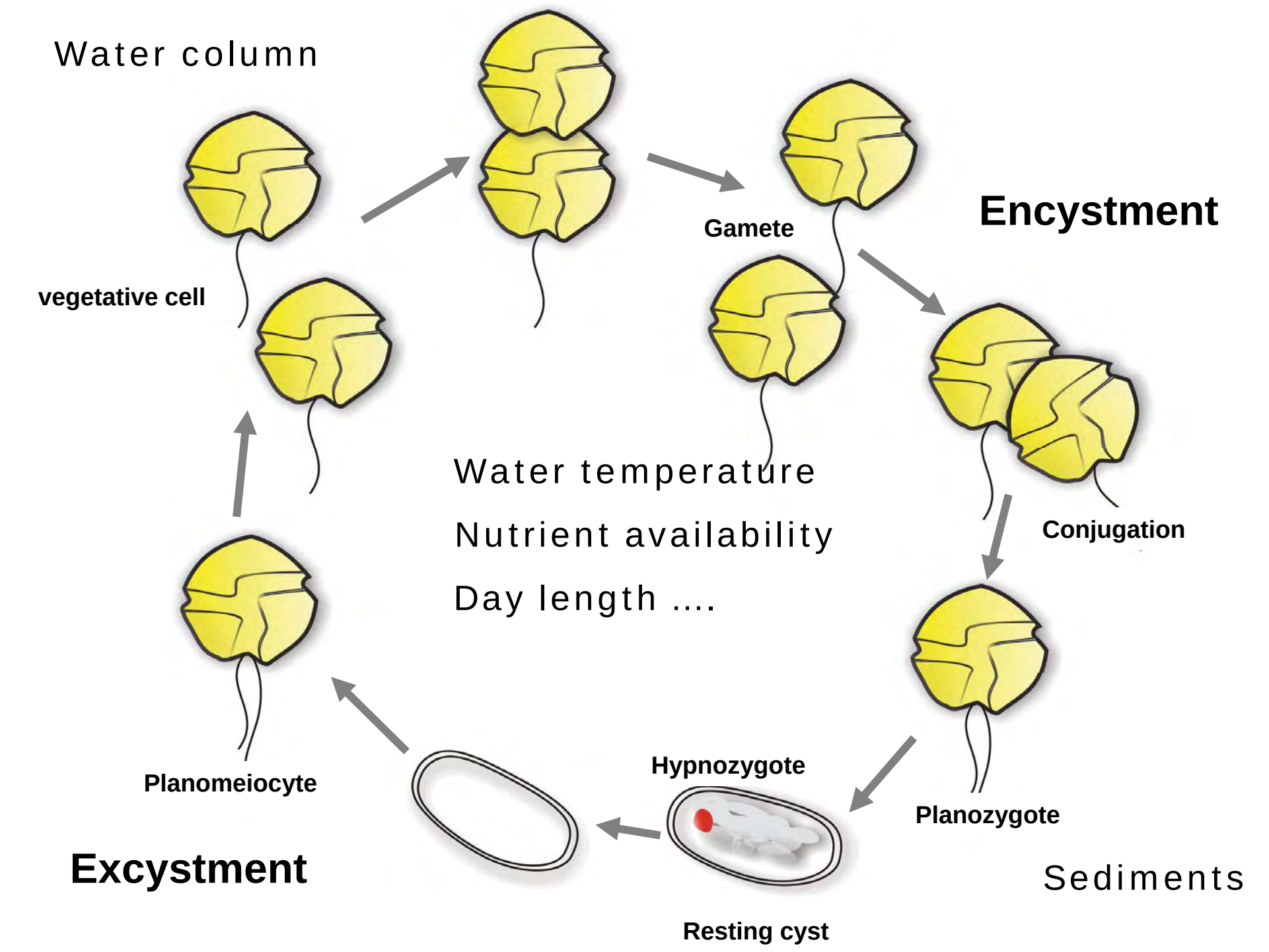
Dinoflagellate cyst assemblages as an indicator of changed nutrient levels in Korean and Japanese coastal areas

Hyeon Ho Shin, Yang Ho Yoon and Kazumi Matsuoka

Chonnam National University, Korea


Water column
vegetative cell
Gamete
Encystment
Water temperature
Nutrient availability
Day length ....
Conjugation
Planozygote
Hypnozygote
Resting cyst
Planomeiocyte
Excystment
Sediments

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Dinoflagellate Cysts as Indicators of Cultural Eutrophication in the Oslofjord, Norway

B. Dale[a], T. A. Thorsen[a] and A. Fjellså[b]

[a]*Department of Geology, University of Oslo, PB 1047 Blindern, N-0316 Oslo, Norway*
[b]*Statoil, N-4035 Stavanger, Norway*

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Eutrophication process recorded in dinoflagellate cyst assemblages — a case of Yokohama Port, Tokyo Bay, Japan

Kazumi Matsuoka*

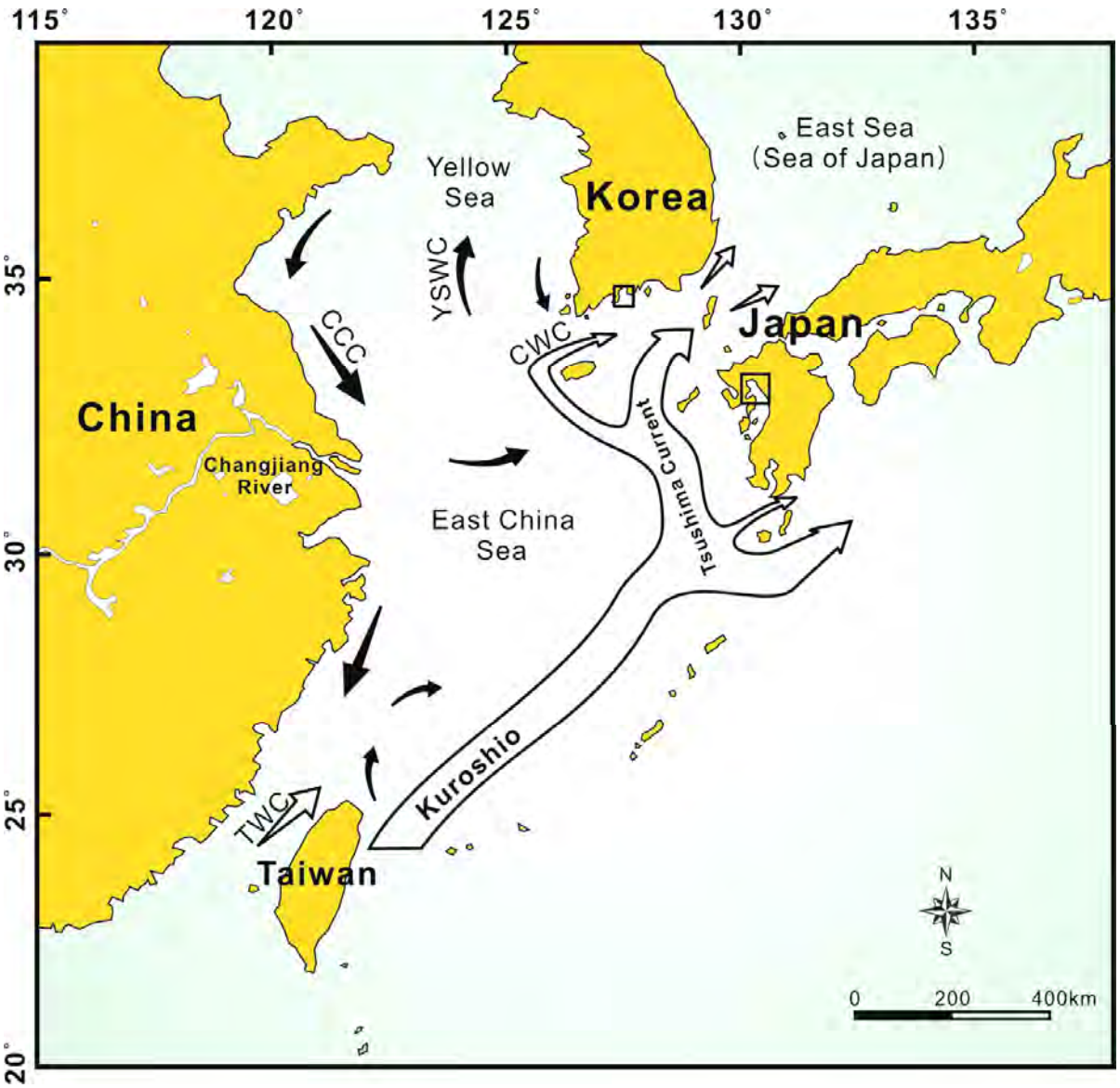
Laboratory of Coastal Environmental Sciences, Faculty of Fisheries, Nagasaki University, 1–14 Bunkyo-machi, Nagasaki 852-8521, Japan

