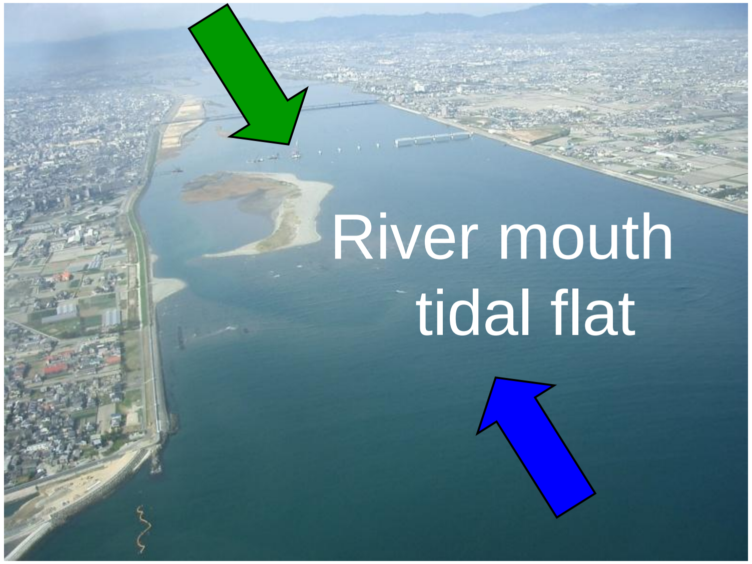
Relationships between food web structure of benthic community and origin of sedimentary organic matter in tidal flats of two river mouths in Shikoku Island, Japan

Sosuke Otani[1,3], Yasunori Kozuki[1], Kengo Kurata[2], Shigefumi Nakai[1], Hitoshi Murakami[1]

1：The University of Tokushima， 2：Shimane University,
3：Kyoto University

Background



River mouth tidal flats receive not only wave action, and tidal changes but also sediment discharge and terrestrial organic loads from the upper streams of rivers.

They have various fluctuations and complicated characteristics.

Stable isotope

- Stable carbon isotope is useful tool for analysis origin and transport process of organic matter. The $\delta^{13}C$ value of sediments have been widely used to elucidate the source of organic matter.

- Stable carbon and nitrogen isotopes is a powerful tool for defining material flows and food web structures in ecosystems.

Objective

The characteristics of sediment in tidal flats are not uniform. It is assumed that spatial distribution of sediment characteristics influences food web structure, and food web structure may be different among the different sediment characteristics.

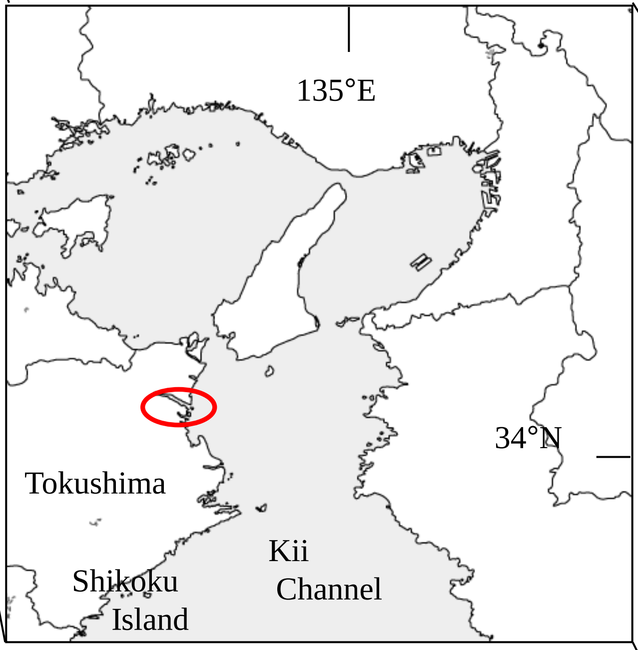
- To estimate the origin of sediment
- To elucidate food web structure

using carbon and nitrogen stable isotope ratios in 2 tidal flats of river mouth.

