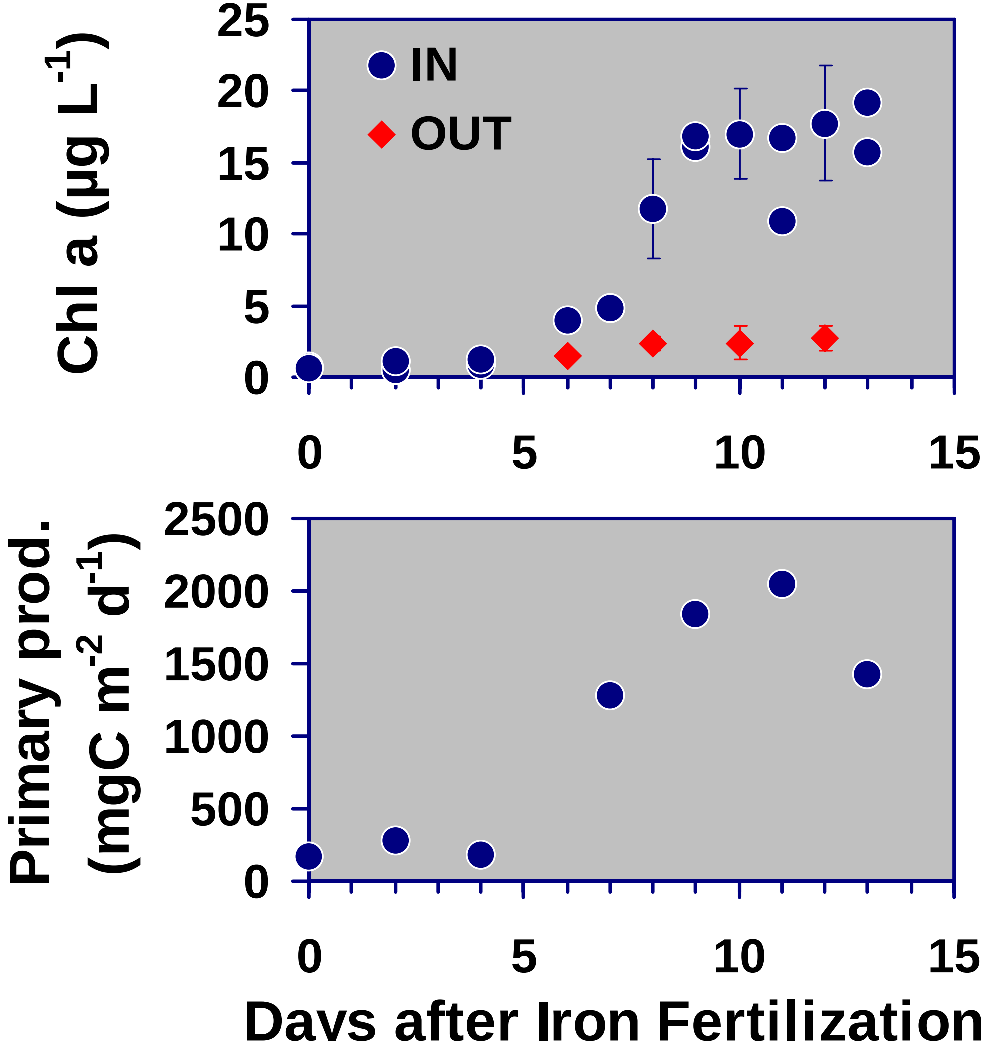