This study aims to reconstruct enhanced nutrient levels in Korean and Japanese coastal areas for the past several decades based on review of literatures relating to dinoflagellate cysts as indicator of increase of nutrient levels.

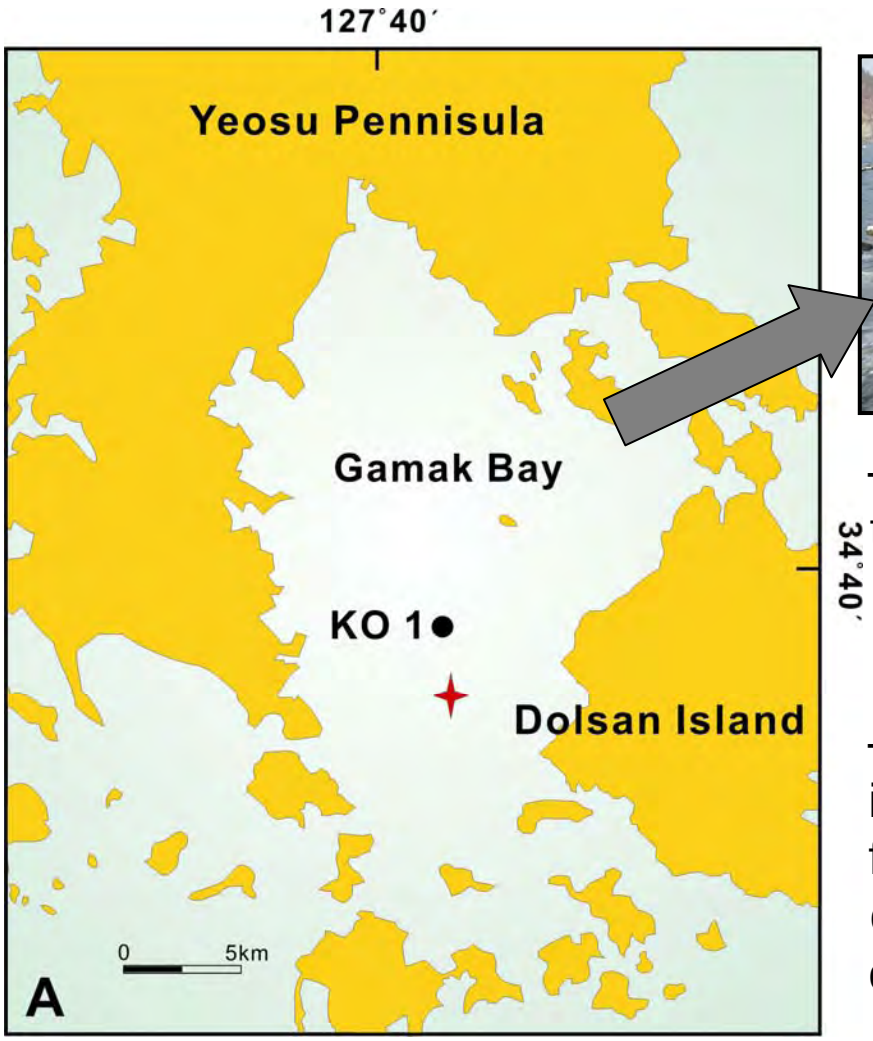
Cultural eutrophication in the inner Oslofjord, Norway was accompanied by corresponding changes in the dinoflagellate cyst record from bottom sediments which is considered to constitute a eutrophication signal, and in particular, the concentration of *Lingulodinium machaerophorum* was changed from < 5 to around 50% of the cyst assemblage.

Matsuoka (1999) concluded that the increase of heterotrophic cyst group is probably a good indicator for eutrophication, and these heterotrophic species were also responded in Tokyo Bay, Japan (Matsuoka et al. 2003) and Apponagansett Bay, Massachussetts, USA (Pospelova et al. 2002)

Study area


115°
120°
125°
130°
135°
35°
30°
25°
20°
Yellow Sea
Korea
East Sea
(Sea of Japan)
YSWC
CCC
CWC
Japan
China
Changjiang River
East China Sea
Tsushima Current
Kuroshio
TWC
Taiwan
N
S
0
200
400km

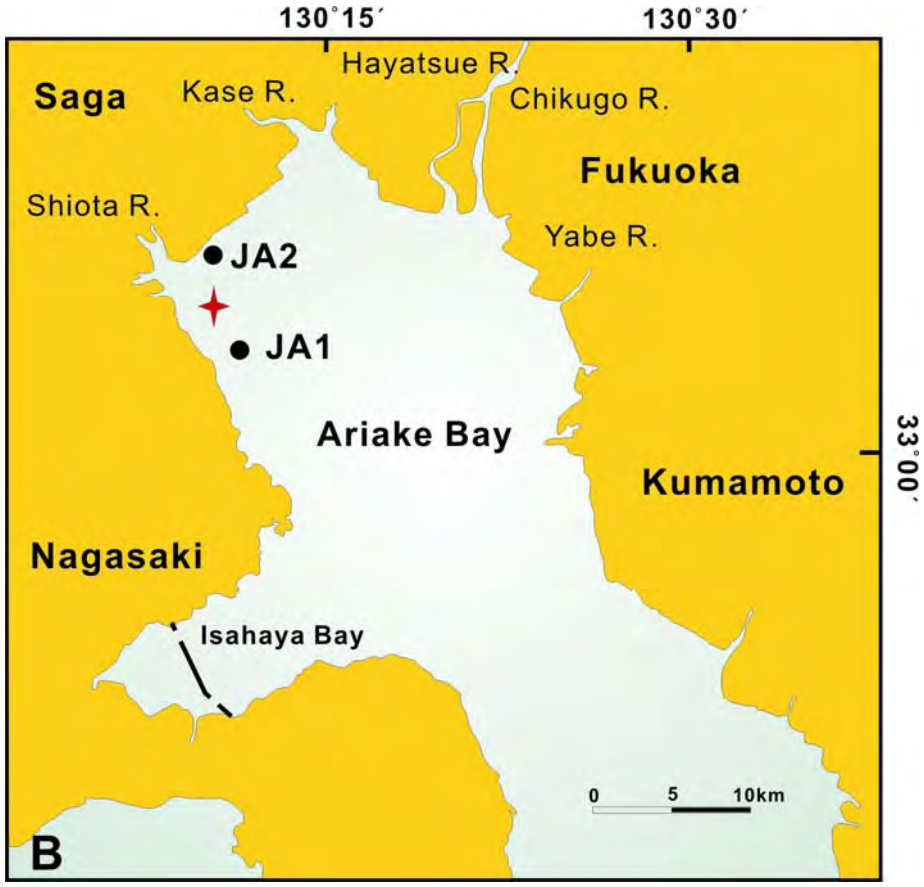
Gamak Bay



- Mussel and fish farms are situated throughout the bay.

