Cyst dynamics and occurrences of red tides of *Heterosigma akashiwo* and *Chattonella* spp. in temperate coastal waters

Ichiro Imai (Hokkaido University),
Shigeru Itakura, Mineo Yamaguchi

Oct 24, 2009
PICES-2009

Contents

1. Dynamics of cysts and blooms in *Chattonella* in the Seto Inland Sea

2. Dynamics of cysts and blooms in *Heterosigma akashiwo* in the Seto Inland Sea

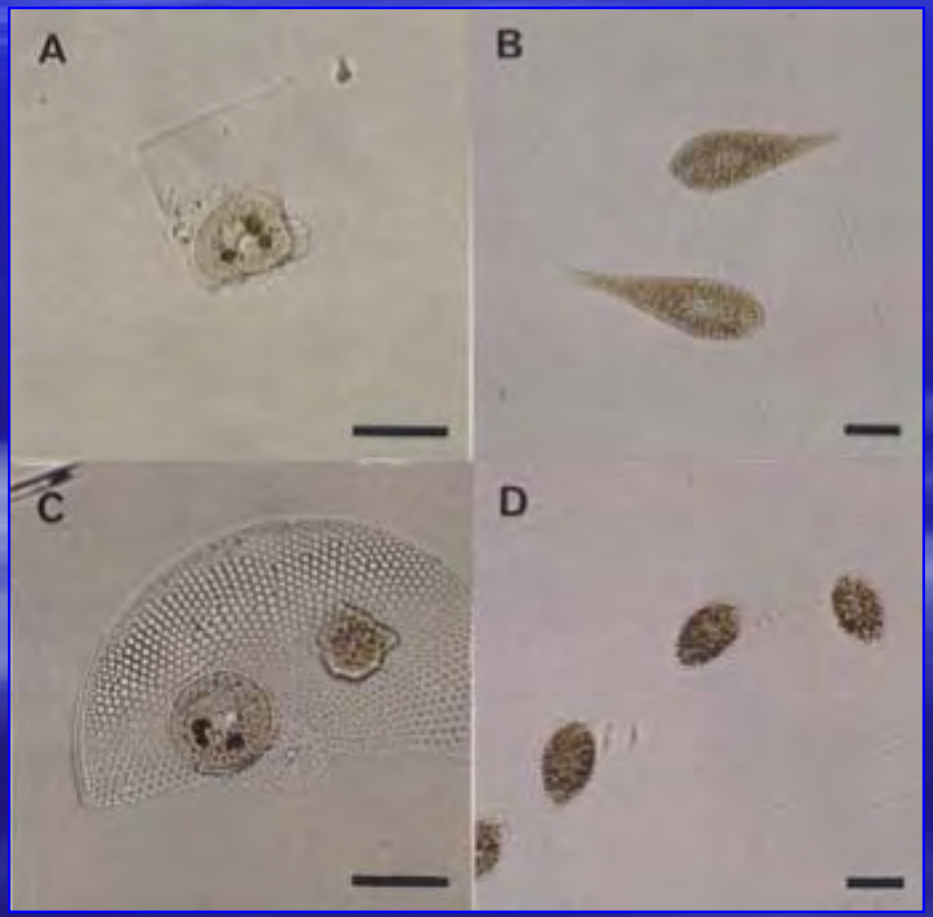
Dynamics of cysts and blooms in *Chattonella* in the Seto Inland Sea

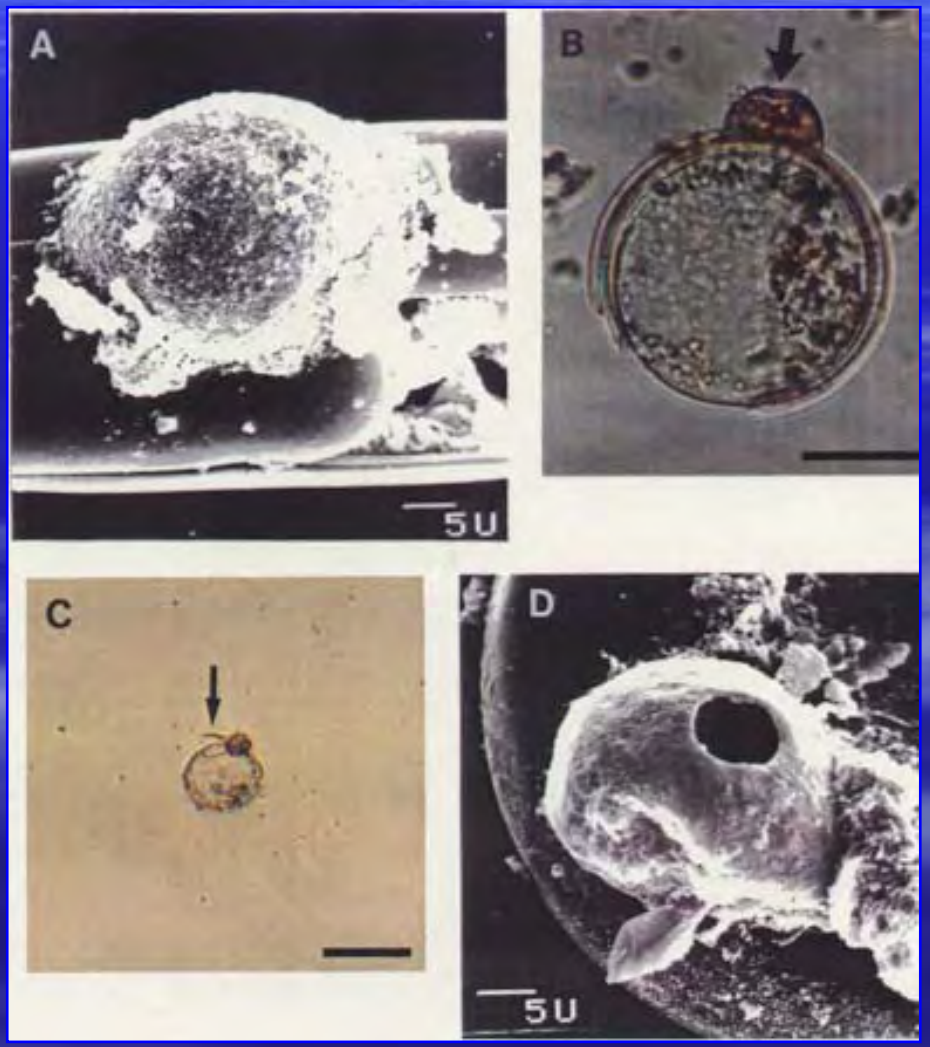
Cysts of *Chattonella antiqua* and *C. marina*

(Imai and Itoh 1988)