The relationship between origin of sedimentary organic matter and food web structure

Investigation area

Shikoku Island,
in Japan



Tokushima prefecture

Yoshino river (56 ha)
Katsuura river (9 ha)

Sample collection

Investigation：October, 2005

Sampling station: 50 in Yoshino river

32 in Katsuura river

- Sediment sample: (Top 1-mm surface)

  Chl.*a*, Stable carbon isotope ratio

- Benthic consumer

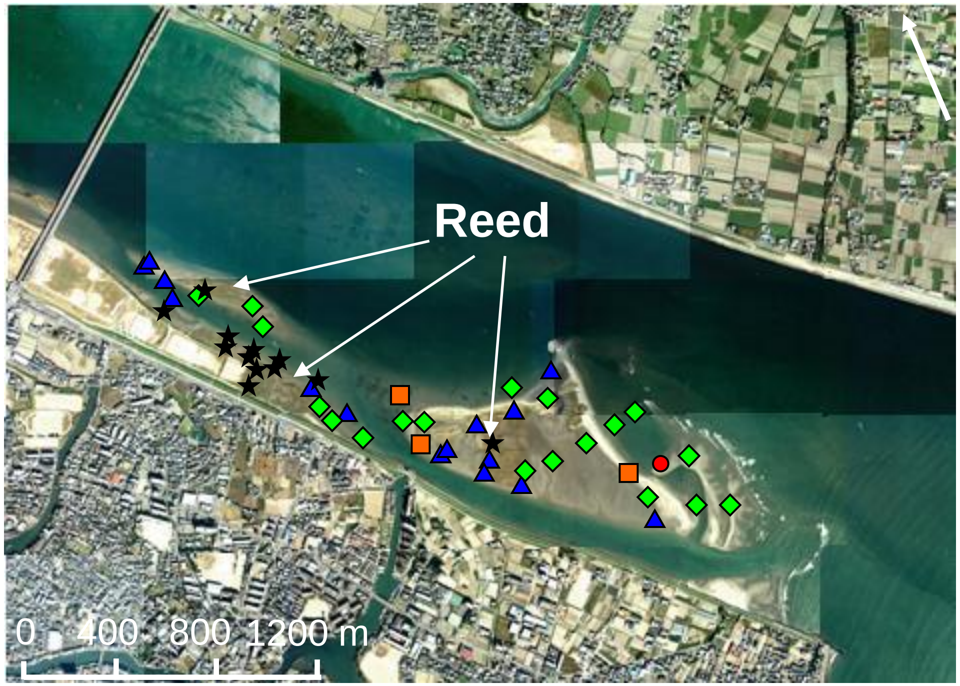
- Potential food source

  Benthic diatom (MPB), Surface sediment (SOM), Detritus, Common reed (Reed),

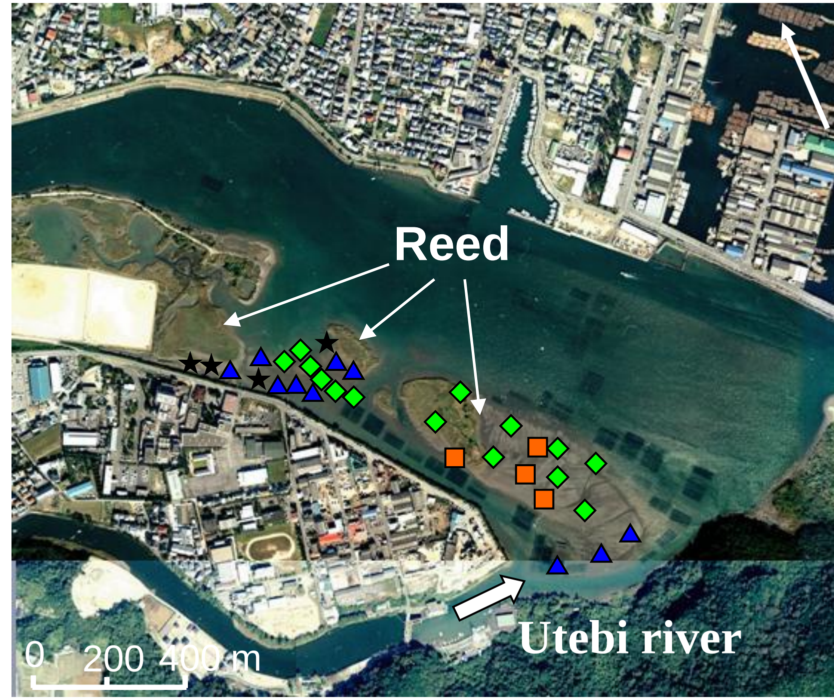
  Terrestrial particulate organic matter (TPOM)