- Aquaculture wastewaters and the increase of urban sewage discharged from Yeosu City have led to eutrophic condition. In addition, the occurrence of red tides also increased.

Ariake Bay

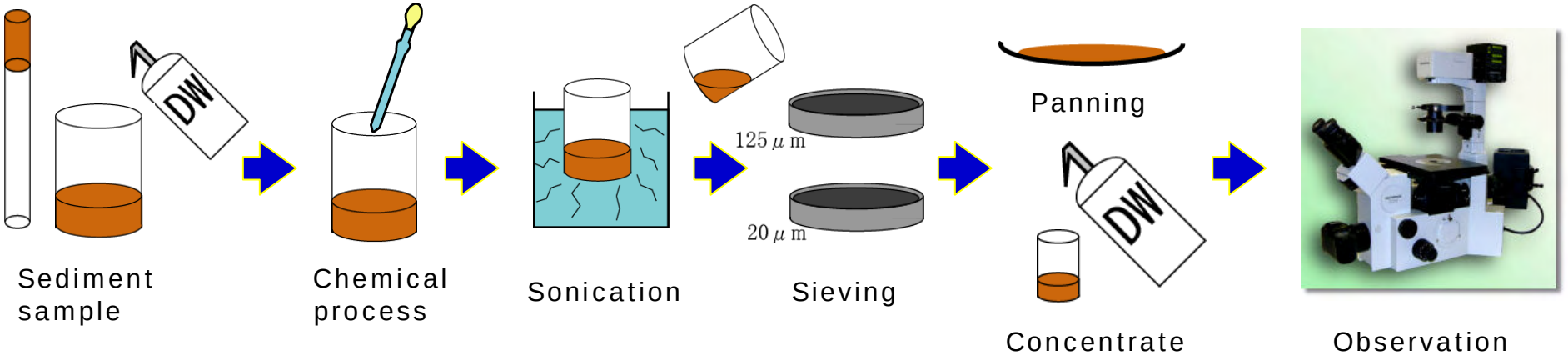


-Increase in reclamation of tidal flats and the construction of sea-dyke in Ariake Bay has caused severe environmental deterioration in change of tidal current, eutrophication, oxygen depletion and so on.

- Marine productivity such as fish, shellfish and others was also decreased from the 1980s to the recent years.

Materials and Methods

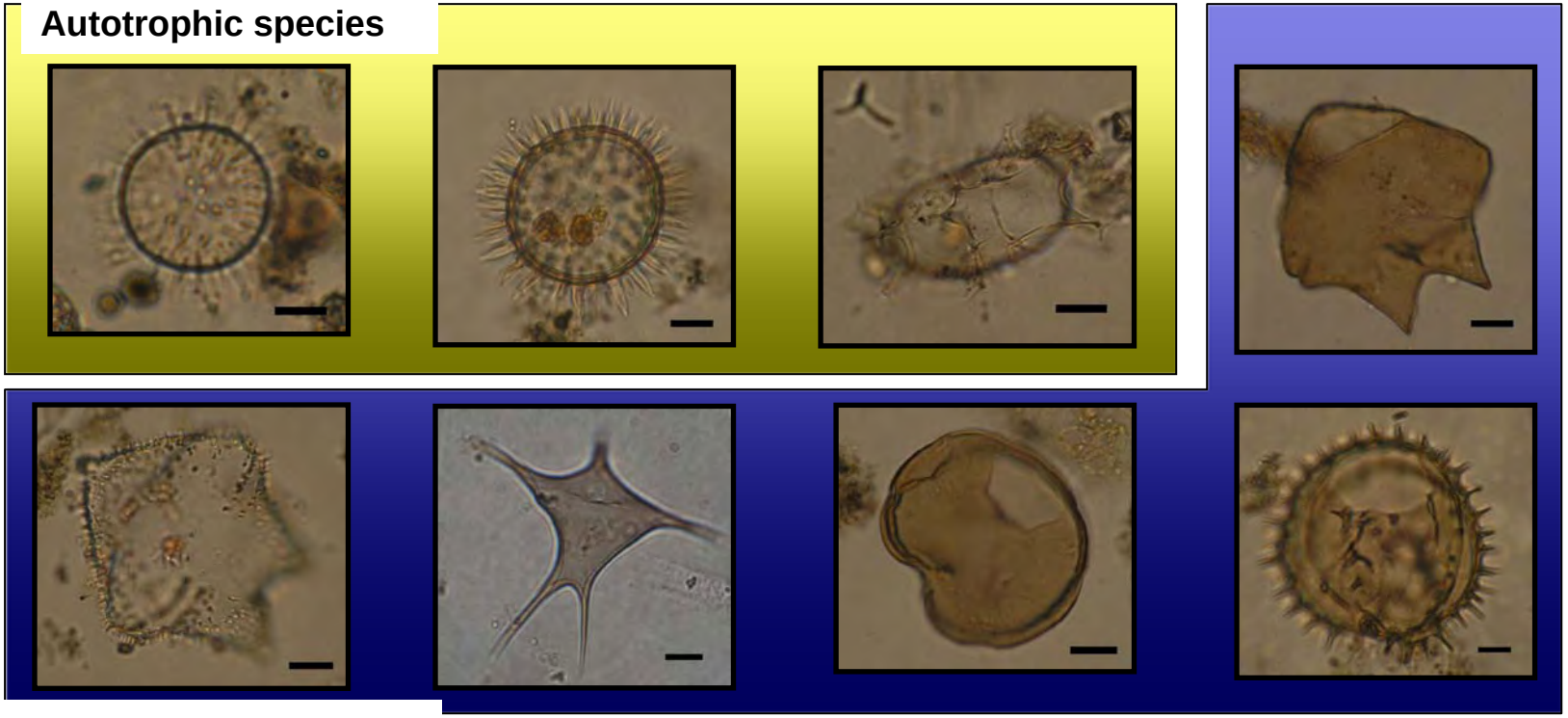
- One core in Gamak Bay (KO1) was obtained with polycarbonate pipe of 10 cm in diameter by the scuba divers in May 2006. Two cores in Ariake Bay (JA1 and JA2) were collected with Geo-slicer in September 2005 and October 2006, respectively.



- The samples were processed with the palynological method suggested by Matsuoka and Fukuyo (2000).

- The depositional ages of each subsample were estimated by ^{210}Pb dating method. According to the result, the sedimentation rate at the KO1 was in 2.5 cm / year and that at JA1 was in 0.75cm / year. Since the upper part of the JA2 core was disturbed, it was impossible to determine the depositional ages. However, the sandy layer of 60-71 cm depth speared out artificially for reconstruction of fishing grounds was nearly 1987 AD.