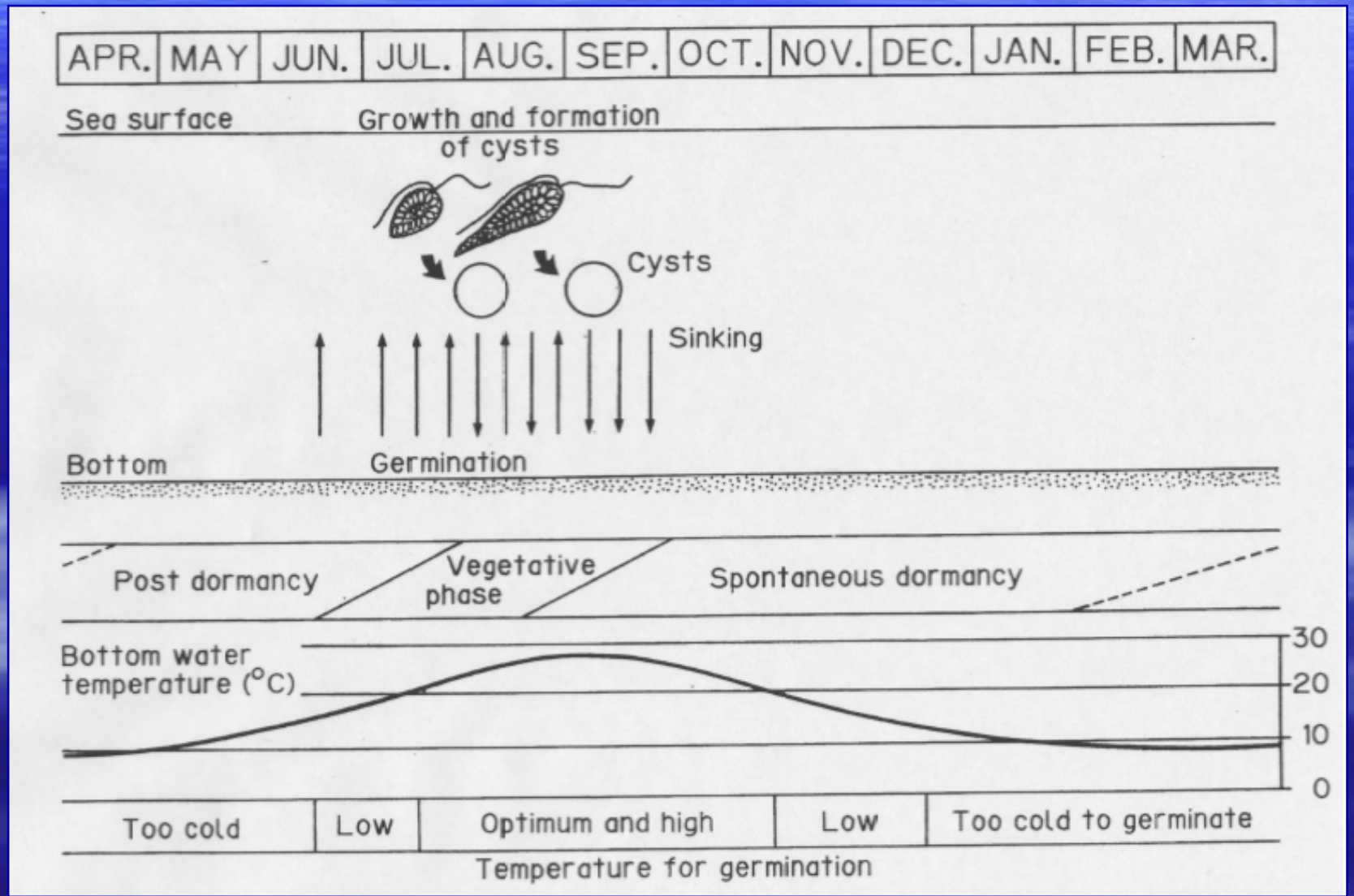
A & B: *C. antiqua*

C & D: *C. marina*

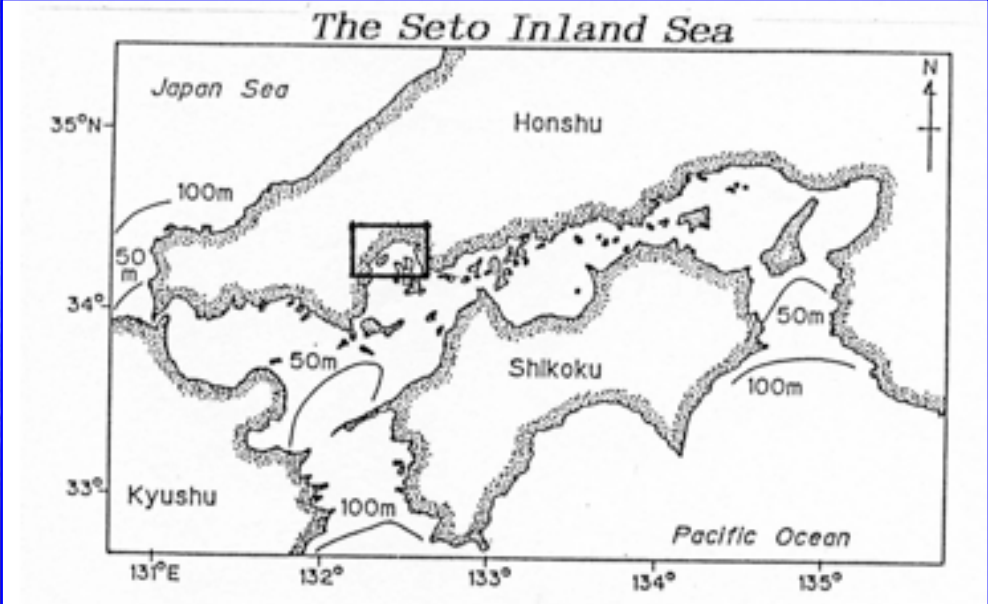


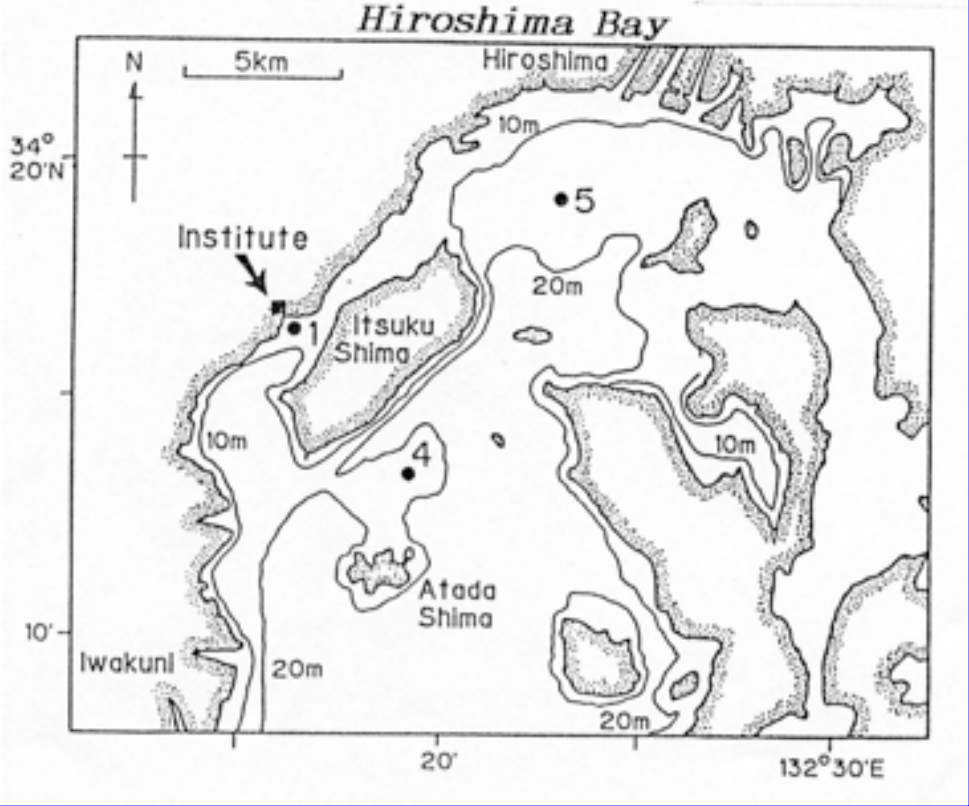


Annual life cycle of *Chattonella* in the Seto Inland Sea, including vegetative cells and cyst phase. (Imai and Itoh 1987)



Sampling stations for *Chattonella* study in Hiroshima Bay, the Seto Inland Sea.





A bloom of *Chattonella* in Hiroshima Bay in the late summer of 1990

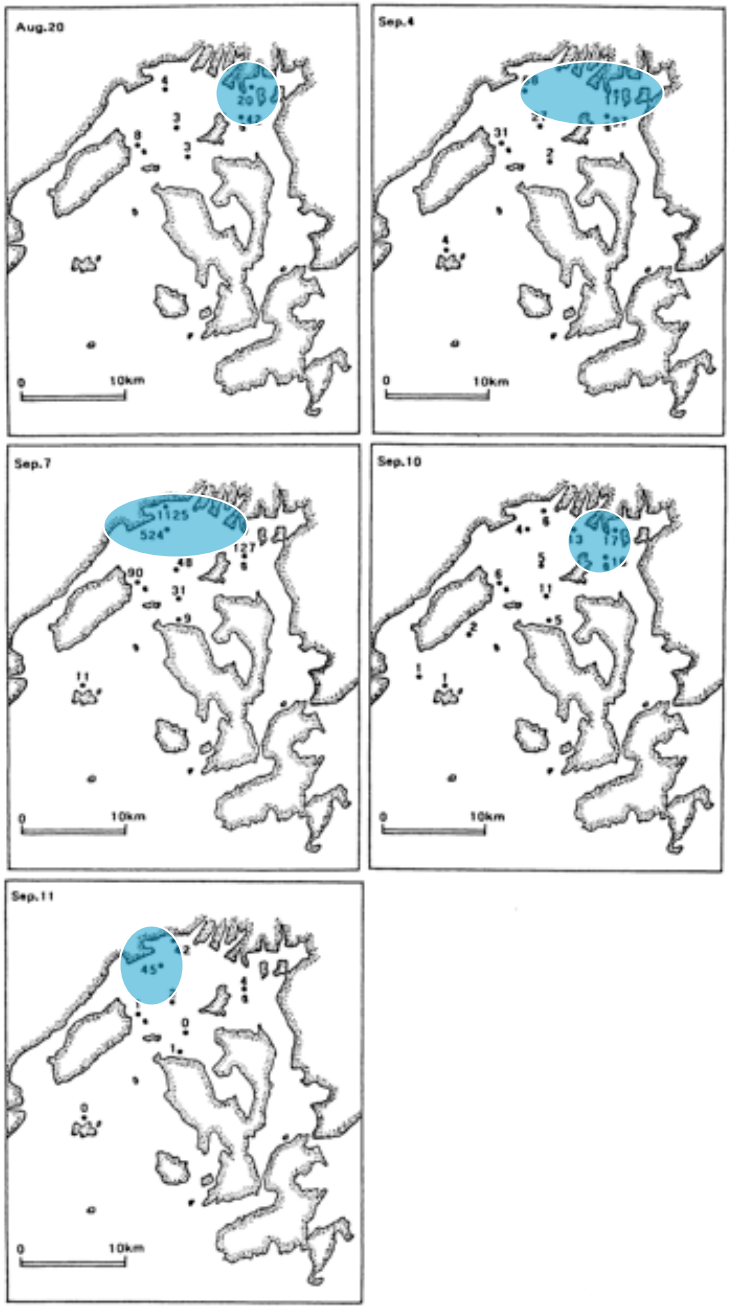


Fig. 2. Successive changes of *Chattonella* cells in northern Hiroshima Bay during the period from August 20 to September 11.
Numerals indicate the cell concentrations (cells/ml) in surface waters.