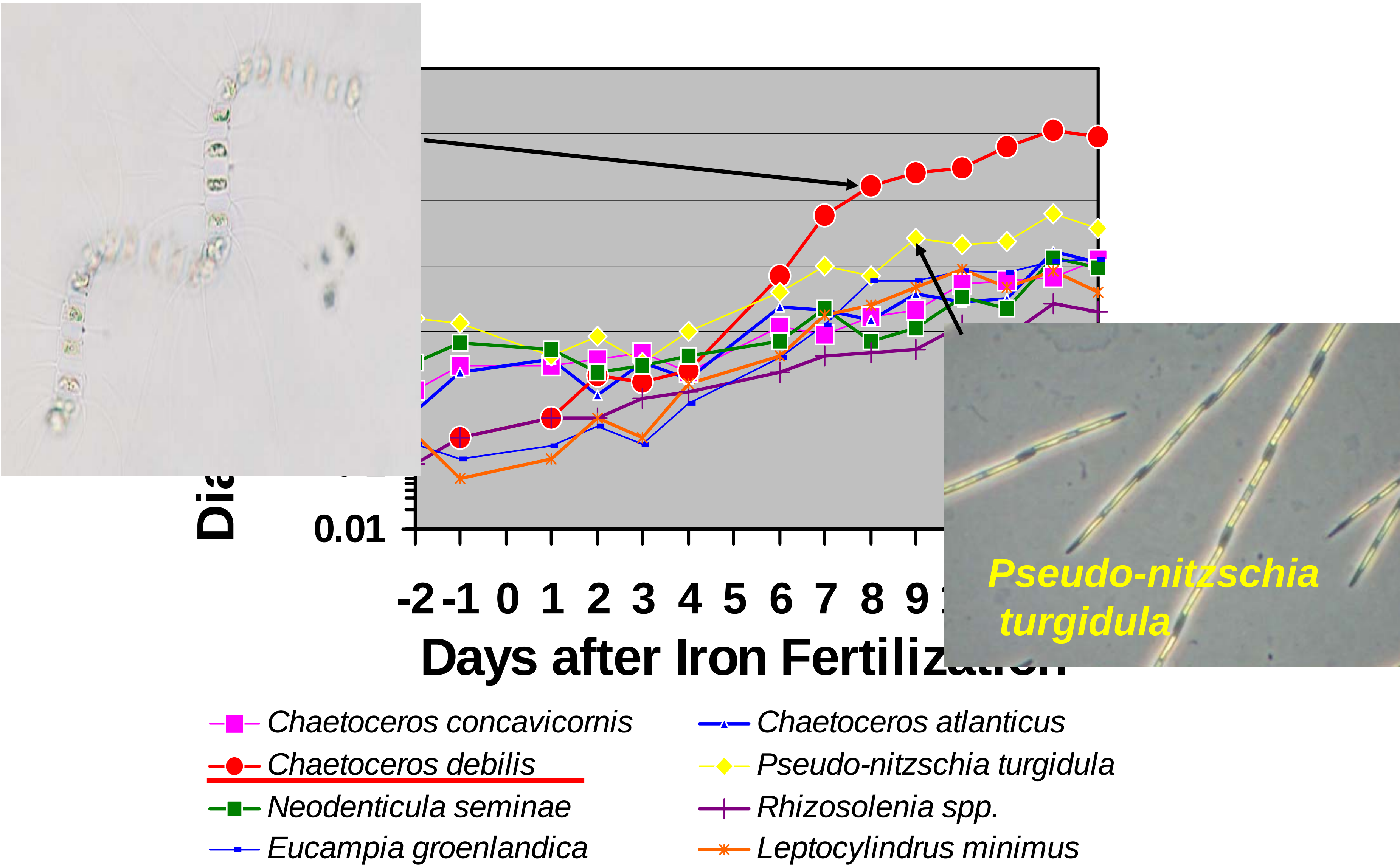