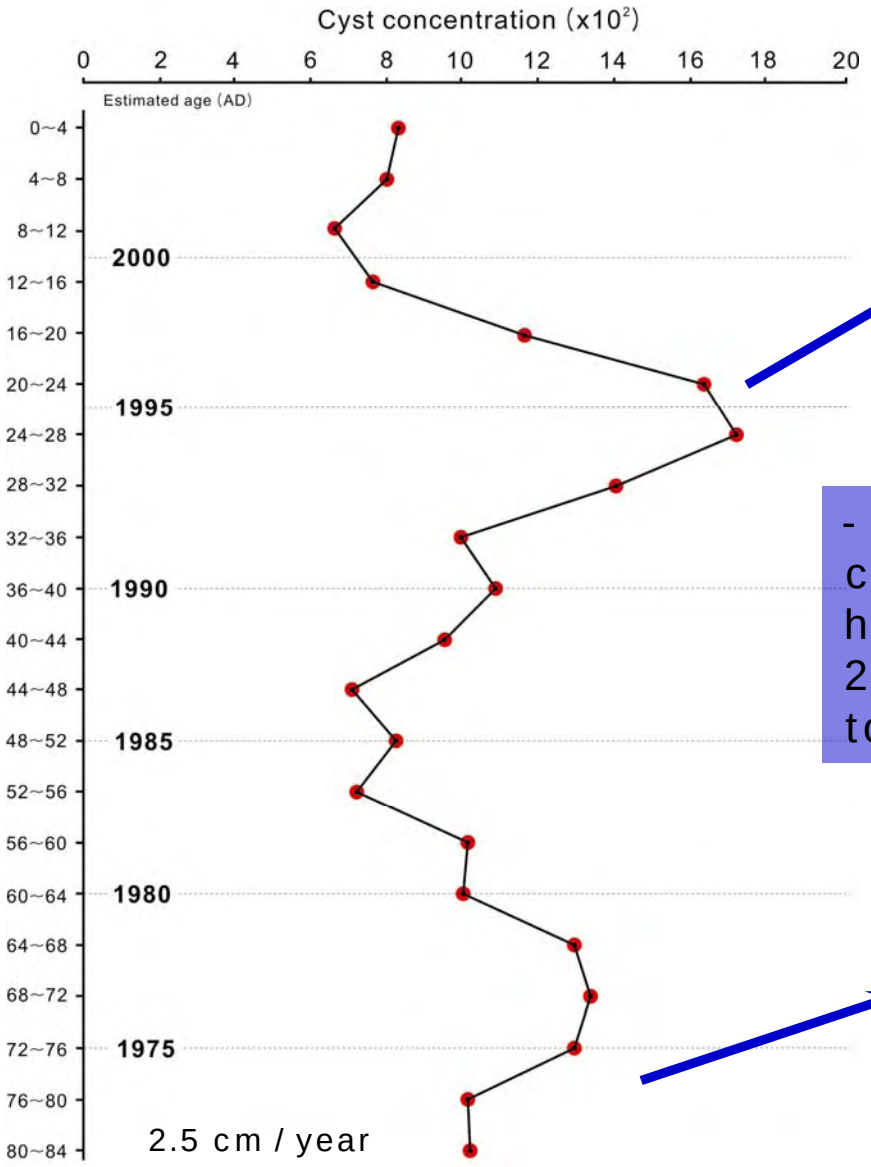
Results and Discussion



- A total of 30 and 37 dinoflagellate cyst taxa was identified in Gamak Bay and Ariake Bay, respectively.

- The dinoflagellate cyst assemblages in Gamak Bay are characterized by high concentrations of heterotrophic species, whereas Ariake Bay cores (JA1 and JA2) are characterized by high concentrations of autotrophic species, particularly *Lingulodinium machaerophorum*

Relationship between dinoflagellate cyst assemblages and environmental changes in Gamak Bay



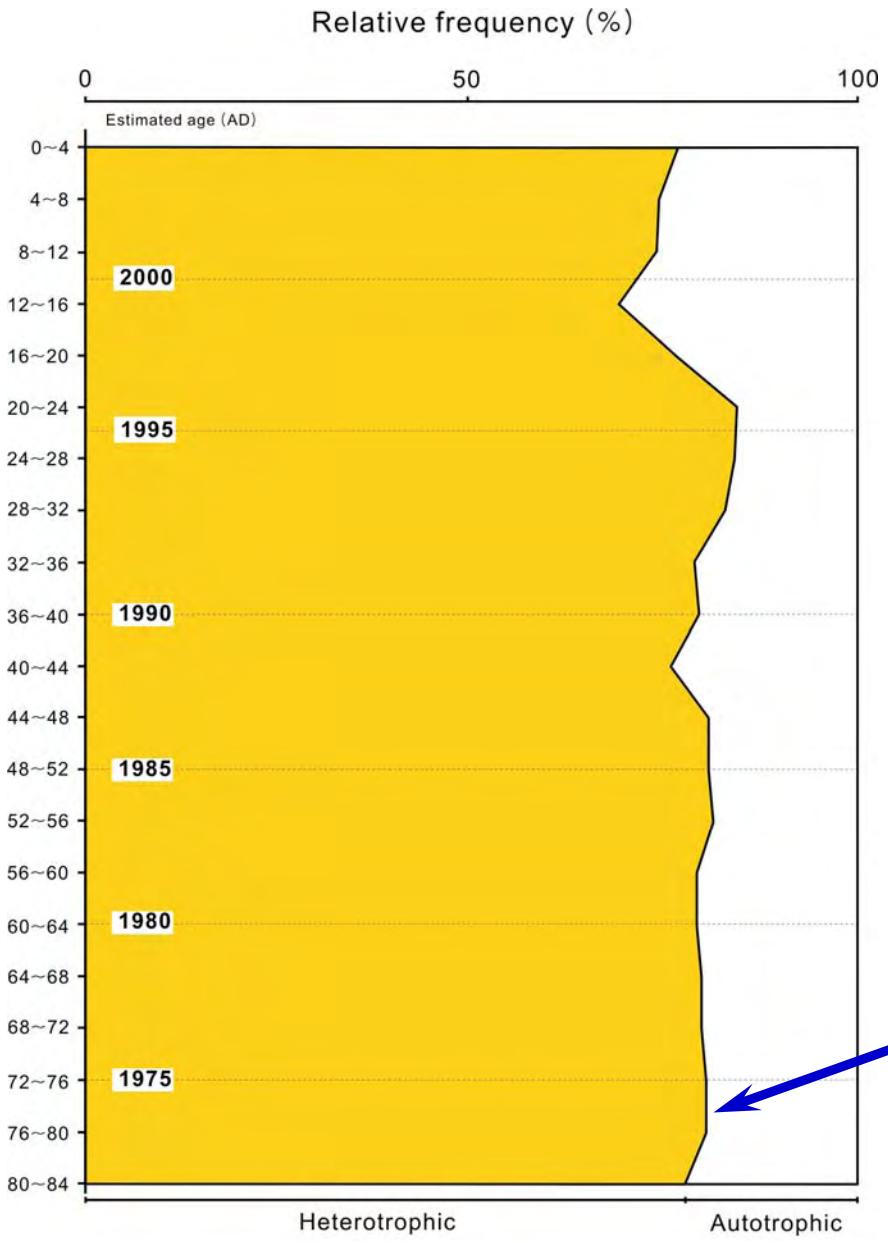
- The occurrences of red tides caused by dinoflagellates have rapidly increased since 1990s (Lee and Kim, 2006).

- The total concentration of dinoflagellate cysts ranged from 655 to 1725 cysts g^{-1}, the highest cyst concentration was recorded at 24 to 28 cm depth and the lowest was at 8 to 12 cm depth

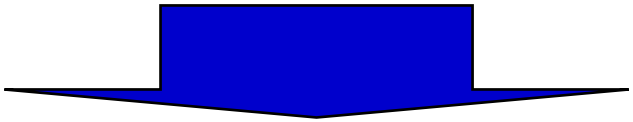
- Development and urbanization of the Yeosu Peninsula were accelerated since the 1970s due to an industrial policy driven by the Korean Government.