Preencystment small cells appeared at the final stage of *Chattonella* bloom

Preencystment small cells of *Chattonella* were more in deeper layer

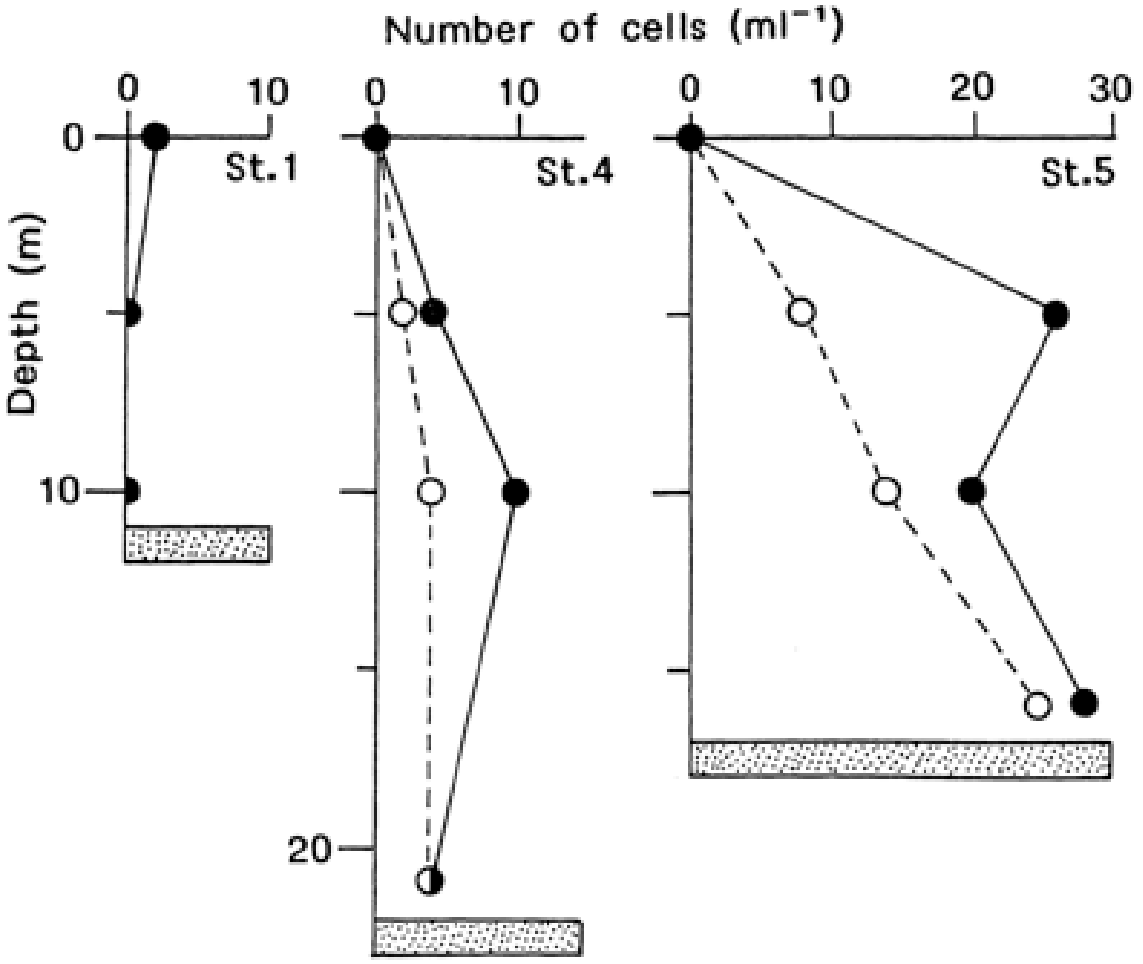


Fig. 4. Vertical profiles of *Chattonella* cell concentrations (●, total cells; ○, small cells) in northern Hiroshima Bay on September 10, 1990.

Chattonella cysts increased after the bloom in sediments

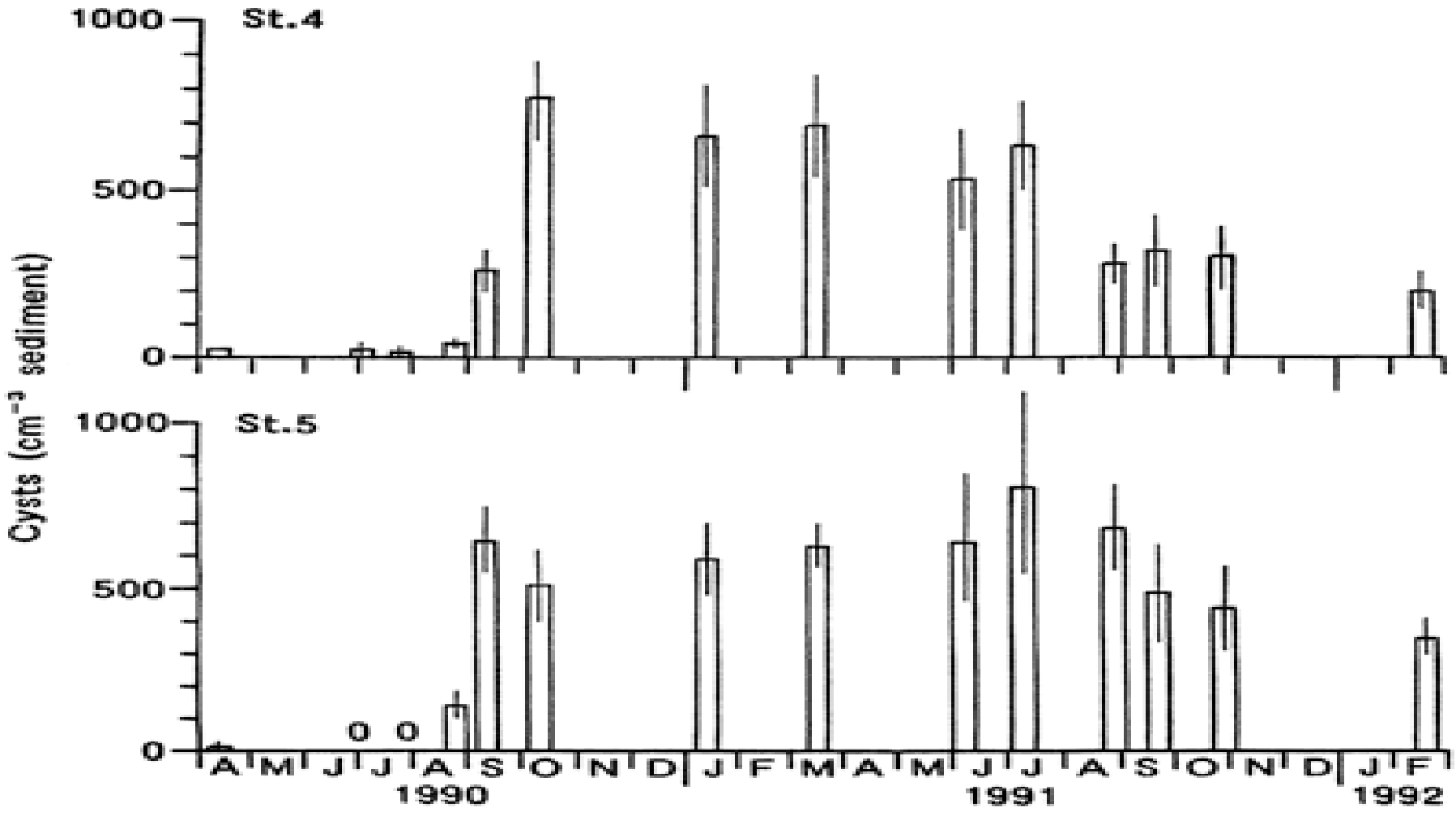
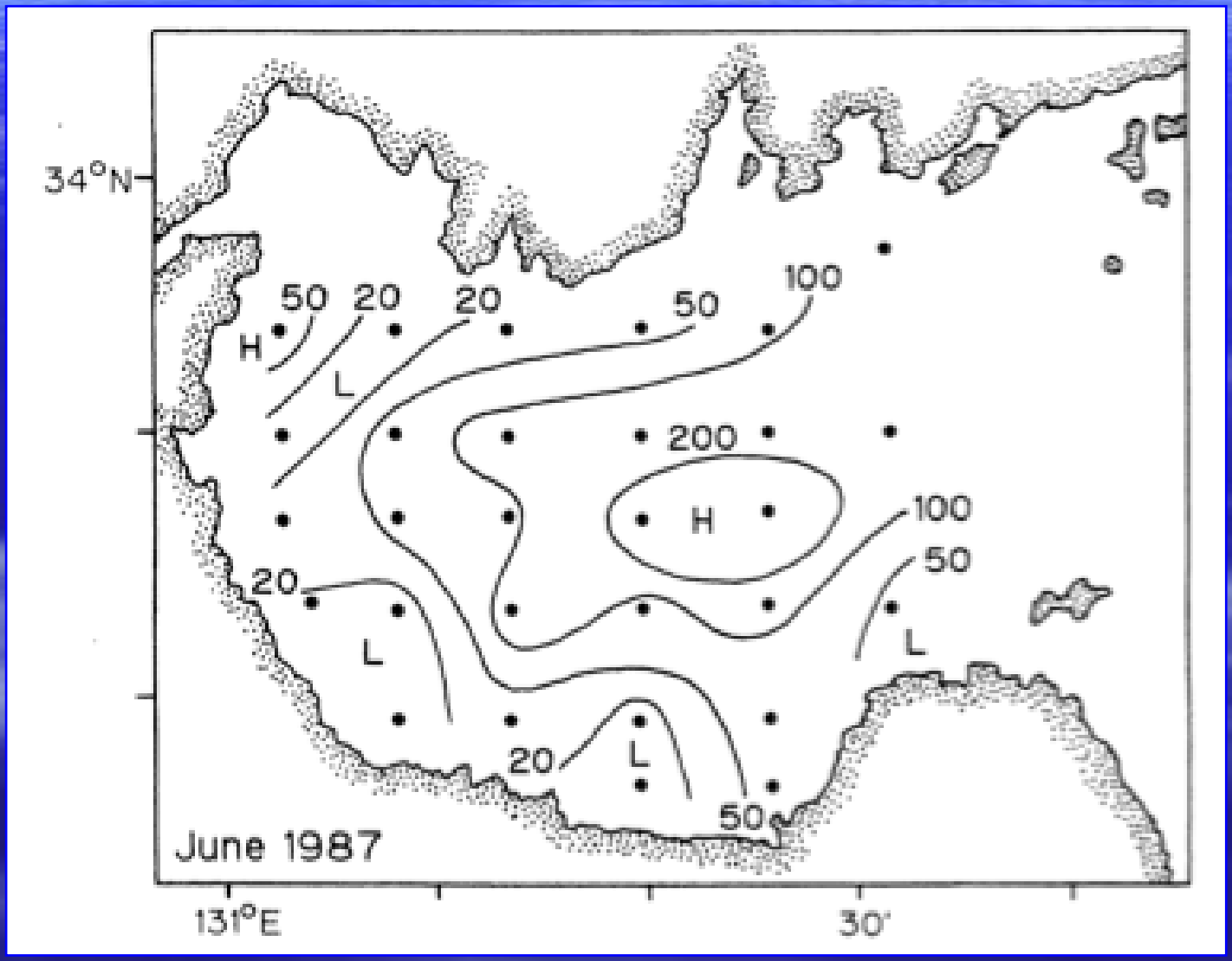