# Diatom outburst



# Dominant phytoplankton:

Chain forming diatoms 100-1000 $\mu m$

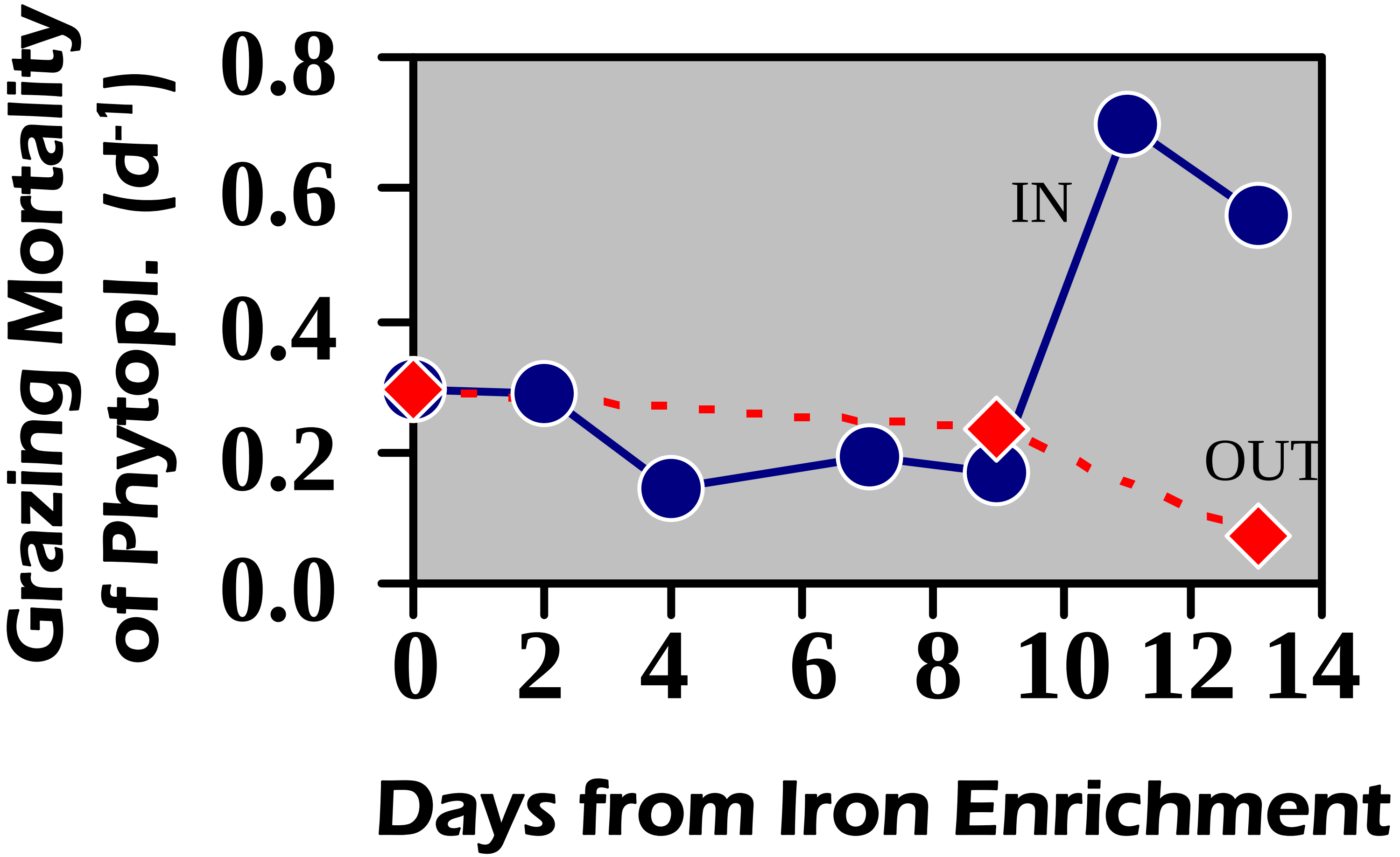
*Mesozooplankton can feed on*

*Too large as prey for most microzooplanton*

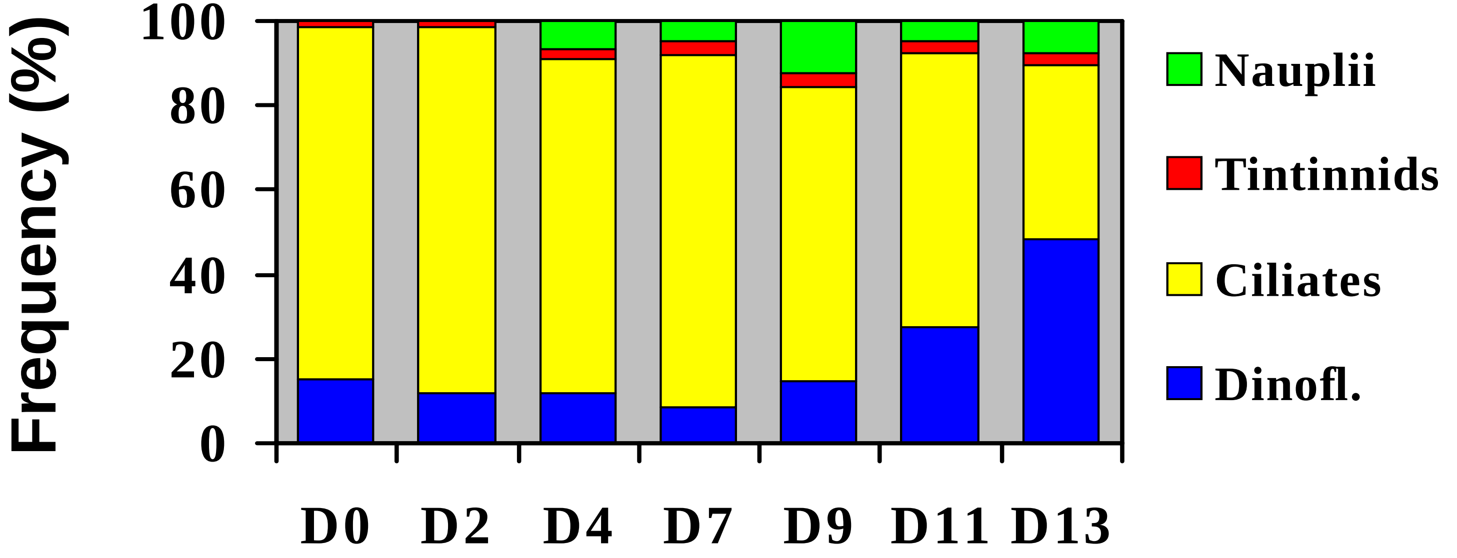
