

# North Pacific Marine Science Organization (PICES)

## Spatiotemporal trophic dynamics of four zooplankton taxa in the East/ Japan Sea revealed by stable isotopes and fatty acid composition

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National Institute of  
Fisheries Science



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# Background Climate change

Spot the difference!! 😊



- Seabirds (upper trophic level species) face dire threats from climate change
- Changes in species composition and population of fishery resources

**The global fishery industry is facing a serious crisis**

# Background Climate change

## Fisheries, shipping industries to reduce greenhouse gas emissions by 70% by 2030

2022-09-15 : 16:07



An oceans ministry official speaks during a press briefing at the Sejong Government Center.

## 경북일보

HOME > 사회 > 환경

### Squid in the East Sea moved to the Yellow Sea due to food web changes caused by ocean warming

손석호 기자 | 승인 2020.08.24 | 8면

이충일 강릉원주대 교수·이상현 부산대 교수 연구



포항시 남구 구룡포수협 활어위판장에서 어민들이 오징어를 상자에 담는 작업을 하고 있다. 경북일보DB

KOSDI

ISSN : 1976-1100

Journal of the Society of Disaster Information  
Vol. 18, No. 1, pp. 194-201, March 2022  
<https://doi.org/10.15683/kosdi.2022.3.31.194>

Original Article

우리나라에서 기후 변화에 따른 어업 생산량의 변동

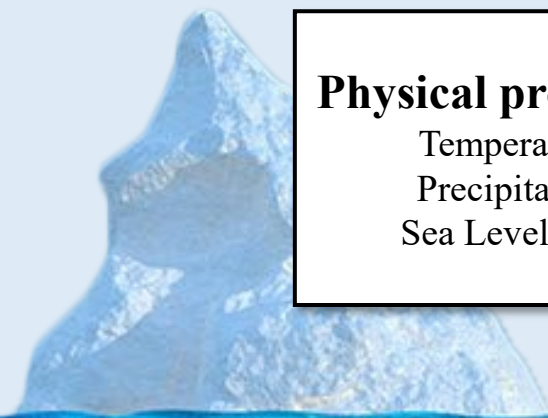
### Variations in Catches of Fisheries according to the Climate Change of Korea

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Jong-Gyu Kim\*

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Kim, J. G. (2022). Variations in Catches of Fisheries according to the Climate Change of Korea. *Journal of the Society of Disaster Information*, 18(1), 194-201.