Fig. 5. Seasonal changes in the total number of *Chattonella* cysts in surface (top 1 cm depth) sediments at Sts. 4 and 5 in northern Hiroshima Bay. Bars represent standard deviations.

Distribution of Chattonella cysts in sediments of Suo-Nada (cm^{-3}) in June 1987



Chattonella bloom in Suo-Nada in the summer of 1987

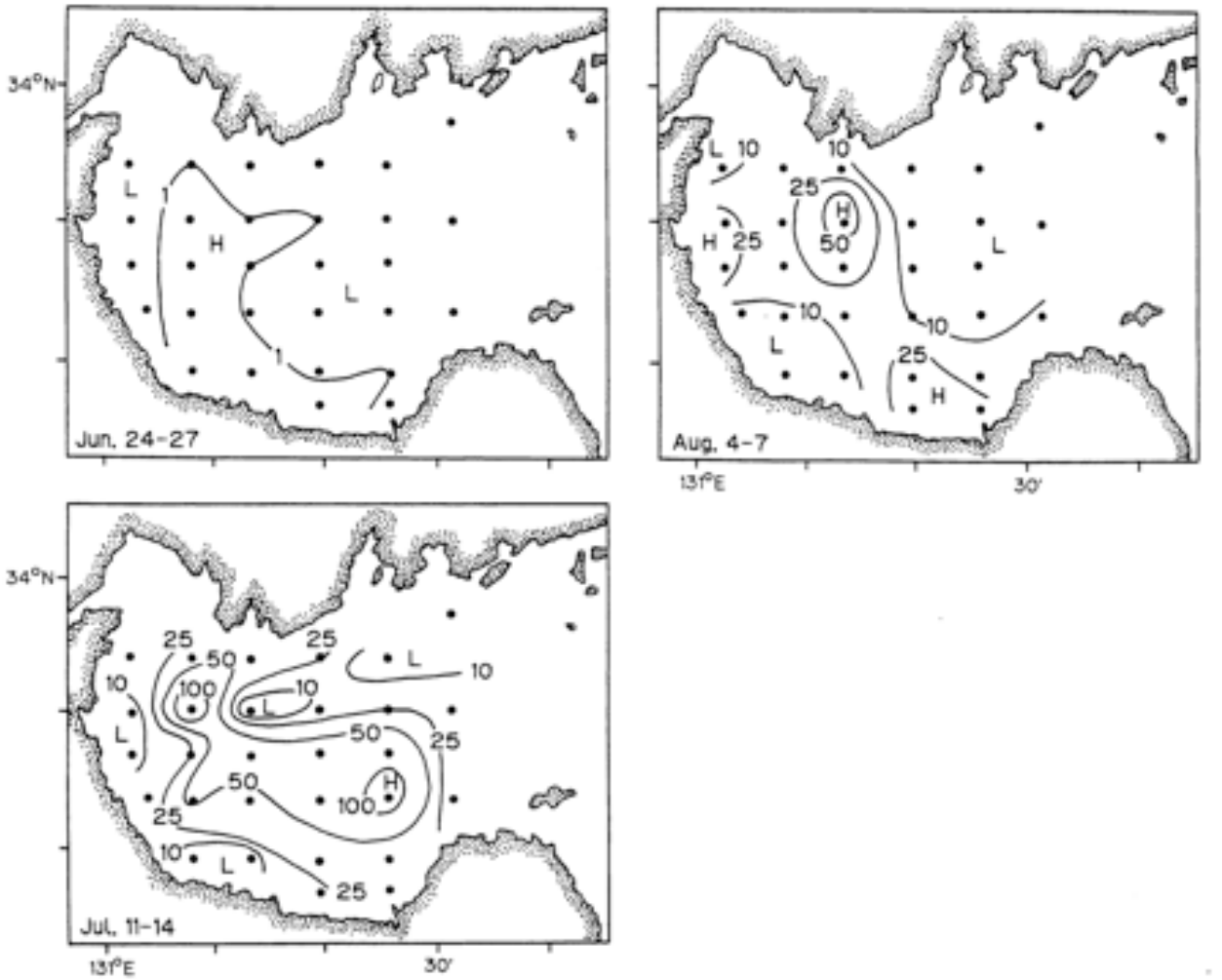


Fig. 47. Distribution of vegetative cells of *Chattonella* in Suo-Nada, during summer of 1987. Numerals indicate mean cell number per milliliter.

Germinable cysts in sediments showed less changes just before the bloom in Suo-Nada.

Chattonella cysts increased in sediments during and after the summer bloom.