# Macrozooplankton grazing

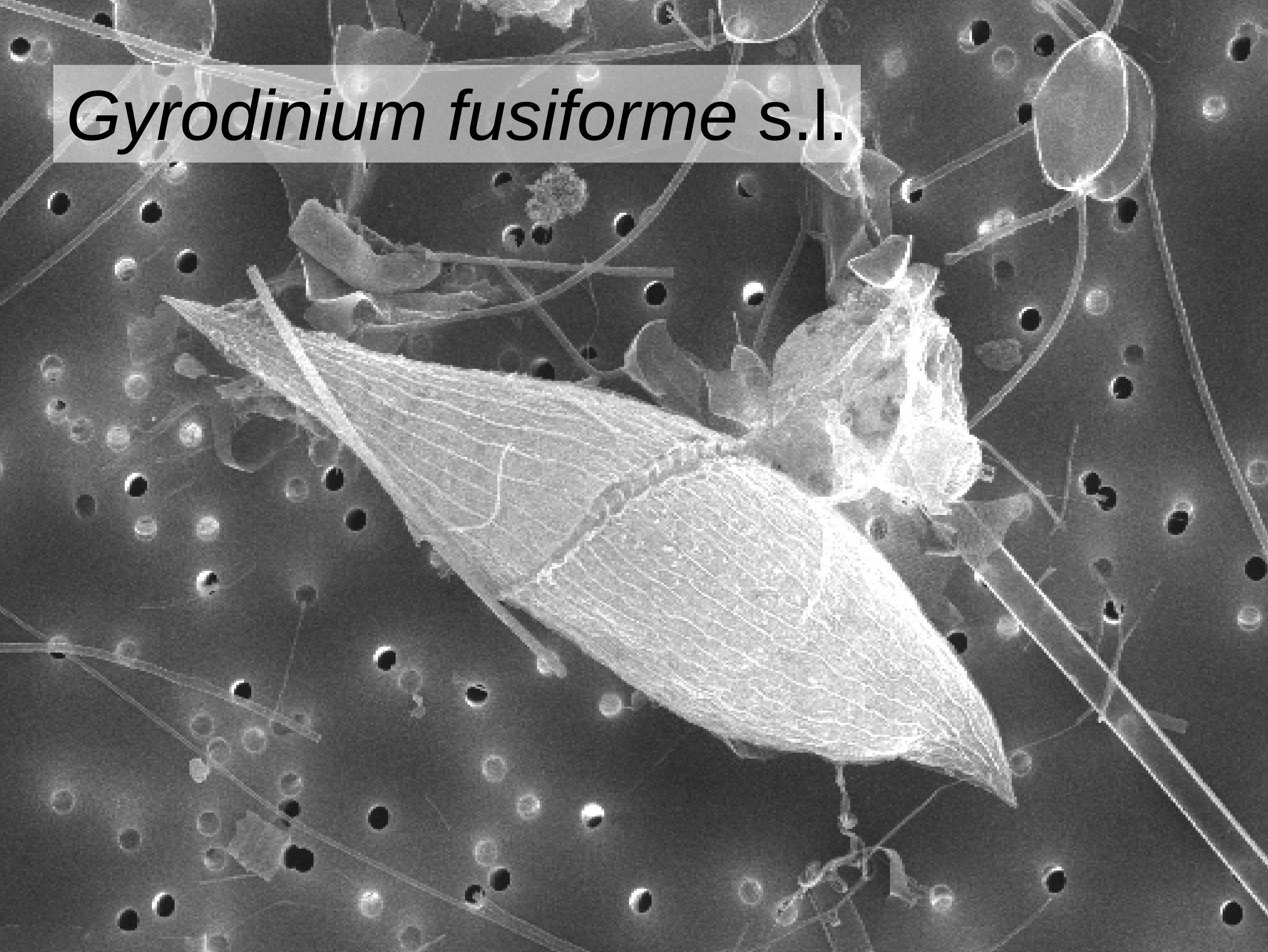
| | D0 | D2 | D4 | D7 | D9 | D11 | D13 |
|---|---|---|---|---|---|---|---|
| Phytopl. biomass (mgC $m^{-3}$) | 32 | 45 | 46 | 216 | 710 | 350 | 676 |
| Copepod grazing ($d^{-1}$) | | 0.010 | 0.023 | 0.001 | | 0.003 | |