  Marine particulate organic matter (MPOM)

Distribution of stable carbon isotope in sediment



a) **Yoshino river:** -26.0‰ to -21.7‰



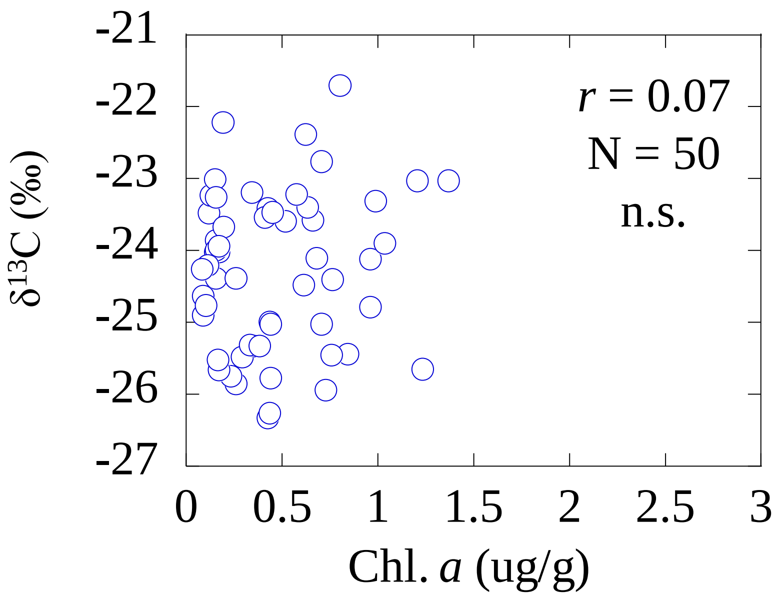
b) **Katsuura river:** -25.3‰ to -22.8‰

Stable carbon isotope ratio (‰)

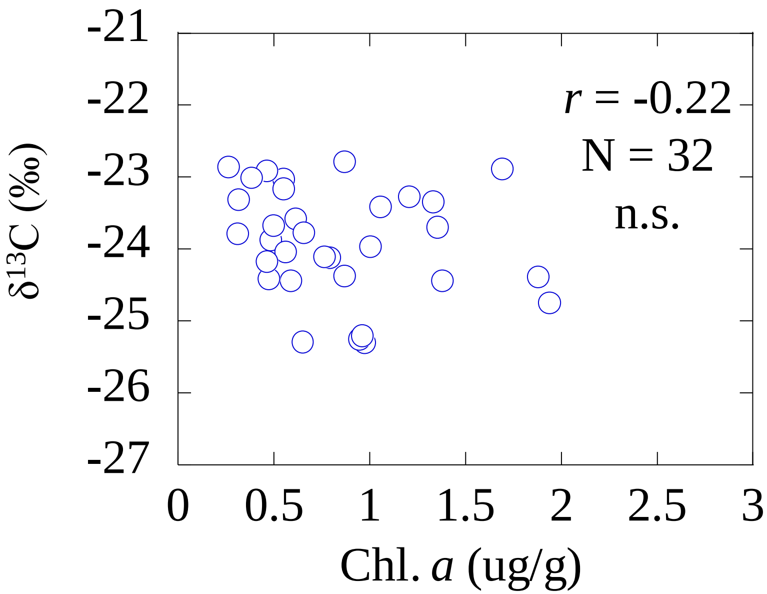
★ : -26.0 ~ -25.1 ▲ : -25.0 ~ -24.1 ◆ : -24.0 ~ -23.1

■ : -23.0 ~ -22.1 ● : -22.0 ~ -21.1

Relationship between Chl. *a* and δ^{13}C in sediment



a) Yoshino river



b) Katsuura river

There were no significant relationships between Chl. *a* and δ^{13}C value of sediment in both tidal flats.
Chl. *a* did not affect to the δ^{13}C value of sediment.