Fig. Changes in the total dinoflagellate cyst concentrations at KO1

Relative abundances (%) of autotrophic and heterotrophic dinoflagellate cysts



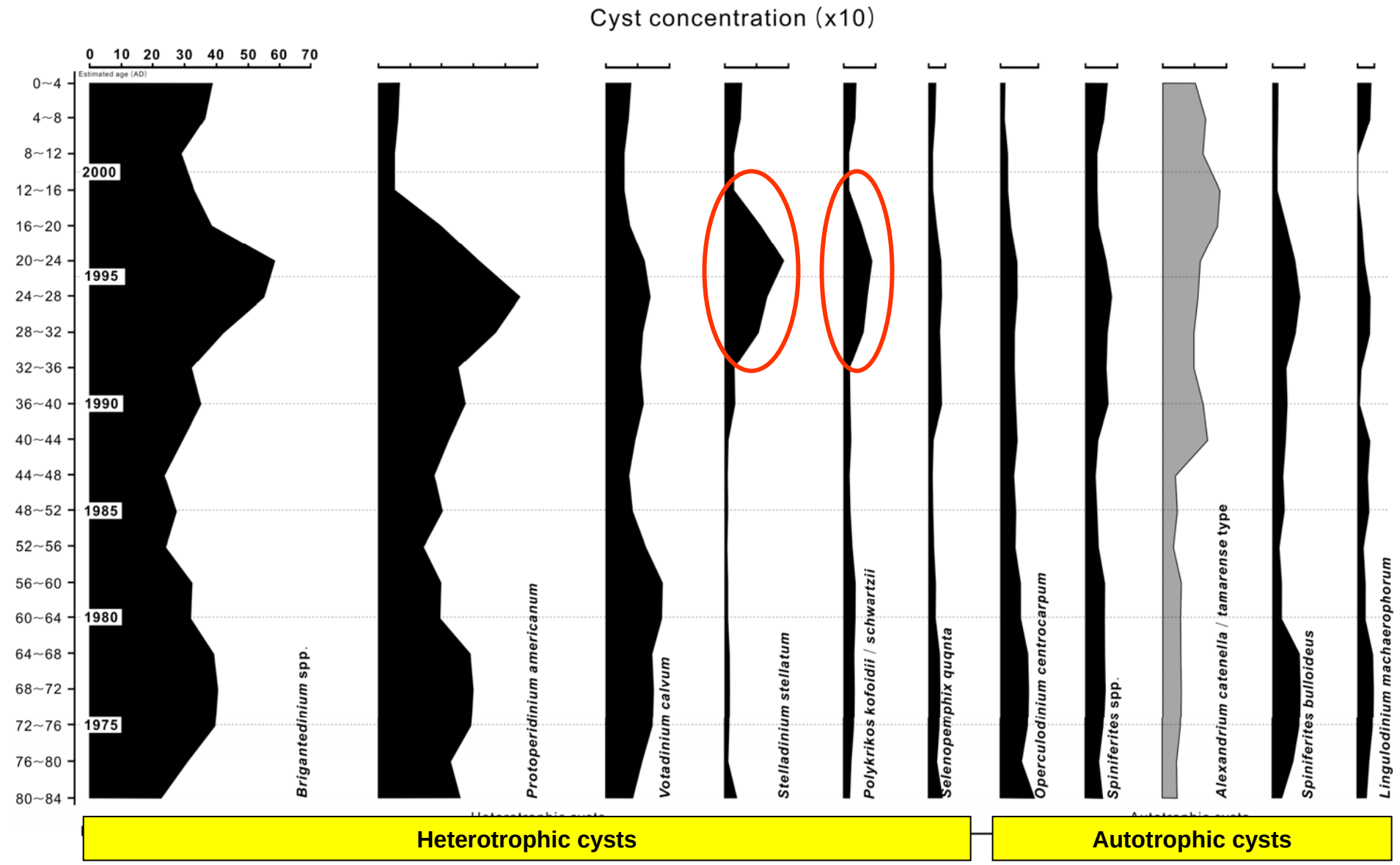
Changes in total cyst concentrations and proportions of heterotrophic cysts



Dinoflagellate cyst assemblages from 1970s to the present may reflect the past eutrophicated conditions in Gamak Bay

According to Kim (2002), COD and DIN concentrations in surface waters were increased from the mid of 1970s

Concentrations of selected dinoflagellate cyst taxa at KO1



Relationship between dinoflagellate cyst assemblages and environmental changes in Ariake Bay