# Microzooplankton grazing



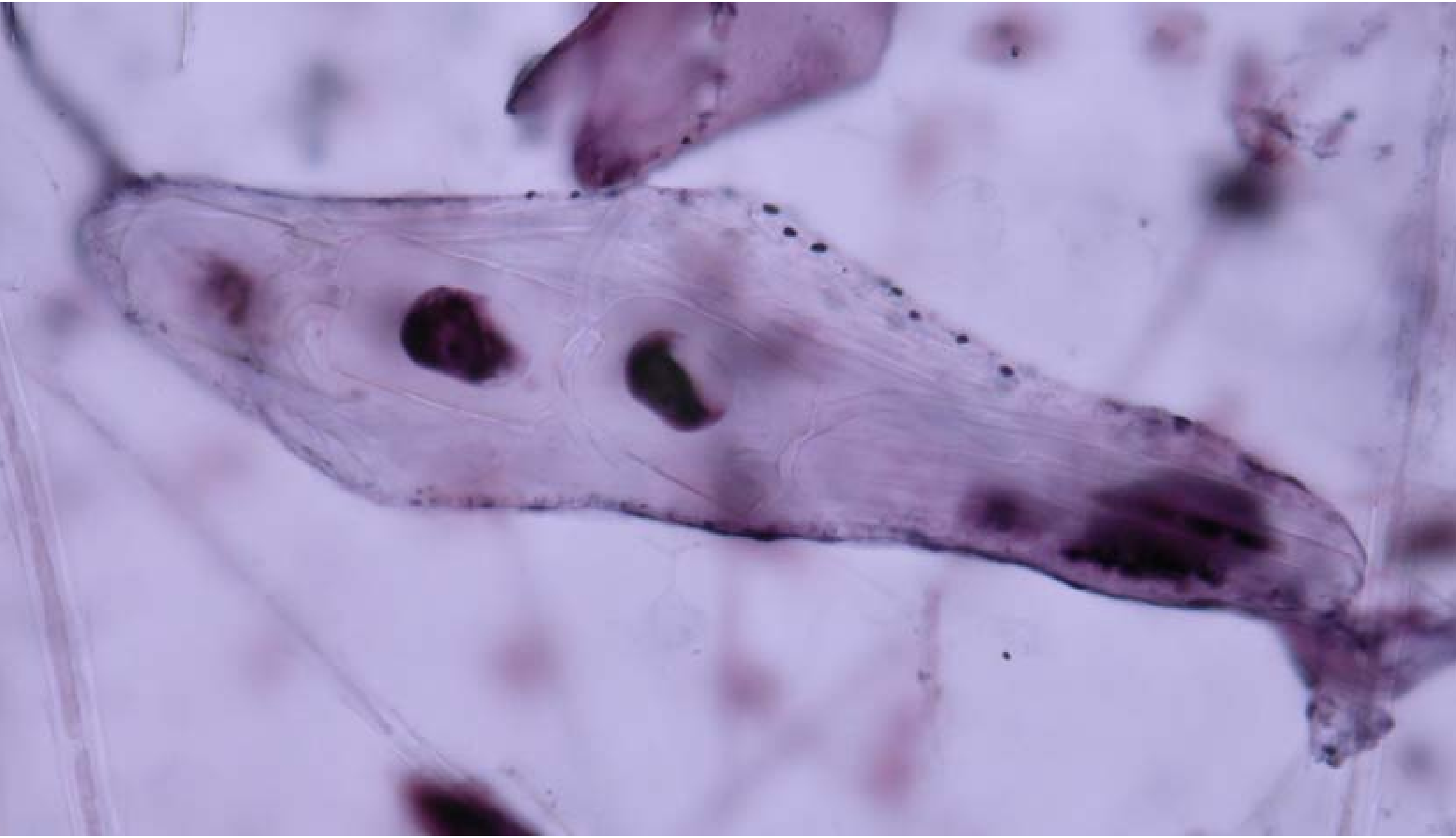
# Microzooplankton composition



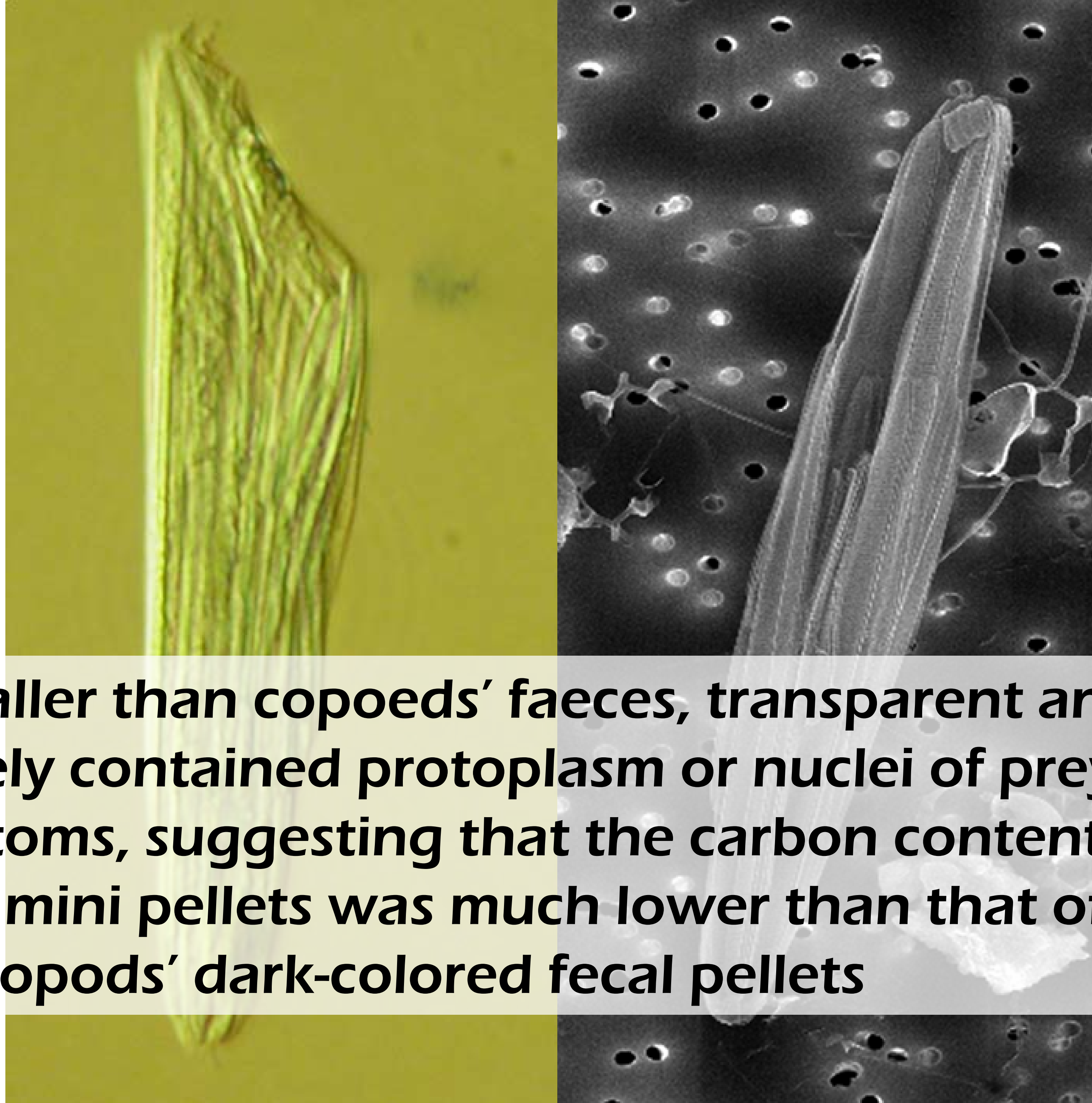

*Gyrodinium fusiforme* s.l.

*Feeding on smaller phytoplankton < 20 μm*

# *Gyrodinium* sp.

# Max prey length: 750 $\mu$m (x12 of *Gyrodinium* length)



Smaller than copoeds' faeces, transparent and rarely contained protoplasm or nuclei of prey diatoms, suggesting that the