**Physical properties**  
Temperature  
Precipitation  
Sea Level Rise



## **Water Resources**

Water supply  
Water quality  
Competition for water

## **Agriculture**

Crop yields irrigation  
demands

## **Species and Natural Areas**

Loss of habitat and species  
Diet shift  
Productivity decrease

## **Coastal Areas**

Erosion of beaches  
Inundation of coastal  
lands

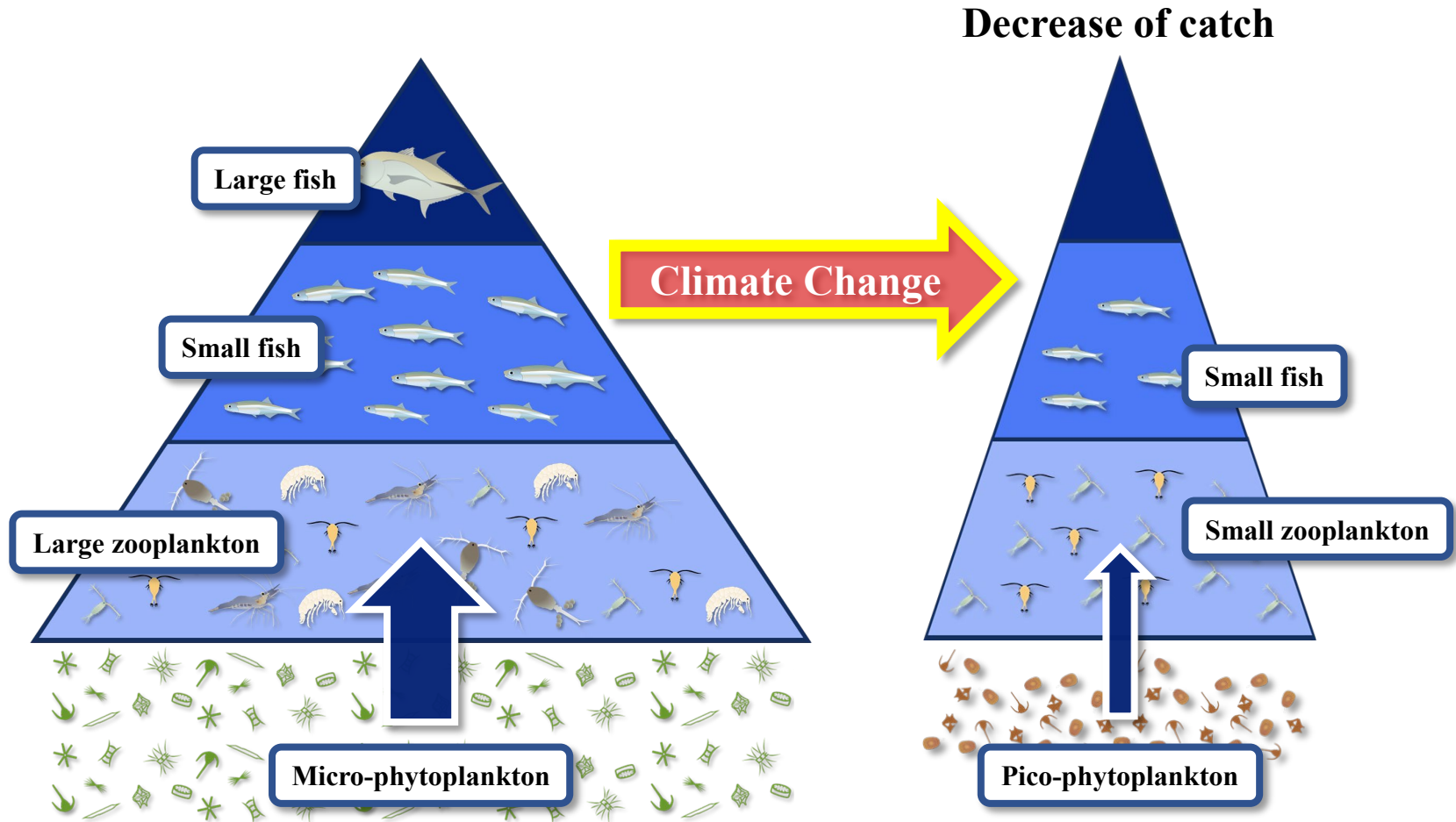
## **Health**

Weather-related mortality  
infections diseases  
Air-quality respiratory  
illnesses