Contribution of terrestrial organic matter

Supposed that the sediment consist of TPOM and MPOM, the origin of sediment can be estimated using stable carbon isotope ratio.

$$f\,(\%) = \frac{\delta^{13}C\ marine - \delta^{13}C\ sample}{\delta^{13}C\ marine - \delta^{13}C\ terrestrial} \times 100$$

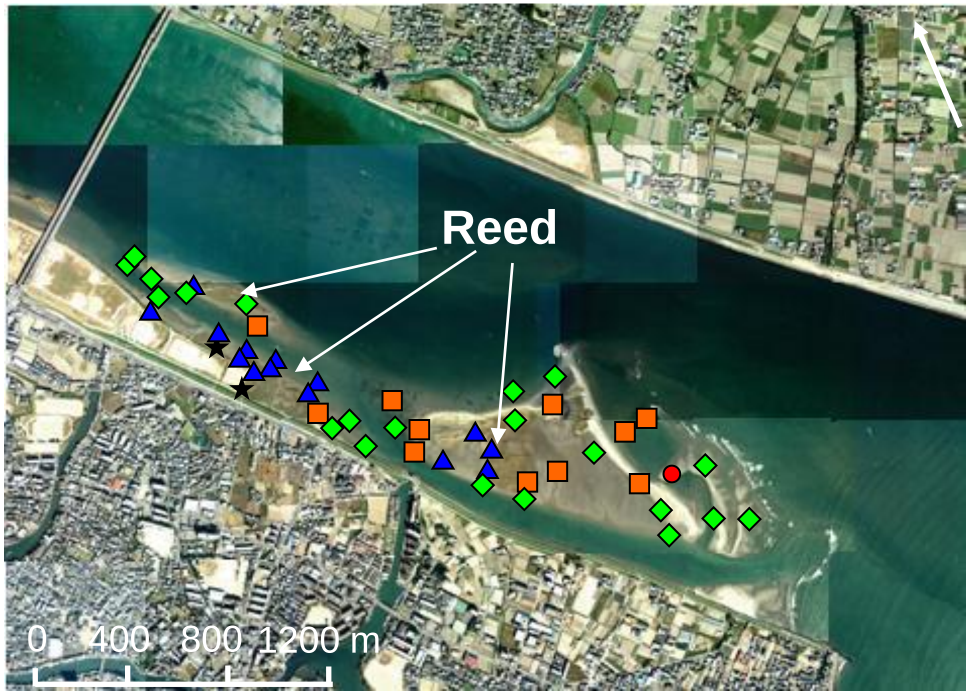
f (%) : Contribution of terrestrial organic matter

$\delta^{13}C$ *terrestrial* : -27.0 ‰ (Wada *et al.*,1990)

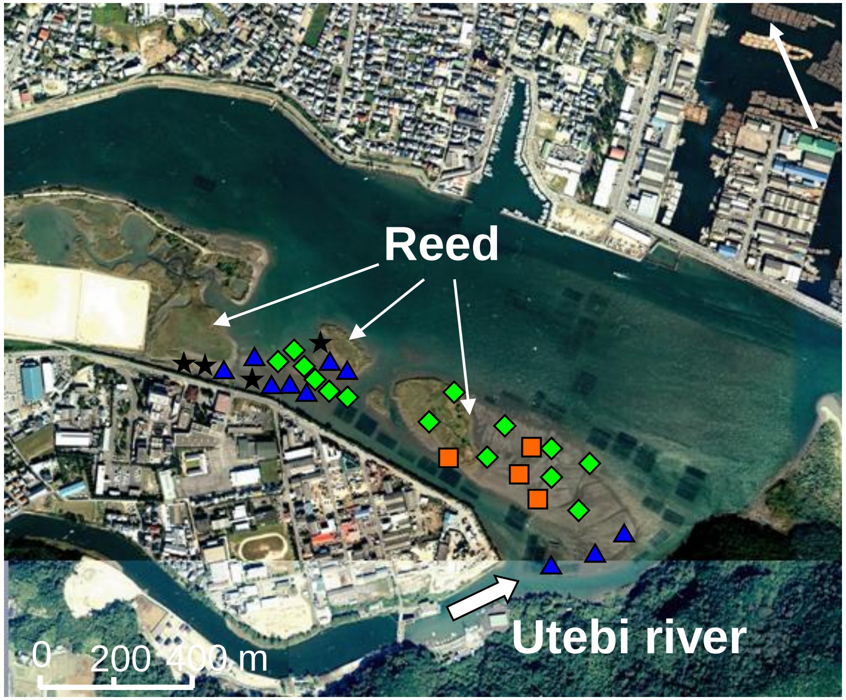
$\delta^{13}C$ *marine* : -21.0 ‰ (Wada *et al.*,1990)