carbon content of the mini pellets was much lower than that of copopods' dark-colored fecal pellets

# Stable diatom biomass from D9

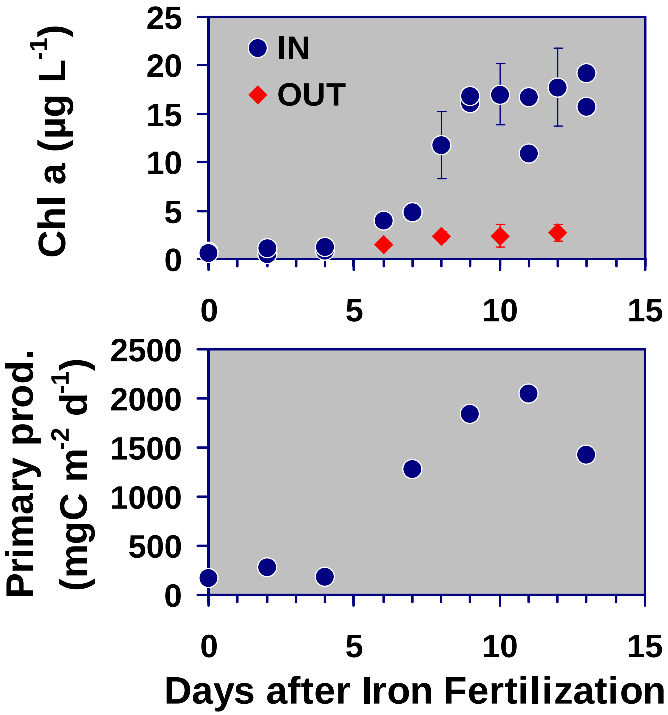
Iron-limitation, self-shading

Prim. prod. > 1.4 gC $m^{-2}$ $d^{-1}$

Replete nutrients

Low lateral dispersion

Low vertical flux




*Gyrodinium* sp. prevented further development of the diatom bloom from D9 prior to the macronutrients depletion