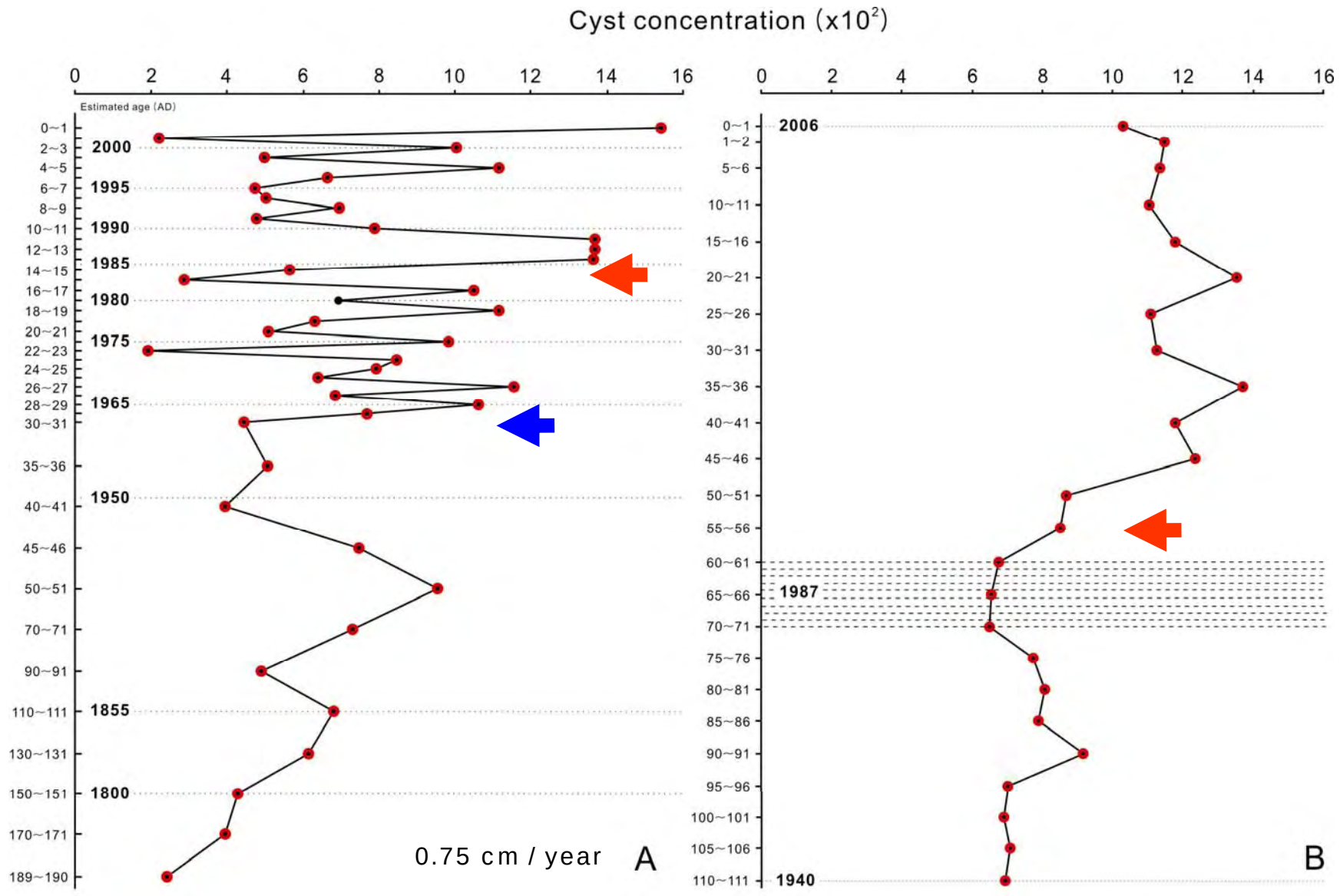
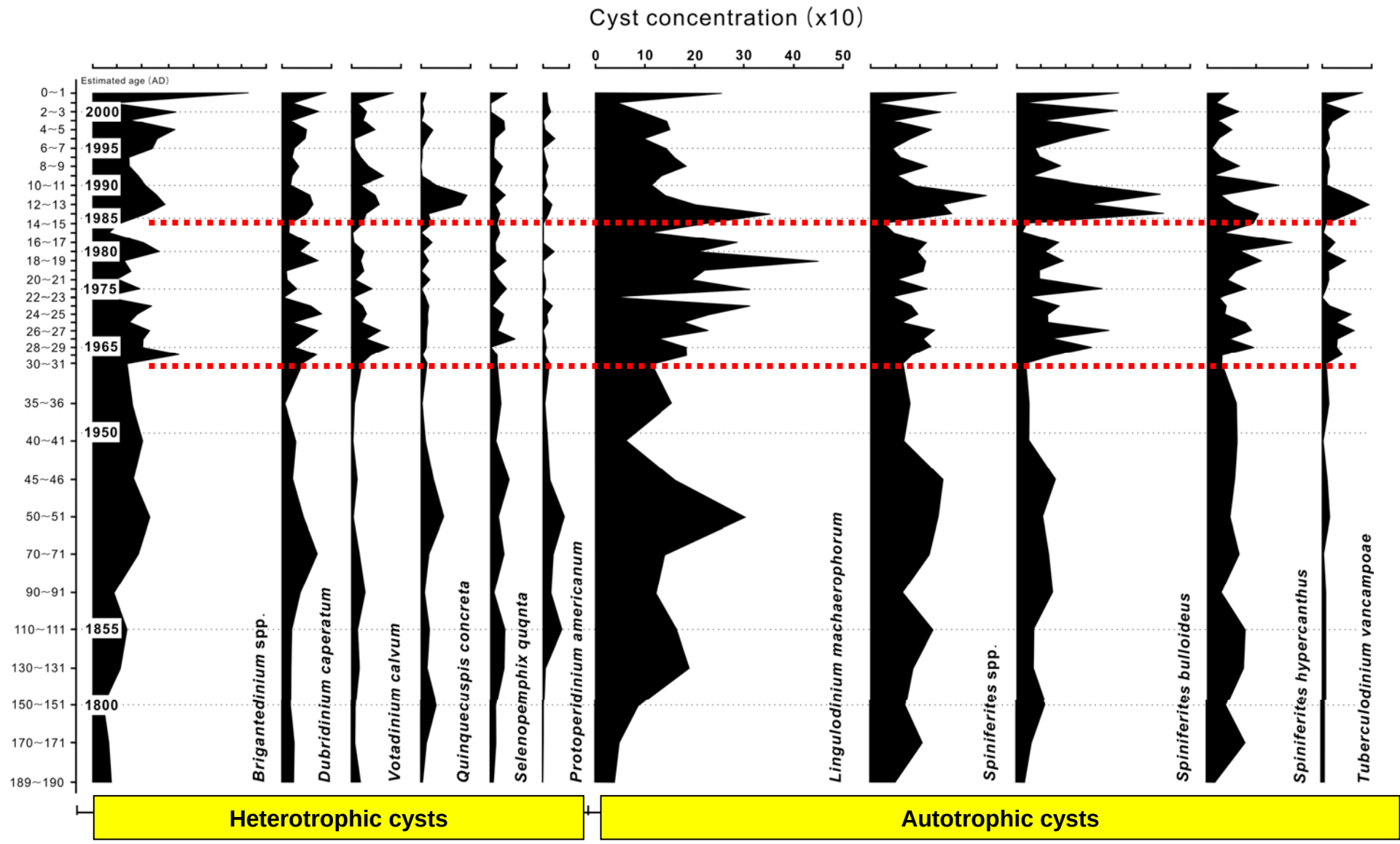
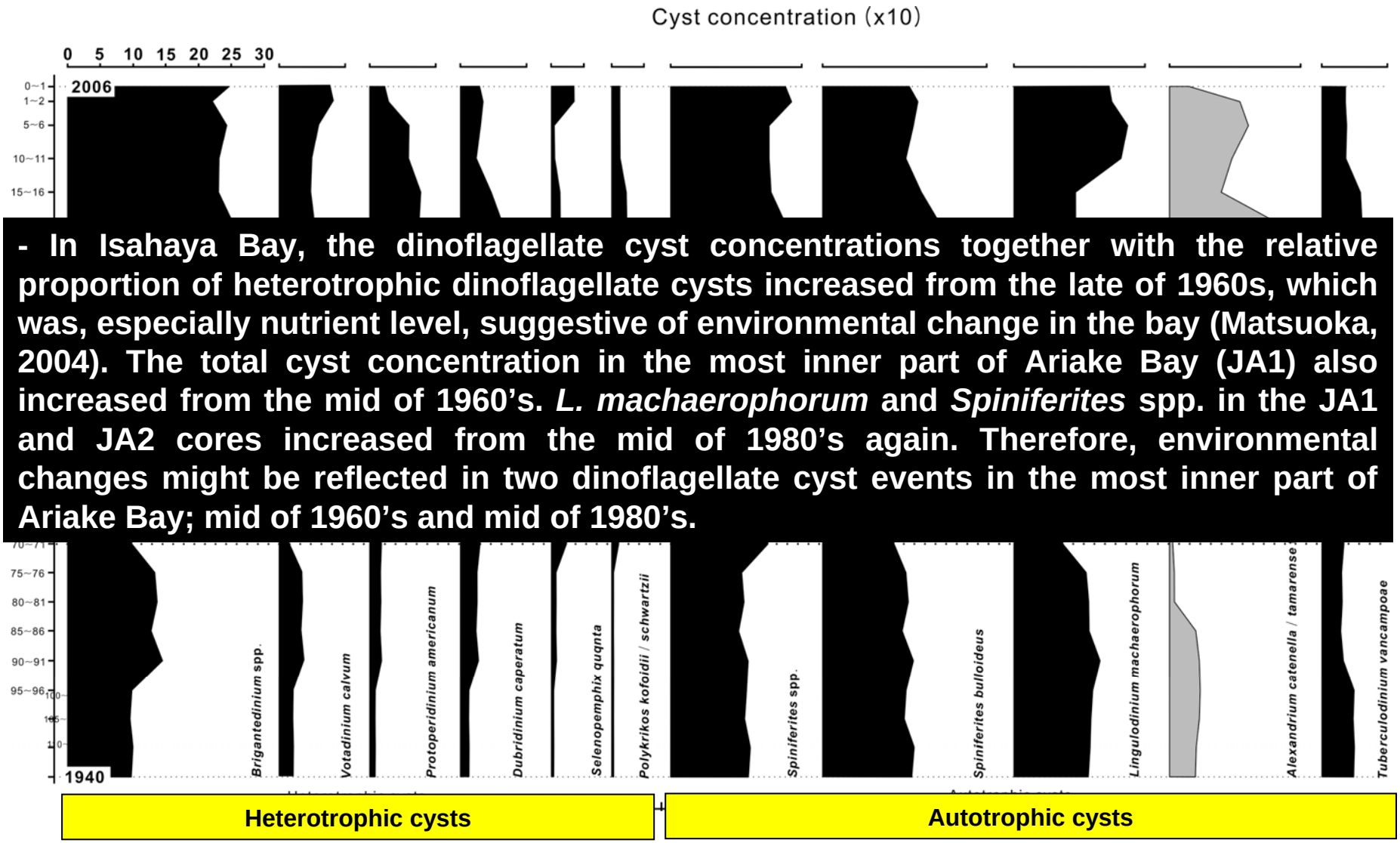


Fig. Changes in the total dinoflagellate cyst concentrations at JA1 (A) and JA2 (B).