$\delta^{13}C$ *sample* : Sediment sample

Contribution of terrestrial organic matter in sediment



a) Yoshino river: 12% to 83



b) Katsuura river: 37% to 86%

Contribution of terrestrial organic matter (%)

★ : 80.1 ~ 100 ▲ : 60.1 ~ 80.0 ◆ : 40.1 ~ 60.0

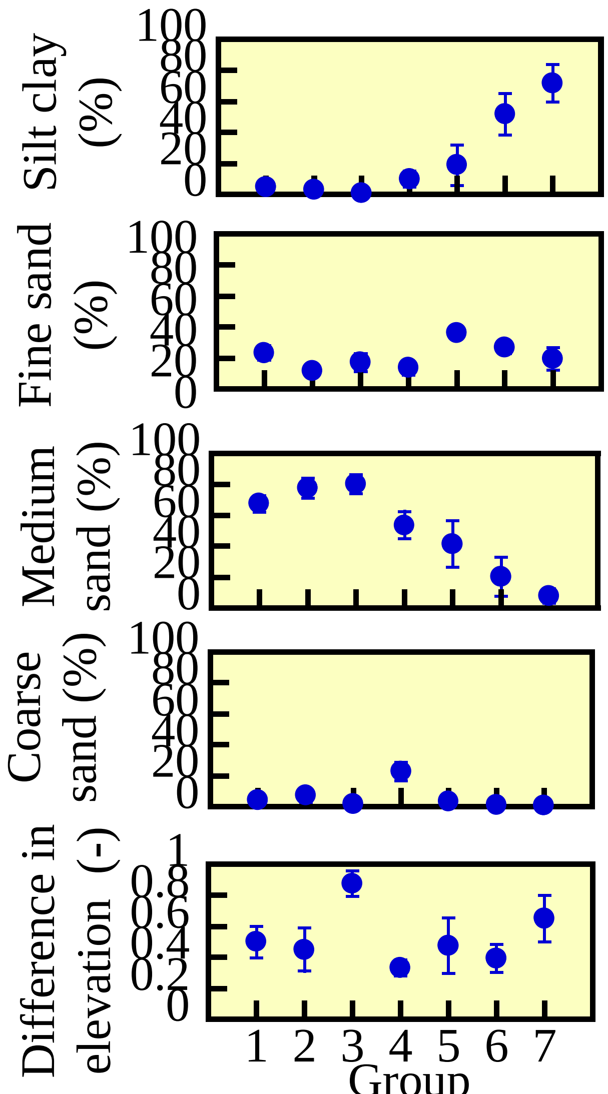
■ : 20.1 ~ 40.0 ● : 0 ~ 20.0

Classification sediment

- Sediment were classified into 7 groups by cluster analysis in relation to particle size composition of sediment and difference in elevation in both tidal flat.
- Those groups were characterized with some specific benthic consumers.