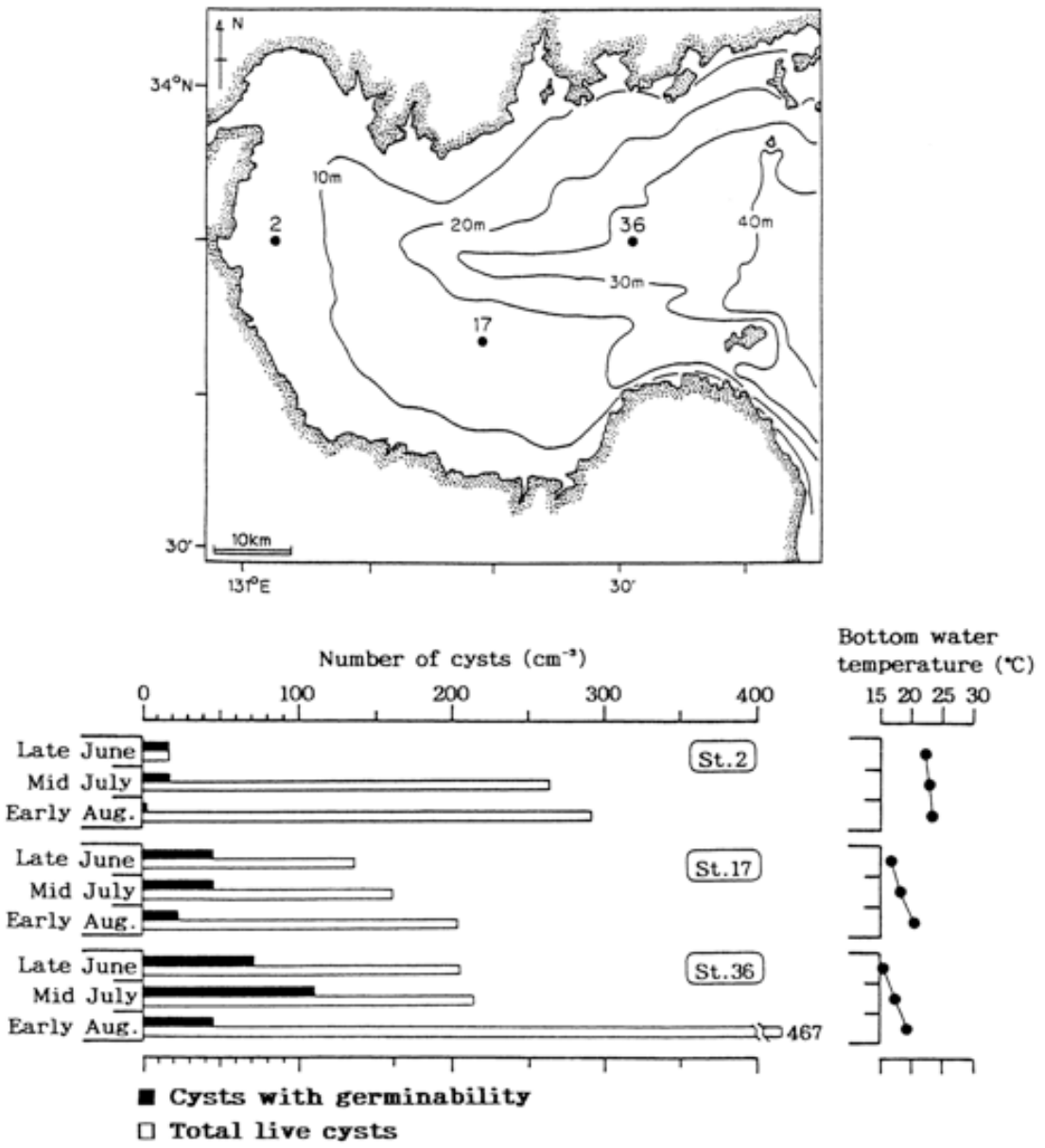
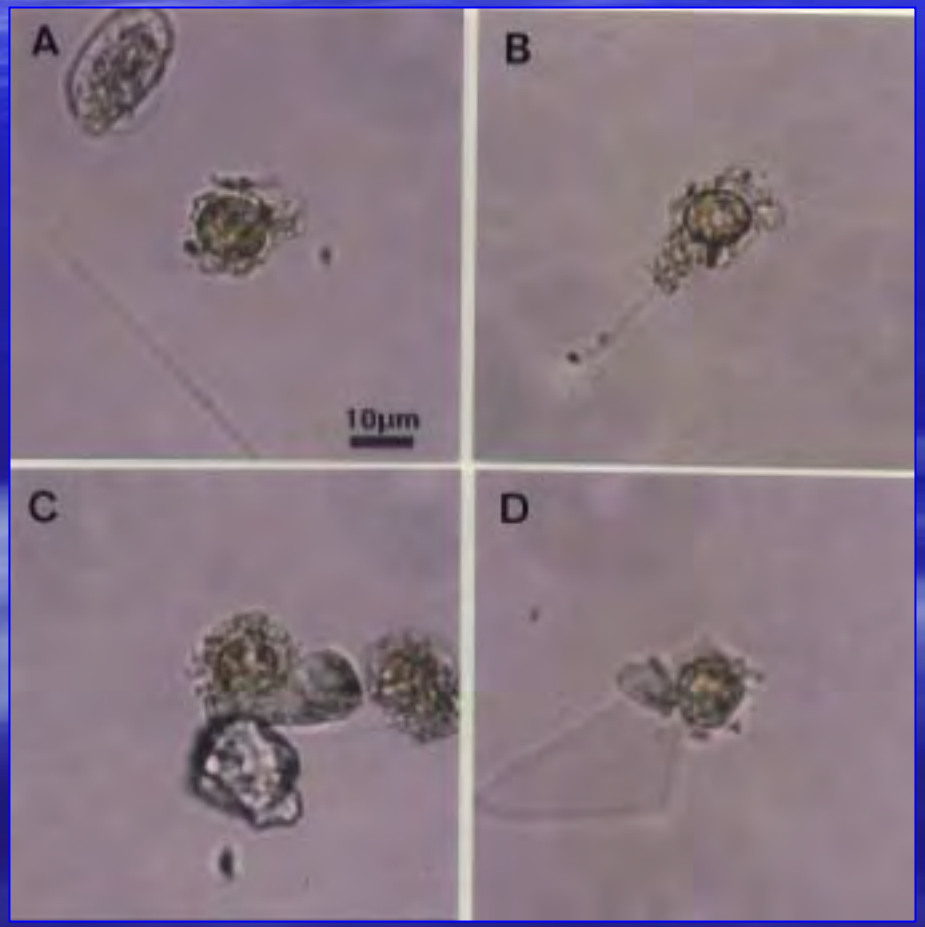
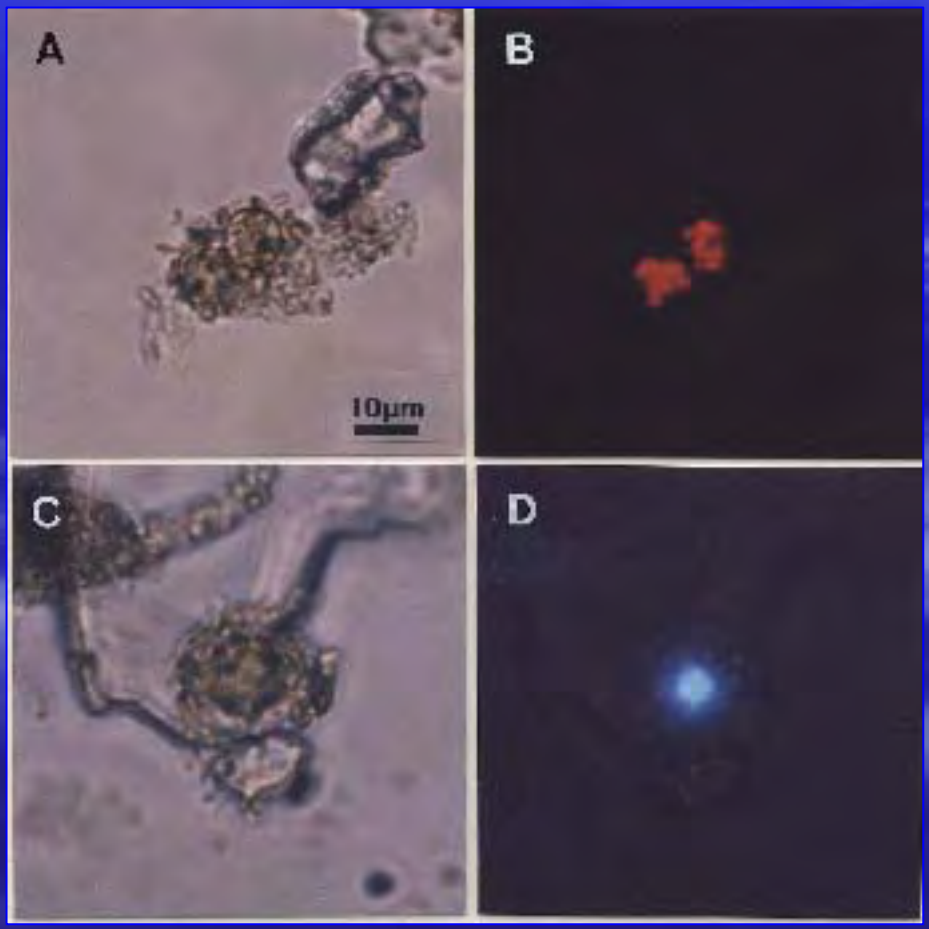