Concentrations of selected dinoflagellate cyst taxa at JA1

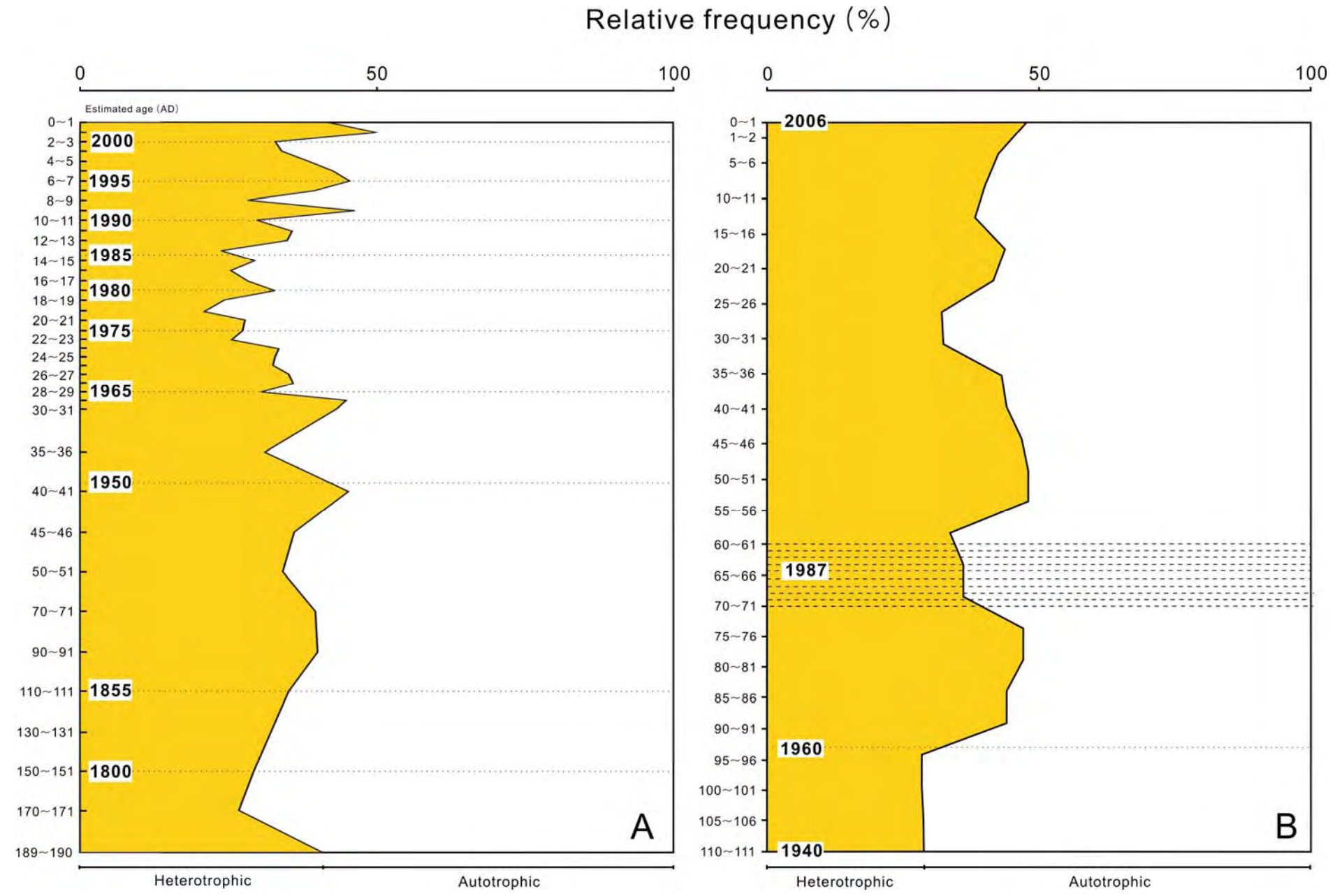


Concentrations of selected dinoflagellate cyst taxa at JA2



- In Isahaya Bay, the dinoflagellate cyst concentrations together with the relative proportion of heterotrophic dinoflagellate cysts increased from the late of 1960s, which was, especially nutrient level, suggestive of environmental change in the bay (Matsuoka, 2004). The total cyst concentration in the most inner part of Ariake Bay (JA1) also increased from the mid of 1960's. *L. machaerophorum* and *Spiniferites* spp. in the JA1 and JA2 cores increased from the mid of 1980's again. Therefore, environmental changes might be reflected in two dinoflagellate cyst events in the most inner part of Ariake Bay; mid of 1960's and mid of 1980's.

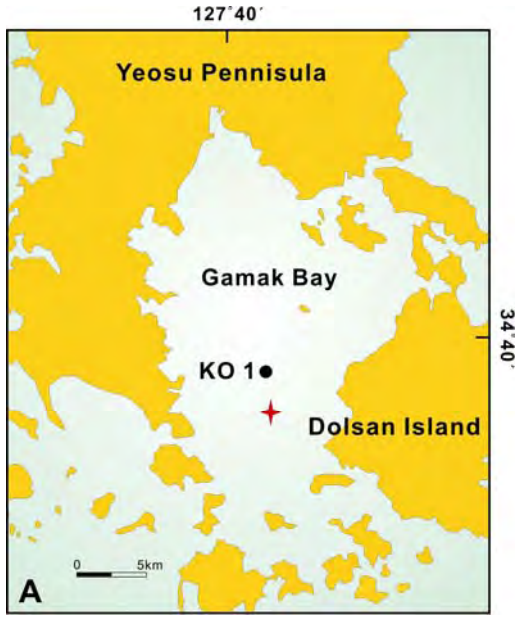
Relative abundances (%) of autotrophic and heterotrophic dinoflagellate cysts at JA1 (A) and JA2 (B)



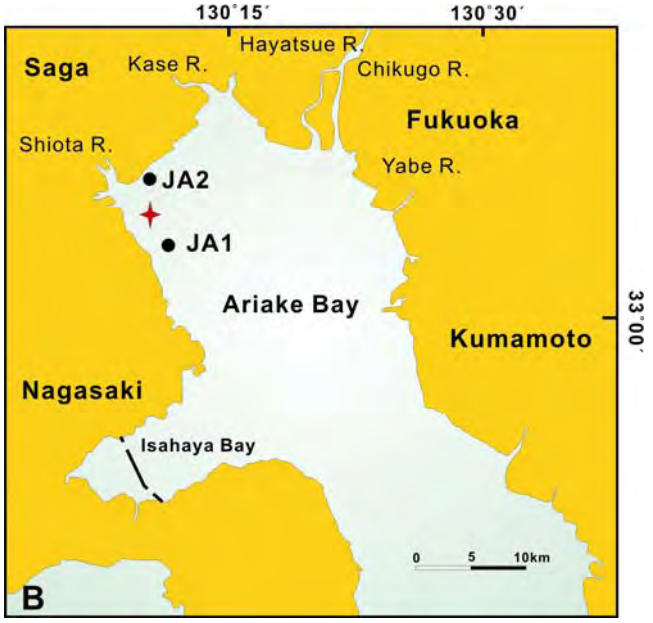
Comparison of dinoflagellate cysts as indicators of nutrient level changes in Gamak and Ariake Bays

- The dinoflagellate cyst assemblages in Gamak Bay are characterized by high concentrations of heterotrophic species

- Ariake Bay cores are characterized by high concentrations of autotrophic species, especially *Lingulodinium machaerophorum*.