## **Forests**

Forest composition  
Geographic range  
productivity

# Background Zooplankton

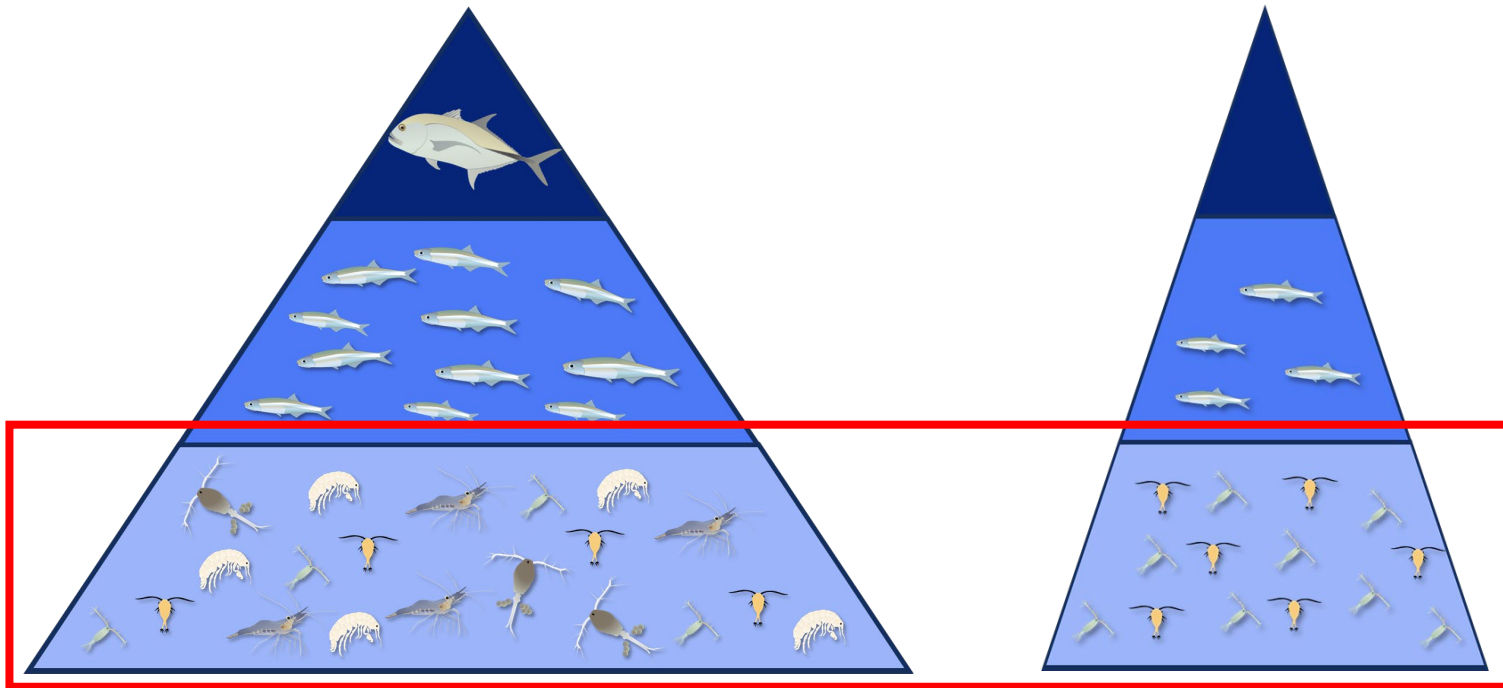


- The dietary shift of fish and decrease in the fishing ground could be occurred by this mechanism