Fig.8. Temporal changes in the total live cysts of *Chattonella* and those with germinability in freshly collected sediment samples at 3 stations in Suo-Nada, during the summer of 1987. The changes of bottom water temperature are also shown. (After Imai 1990, modified)

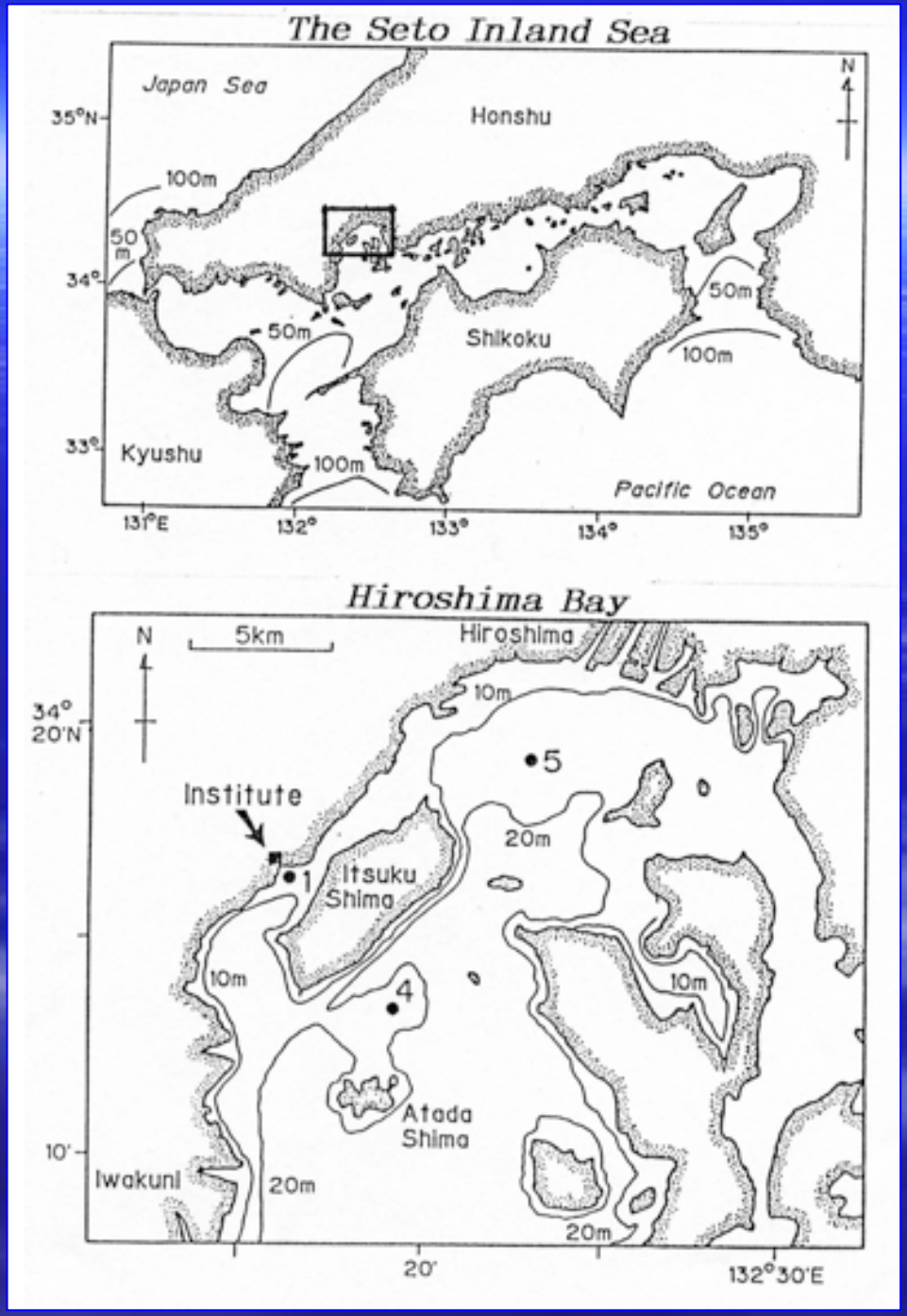
Dynamics of cysts and blooms in *Heterosigma akashiwo* in the Seto Inland Sea

Cysts of *Heterosigma akashiwo* discovered from the sediments of the Seto Inland Sea (Imai et al. 1993)





Sampling stations for H. akashiwo study in Hiroshima Bay, the Seto Inland Sea.



Distribution of cysts of *Heterosigma akashiwo* in bottom sediments of Hiroshima Bay, the Seto Inland Sea (Imai and Itakura 1991).

Cysts were abundant in the coast.

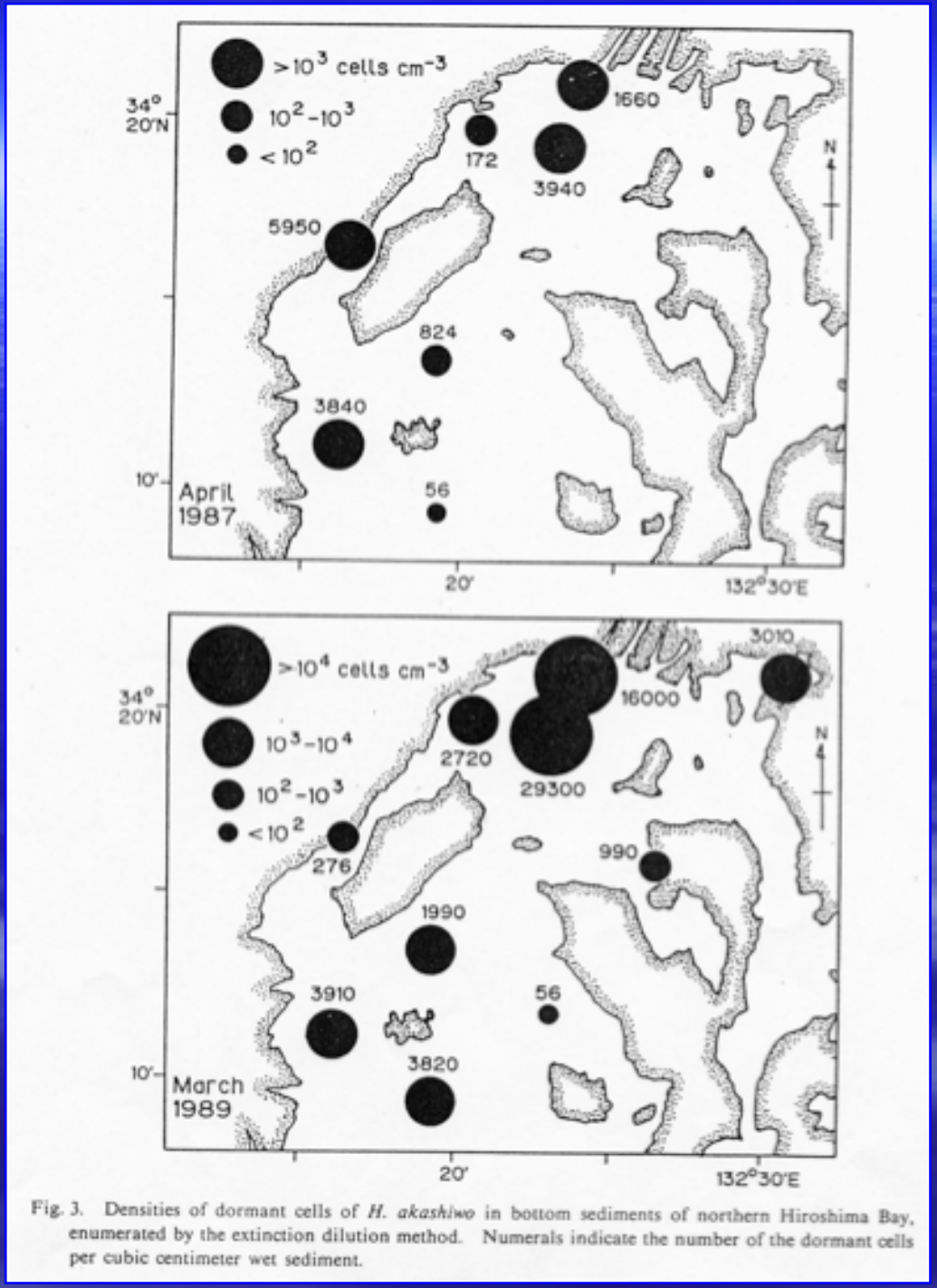


Fig. 3. Densities of dormant cells of *H. akashiwo* in bottom sediments of northern Hiroshima Bay, enumerated by the extinction dilution method. Numerals indicate the number of the dormant cells per cubic centimeter wet sediment.