# A Question for the Fate of the Bloom

*sink or respired?*

# MODEL

$$I_t = I_{max}(MP_t / (MP_t + K_c))\ C_t W_t$$

$$MP_{t+1} = MP_t + Pmp_t - I_{max}(MP_t / (MP_t + K_c))\ C_t W_{13} \Delta_t$$

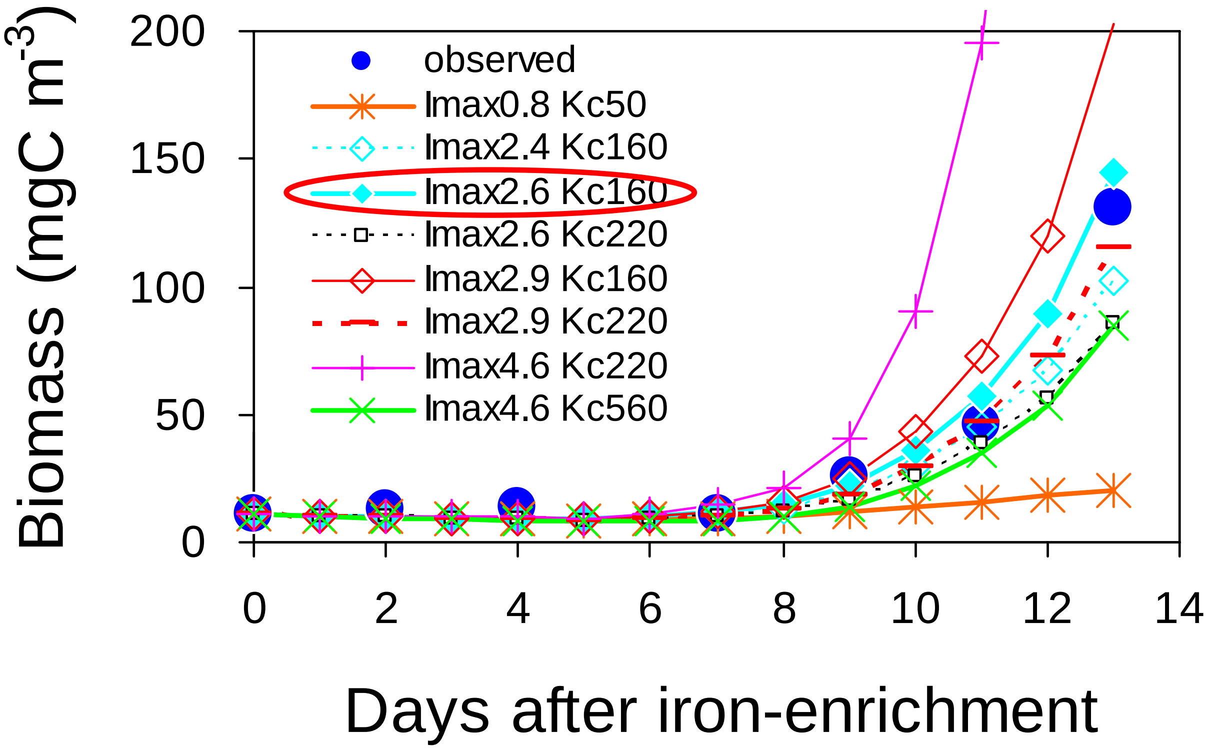
$$C_{t+1} = C_t \exp(g_t - m_t)$$

$$g_t = I_{max}(MP_t / (MP_t + K_c))E$$

$C_t$ is the abundance of *Gyrodinium* sp. (ind. $m^{-3}$),
$W_t$ their carbon weight (mgC $ind.^{-1}$).
$W_{13}$ is the carbon weight of a *Gyrodinium* sp. on D13 (1.88 ngC $ind.^{-1}$)
$P_{mpt}$ is calculated from chlorophyll a specific production on D13 (9.1 mgC mg chlorophyll $a^{-1}$ $d^{-1}$)
*gt* and *mt* are the specific growth rate ($d^{-1}$) and mortality ($d^{-1}$) of *Gyrodinium* sp.
gross growth efficiency (*E*) is 0.31 [*Nakamura et al.*, 1992]