Group characteristics

Physical characteristics of sediment

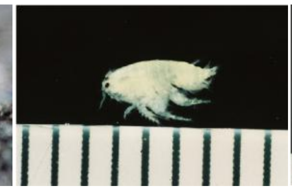


Dominant species of benthic consumer

Grp.1

Scopimera globosa

Grp.2

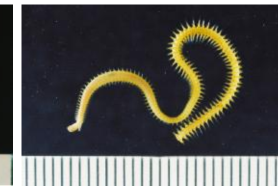


***Urothoe* sp.**

Grp.3

Excirolana chiltoni

Grp.4



***Goniada* sp.**

Grp.5

There was no dominant species

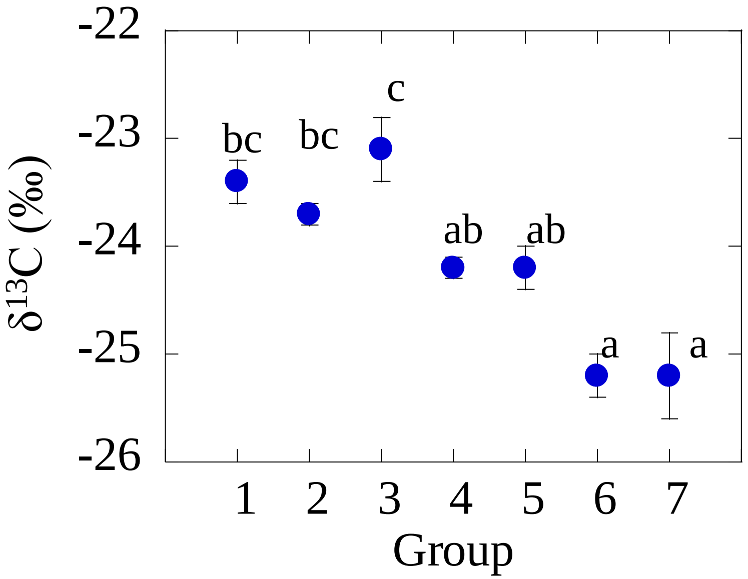