Seasonal fluctuations of the highest cell densities of *H. akashiwo* cells in water columns at 3 stations in Hiroshima Bay (Imai and Itakura 1999).

Blooms in May ~ June with great seasonality !!

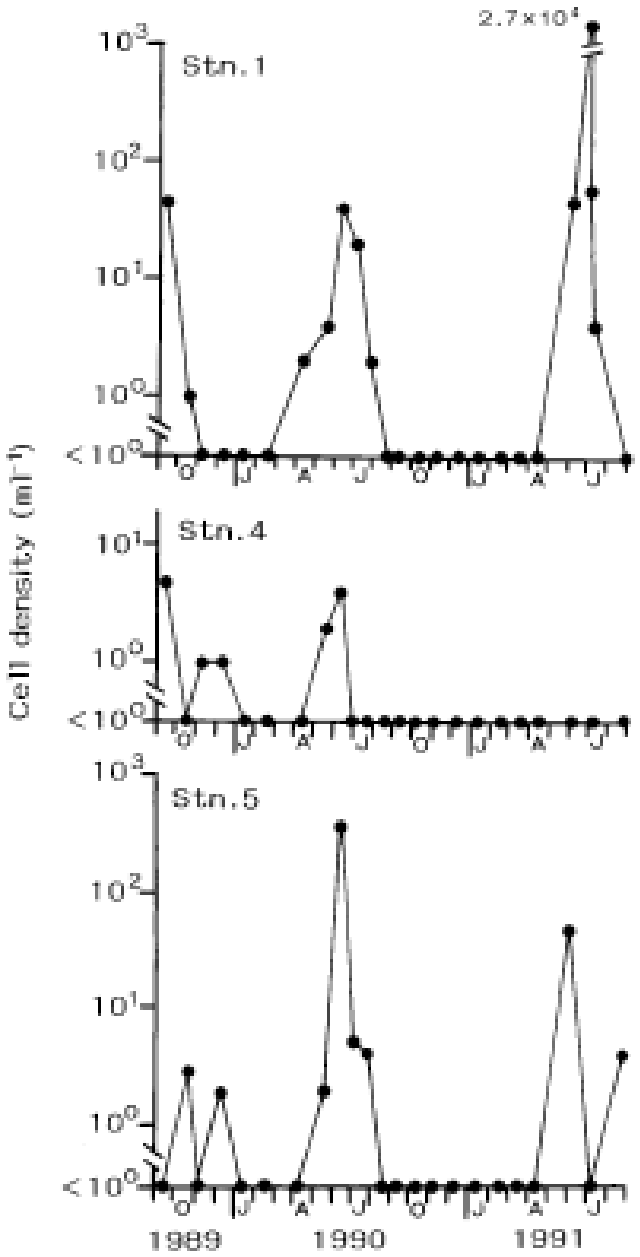


Fig. 3 *Heterosigma akashiwo*. Seasonal fluctuations in the highest densities of vegetative cells in the water columns at three stations in northern Hiroshima Bay during the research period

Seasonal fluctuations of germinable cysts (MPN) in the surface sediments (0 - 1cm) of Hiroshima Bay (Imai and Itakura 1999).

Many cysts are always physiologically germinable.

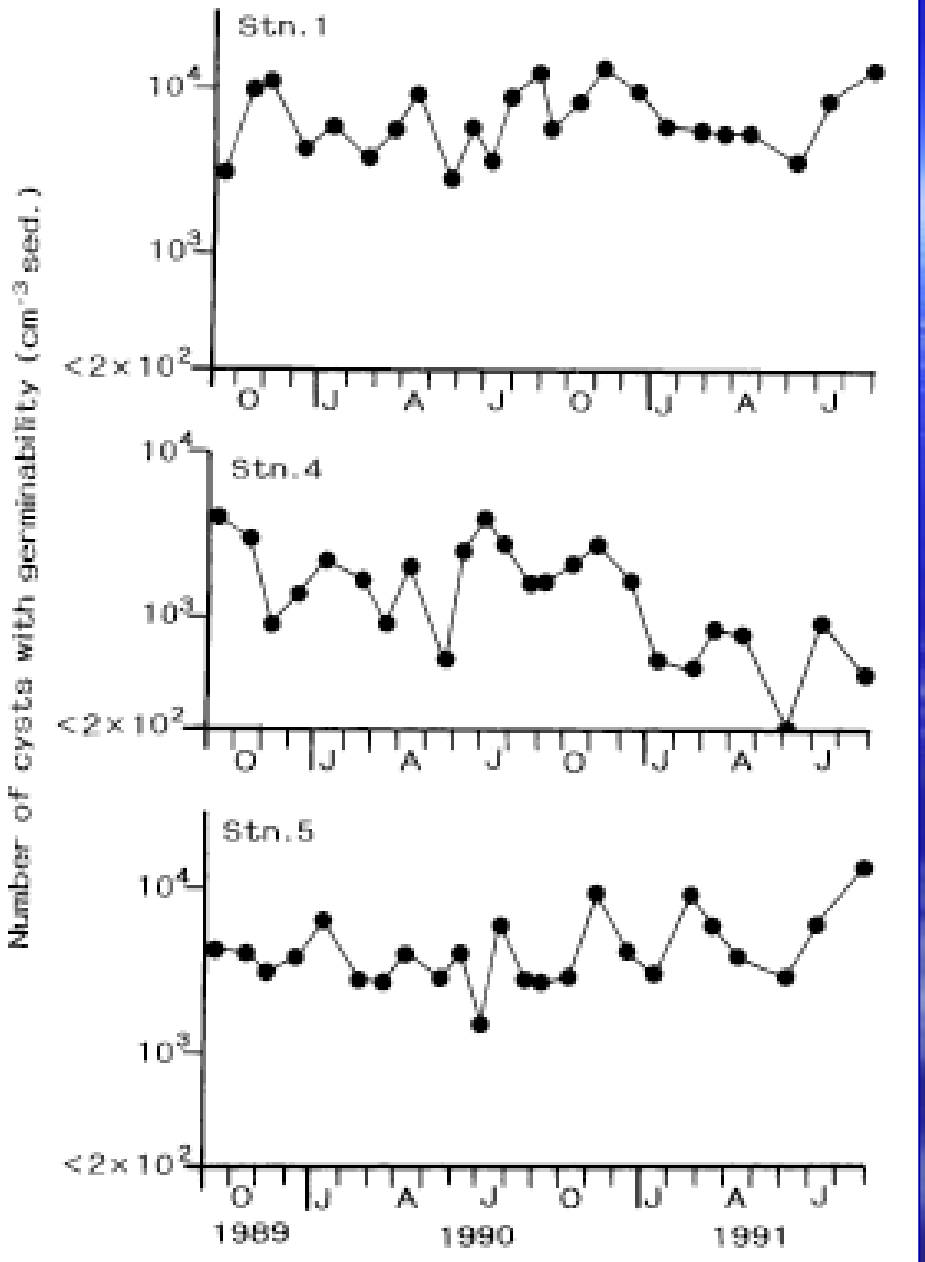


Fig. 5 *Heterosigma akashiwo*. Seasonal fluctuations in the number of germinable *H. akashiwo* cysts in surface sediments (top 1-cm layer) collected at three stations in northern Hiroshima Bay. Enumeration by extinction dilution method

Weekly changes in water temperature, *H. akashiwo* in surface water, and the total *H. akashiwo* live cysts in surface sediments (0-1cm) at Stn.1 in Hiroshima Bay (Imai and Itakura 1998). Total live cysts increased just after the peak of bloom and needed 1 week for maturation.