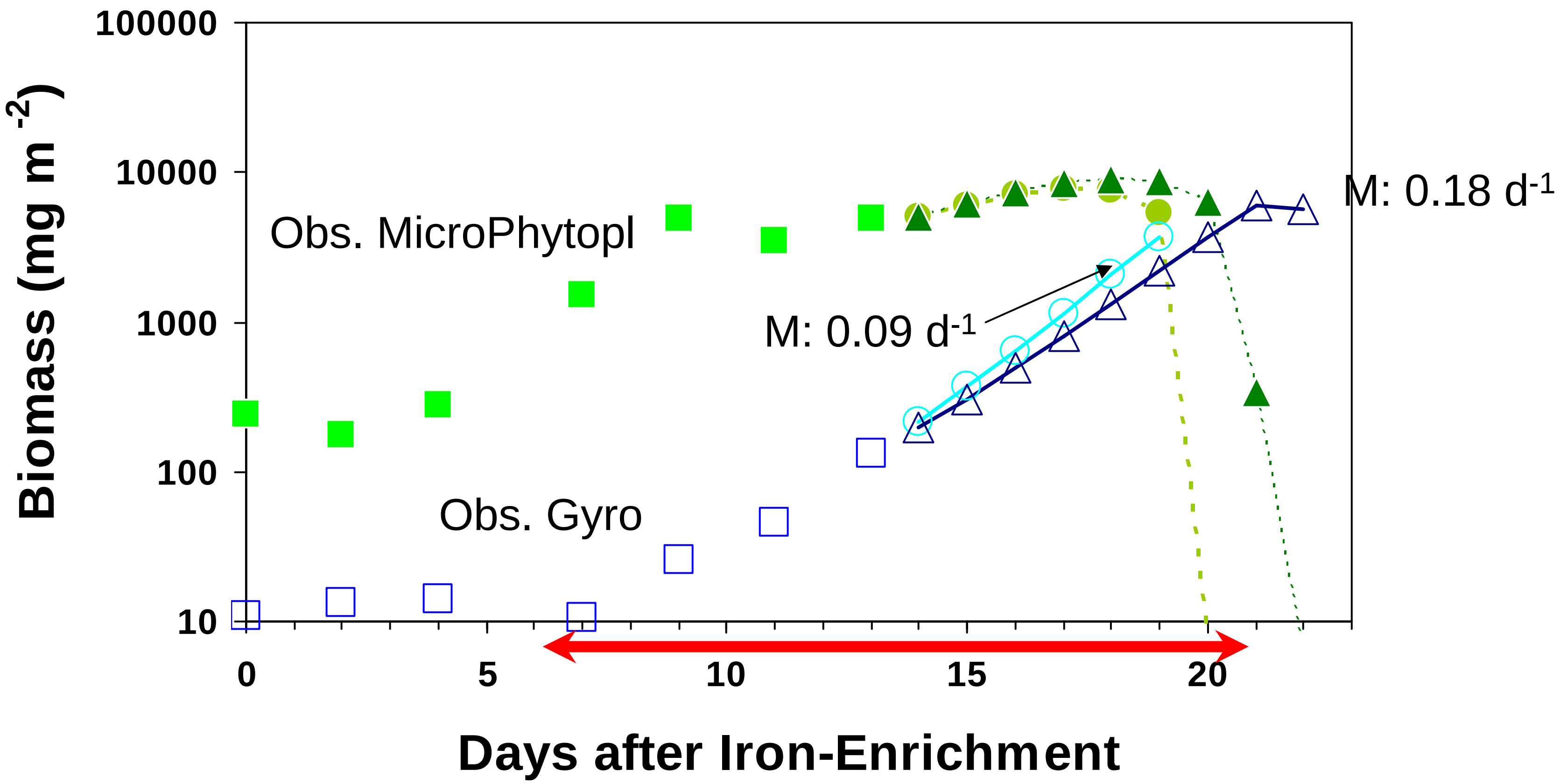
# Preliminary model exps for the selection of $I_{max}$ and $K_c$

Selected from reported parameter values for heterotrophic dinoflagellates summarized in Nakamura et al. 1995




*Imax*: 2.6 $d^{-1}$, *Kc*: 160 mgC $m^{-3}$

# Model Results




***Gyrodinium*** **sp. would graze down the diatom bloom after 14-15 days from the initiation (D6)**

# Fate of the diatom bloom: *Gyrodinium* sp. graze down

Model exps estimated that *Gyrodinium* sp. would graze down the diatom bloom after 14-15 days from its initiation.

Faecal pellets of *Gyrodinium* sp. rarely contained protoplasm or nuclei of prey diatoms, suggesting low carbon content compared with copopods' dark-colored fecal pellets. Sinking speed is estimated to be 1-2 order lower than FPs of salps and crustaceans. These suggest low transport efficiency of ingested carbon to the depths by their sinking.

# Complex Ecosystem Responses: Outburst of Minor Components

*C. debilis* was a negligible component in phytoplankton assemblage prior to the IF and increased abruptly after the IF and dominated. Grazers responded to the outburst of *C. debilis* was relatively minor components in zooplankton at the beginning, *Gyrodinium* sp.

These results indicated that prediction of the ecosystem response to anthropogenic or natural perturbations is still challenging issue.

We need further study on the ecosystem structure and the functions of its components.

# Iron-enrichment to HNLC as an geoenginering technique

Diatom-Engine power for biological carbon pump (potentially quite powerful!) is inefficiently transmitted through *Gyrodinium* sp.

Effective carbon sequestration as a geoengineering technique may not be accomplished by purposeful iron-enrichment, at least in the western subarctic Pacific where rapid-growth diatom grazers stand by.

(Saito et al. GRL, 2006)