Grp.6

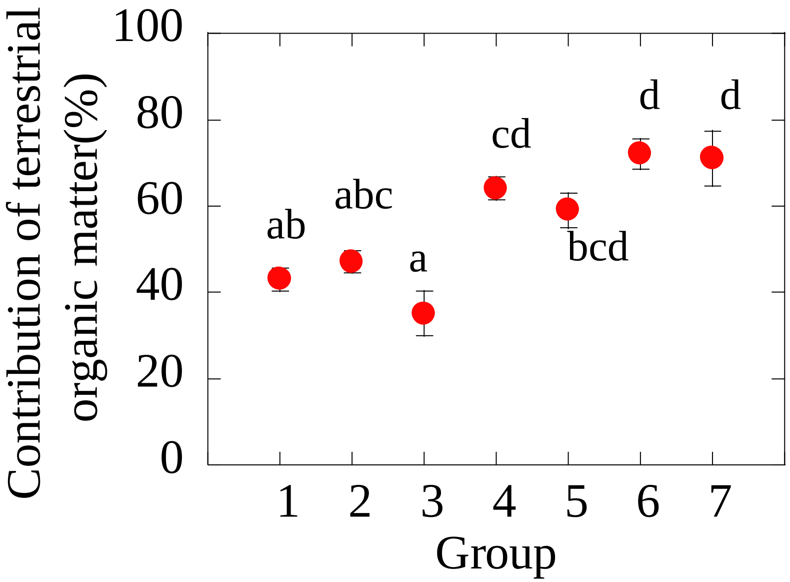
Macrophthalmus japonicus

Grp.7

Iyoplax pusilla

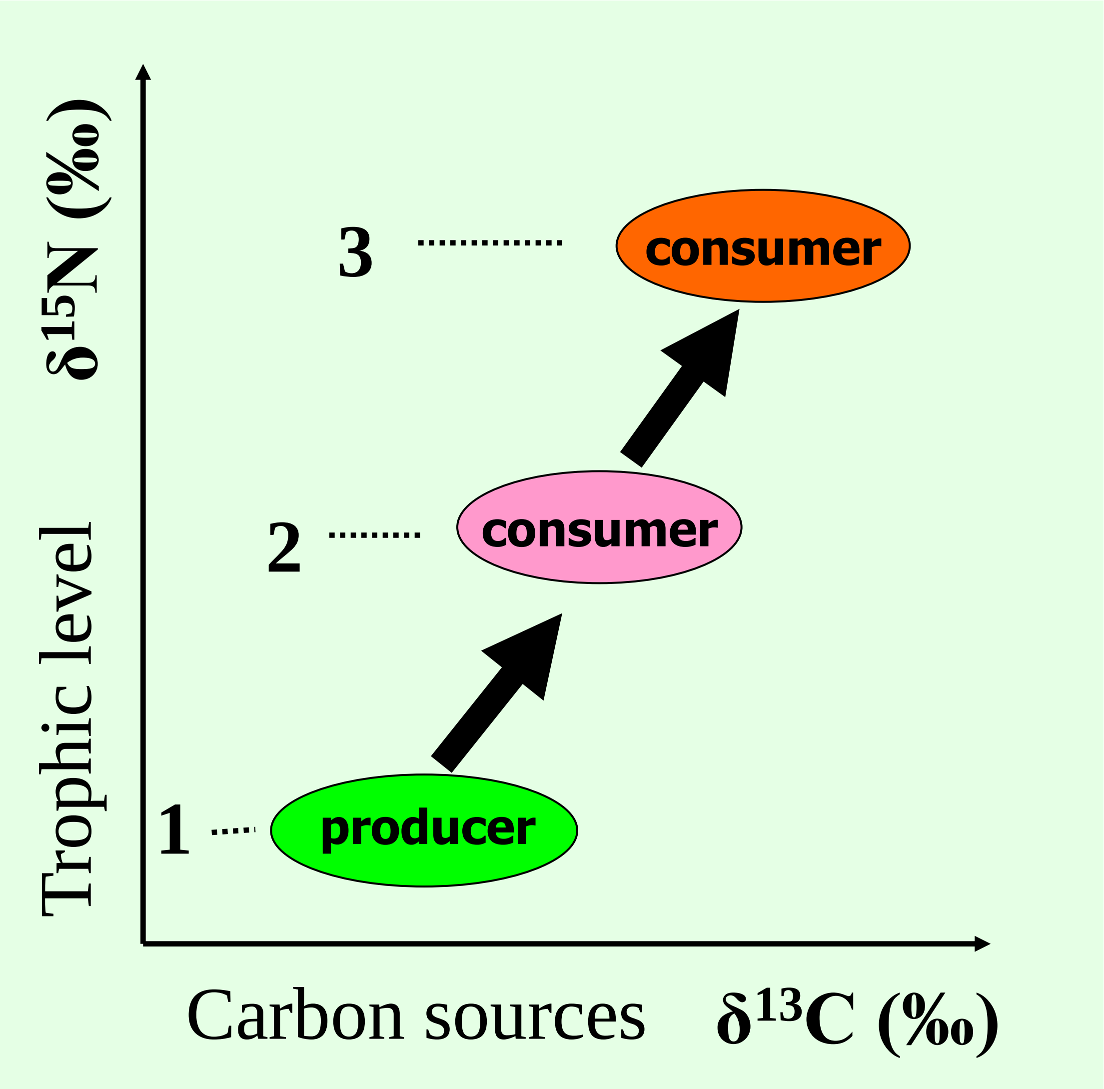
Stable carbon isotope and contribution of terrestrial organic matter in each group





It was recognized that carbon stable isotope ratio of sediment related to physical characteristics of sediment