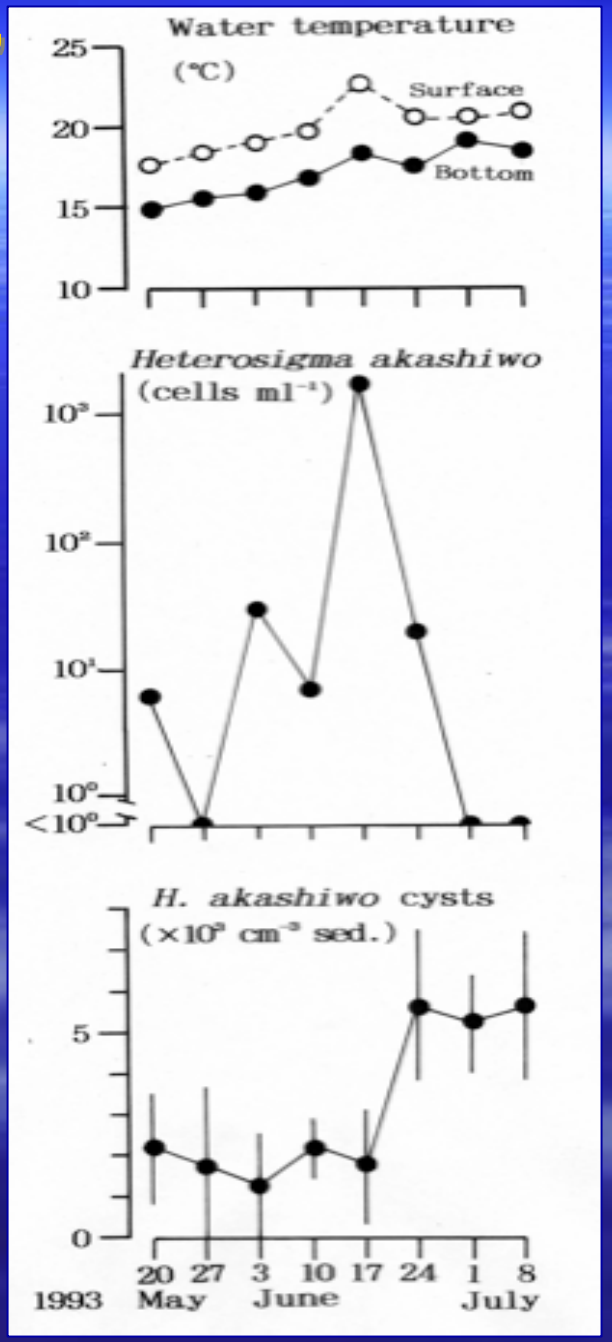
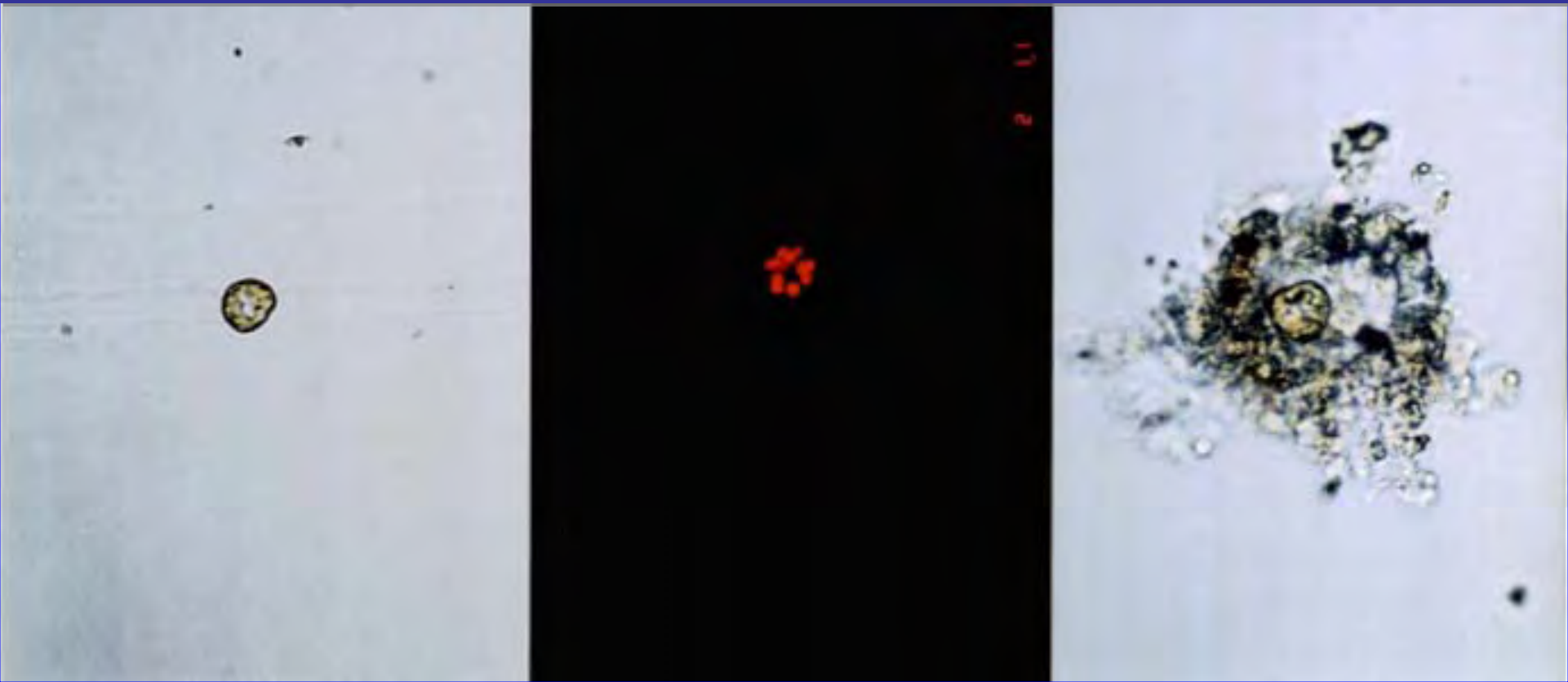


Table 1. *Heterosigma akashiwo*. Numbers of the total cysts enumerated by the direct count method and the germinable cysts enumerated by the extinction dilution method in surface (top 1-cm depth) sediments collected at St.1 on 24 June and 1 July, 1993.

Date	June 24	July 1
Total cysts	5676	5240
Germinable cysts (cm^{-3} wet sediment)	419	4223

1) Cyst formation was observed after the cessation of diurnal vertical migration at the final stage of *H. akashiwo* red tide in Hiroshima Bay.

2) Preencystment small cells were produced before cyst formation.



Cysts were formed in the dark after the cessation of diurnal vertical migration in *Heterosigma* bloom.

Cysts need 2 week for maturation (obtaining germination ability)

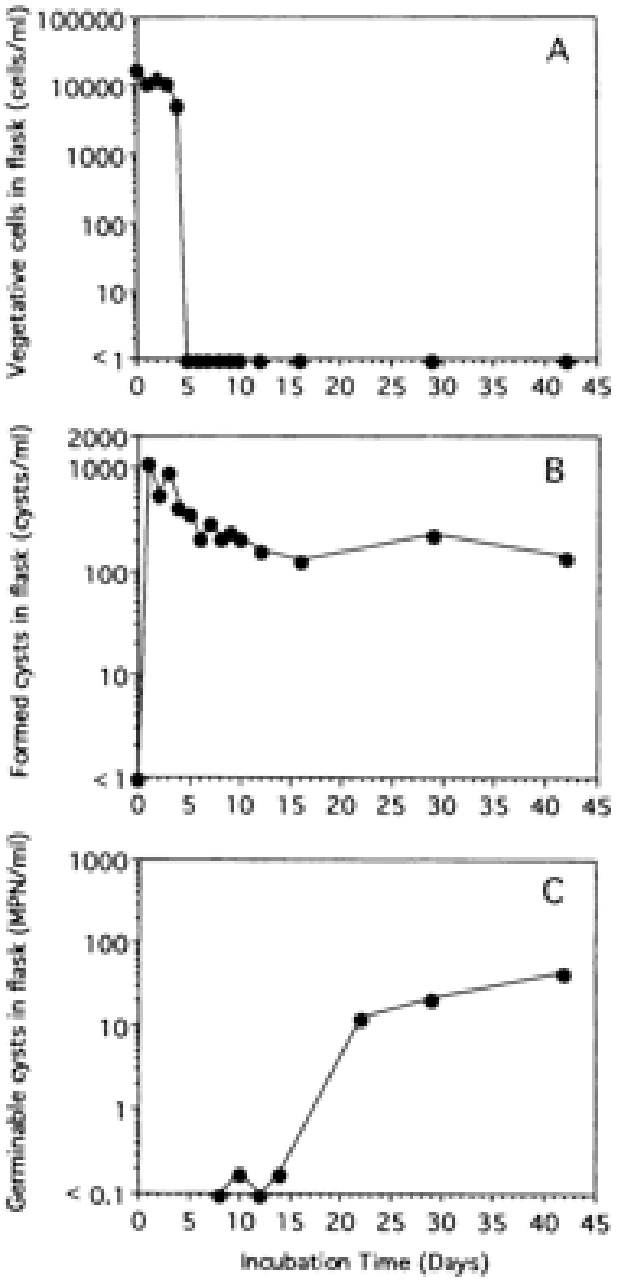


Fig. 2. Changes in the number of vegetative cells (**A**), newly formed cysts (**B**) and germinable cysts (**C**) in the culture of *H.akashiwo* (at 20°C in the dark) which derived from the natural population in the final stage of a red tide.

Summary

- *Chattonella* blooms
- 1. Summer red tides are seeded by the germination of relatively low number of cysts in sediments.
- 2. Cyst formation was induced at the end of blooms by nutrient depletion and completed in the dark.

- *Heterosigma* blooms
- 1. Red tides show great seasonality, and hence seeded by the germination of cysts in sea bottom.
- 2. Cyst formation was induced at the end of blooms and completed in the dark.
- 3. New cysts need ca. 2 weeks for maturation.