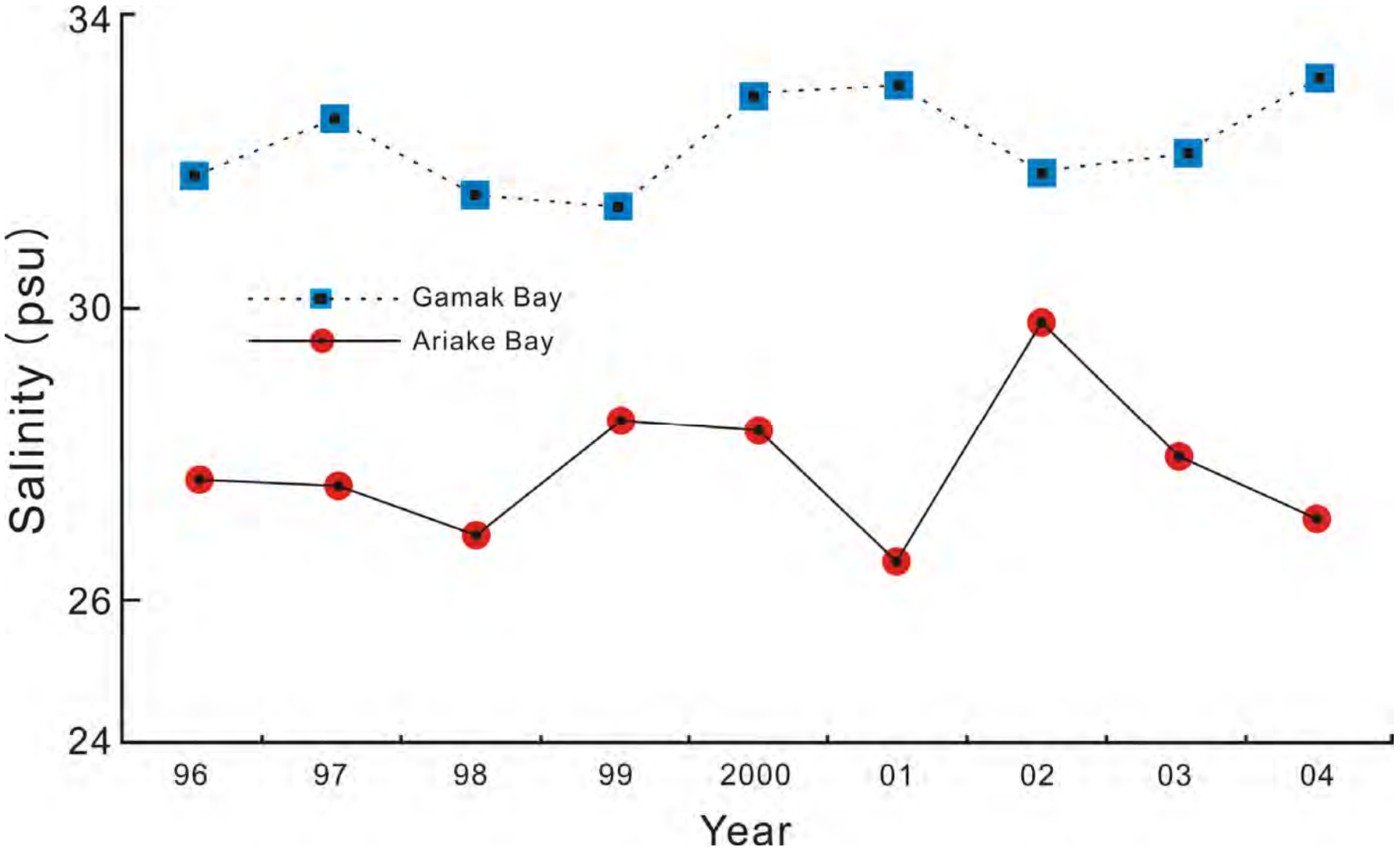
Gamak Bay is mainly affected by the intrusion of seawater, as there are no surrounding rivers.



The most inner part of Ariake bay is strongly affected by the intrusion of freshwater from several rivers such as Chikugo River, Rokkaku River and others

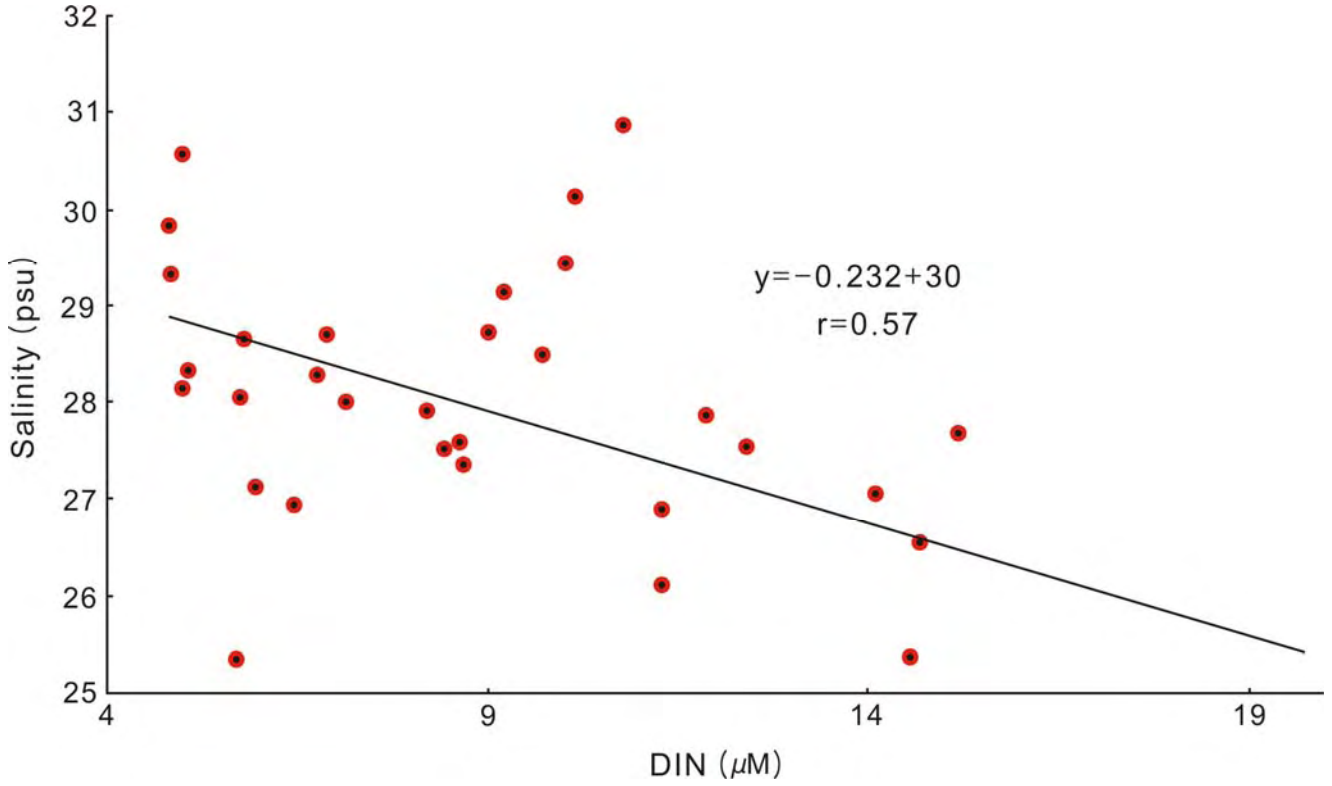
The two bays are different in salinity levels and mechanisms of nutrient enrichment.

Temporal variations of salinity in surface seawater in Gamak and Ariake Bays



According to Vink et al. (2000), high abundance of *Lingulodinium machaerophorum* is related to low salinity (in the range 23-30psu).

- According to Yokouchi et al. (2005), the nutrients (nitrogen or phosphorus) in Ariake Bay are generally related to the intrusion of fresh water from the rivers.



-While, according to Lee and Kim (2006), and Noh et al. (2006), the limiting nutrient for the growth of dinoflagellates in Gamak Bay is nitrogen, which was supplied in high concentration by the inflow of sewage and aquaculture activities.

Gamak and Ariake Bays possess different environmental characteristics as a result of unique nutrient enrichment mechanisms.

Conclusion

- Dinoflagellate cyst assemblages from 1970s to the present reflected the past eutrophicated conditions in Gamak Bay, although this study can not establish the dinoflagellate cyst assemblages before 1970 as the sediment samples represents the past 35 years.

- The total cyst concentration in the most inner part of Ariake Bay (JA1) increased from the mid of 1960's. *Lingulodinium machaerophorum* and *Spiniferite bulloideus* in the JA1 and JA2 cores increased from the mid of 1980's again. Therefore, environmental changes might be reflected in dinoflagellate cyst assemblages in the most inner part of Ariake Bay; mid of 1960's and mid of 1980's.

- The signals of nutrient levels encoded in dinoflagellate cyst assemblages may vary with different estuarine types like those in Tokyo Bay of Japan and the Oslofjord of Norway.

Thank you for your attention