Food web analysis using stable isotope ratio

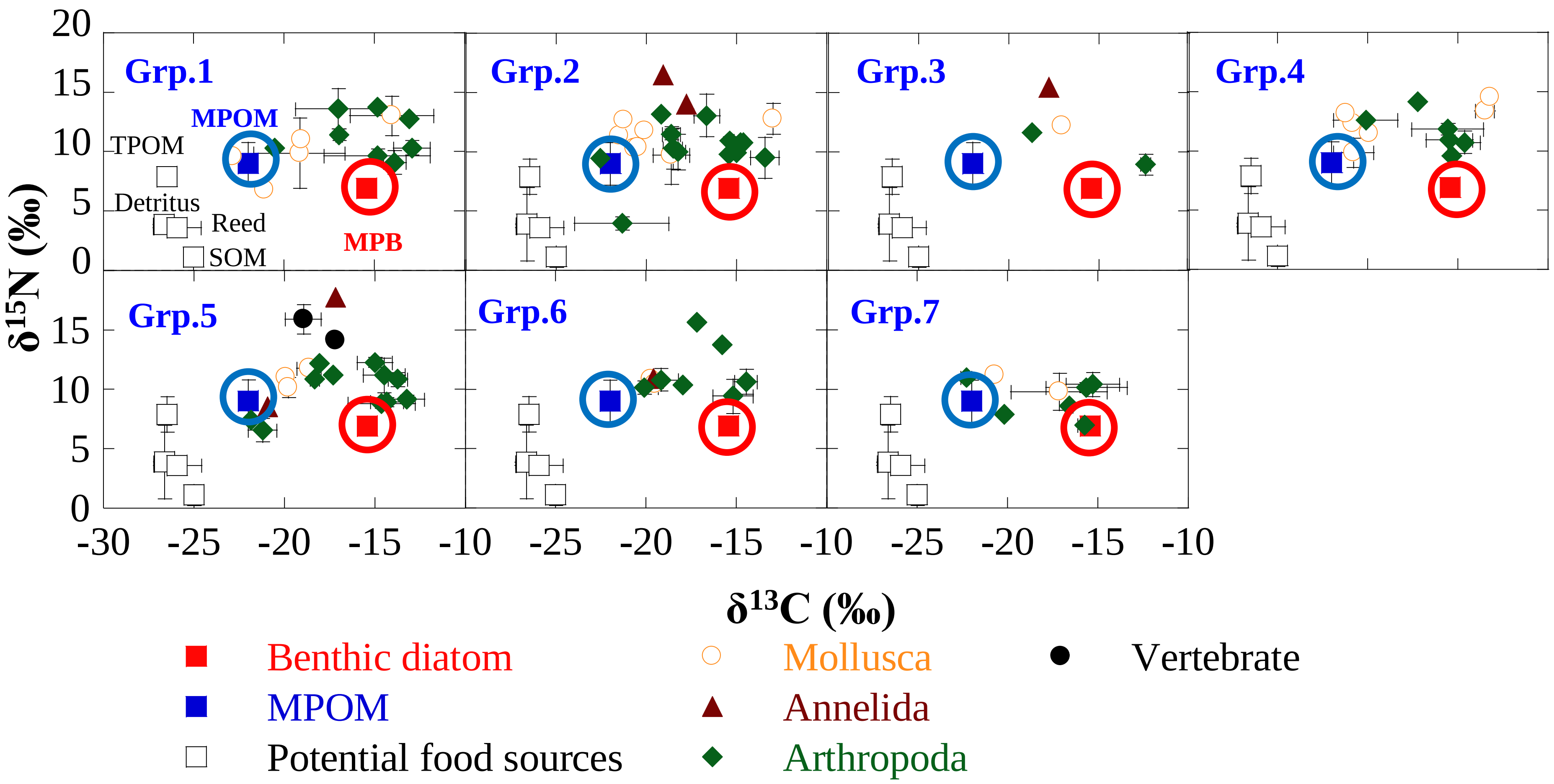


$\delta^{13}C = 0 \sim 1$ ‰

$\delta^{15}N = 3 \sim 4$ ‰

enriched

Comparison in the δ13C and δ15N values of benthic community in each group



Benthic consumers assimilated mainly benthic diatoms or MPOM in different sediment groups

The relationship between origin of sedimentary organic matter and food web structure

- **Origin of sediment**

  Sediment in a number of stations consisted of originated terrestrial organic matter

- **Food web structure**

  Benthic consumer assimilated MPOM and benthic diatom

•Benthic consumers utilize sediment as their habitats originated from terrestrial organic matter
•Benthic consumer assimilates food sources selectively

It was implied that the difference in sediment characteristics hardly corresponded to food web structure of benthic community.

Conclusion

This study was conducted to estimate origin of organic matter in sediment and elucidate the food web structure using carbon and nitrogen stable isotope ratio in 2 tidal flats of river mouth.

1. Carbon stable isotope ratio of sediments were distributed with spatial characteristics in the 2 tidal flats. Contribution of terrestrial organic matter was lower in the downstream section of the tidal flat comparing with in the upstream section.
2. Benthic consumers were distributed in the stations with sediment from terrestrial organic matter, they did not assimilate terrestrial organic matter as their food sources. Moreover, benthic consumers have selectively assimilated food sources.
3. Benthic consumers mainly assimilated MPOM and benthic diatoms as their food sources even in the station of sediment groups with rich terrestrial organic matter.