 :Flow of energy and materials<sup>m</sup>

# Background Zooplankton

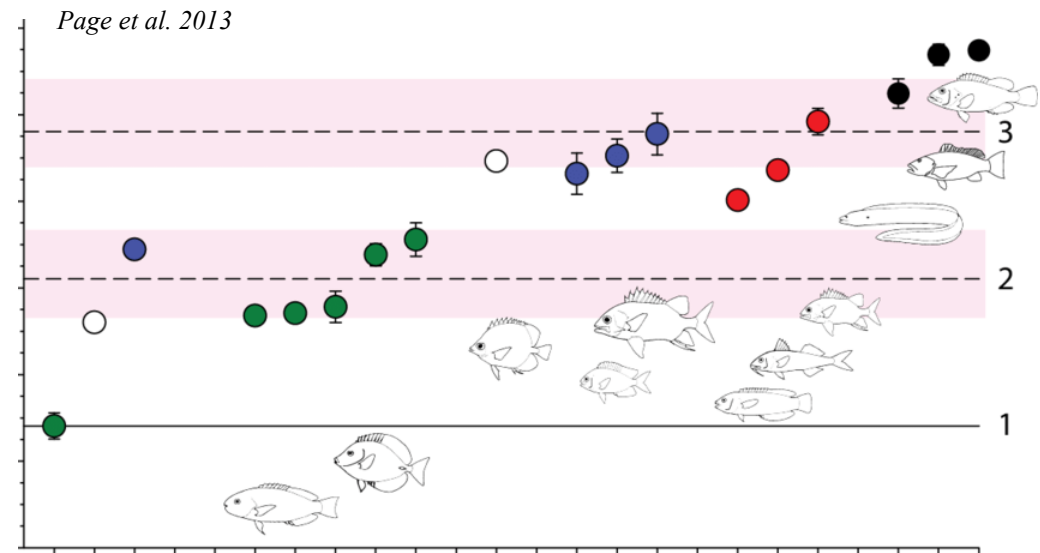
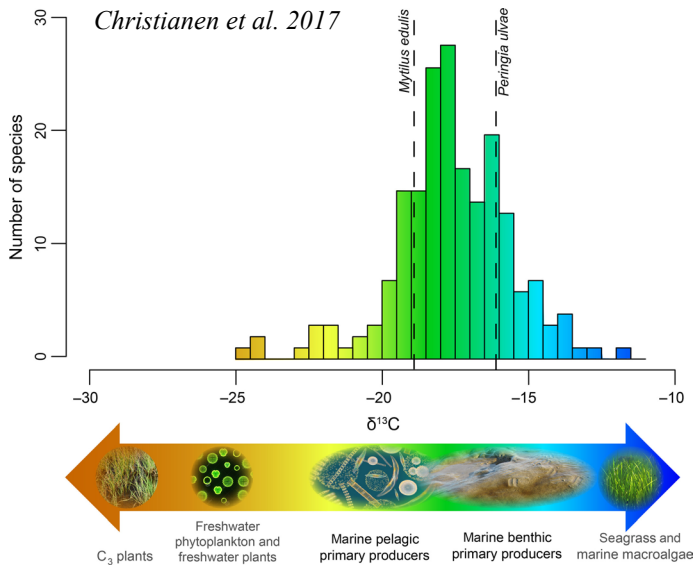
- Zooplanktons serve as an **intermediate species in the marine food web**, transferring energy from phytoplankton (primary producers) to the upper trophic level consumers (fish)
- The effects of environmental disturbances can be detected through changes in **species composition, abundance, spatial distribution, body size and physiology** of zooplanktons





# Materials & methods **Stable isotopes**

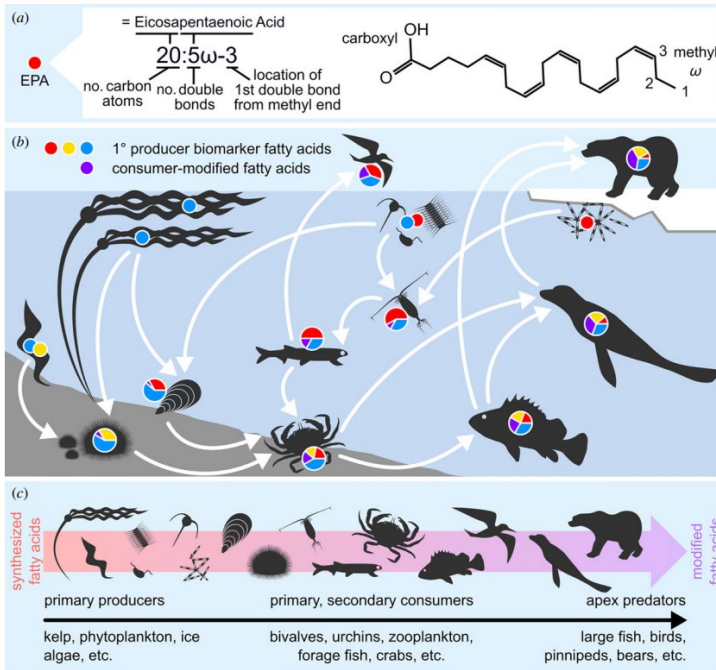
Research approach	Characteristics	Information
<p><b>Bulk stable isotope</b> (<math>\delta^{13}\text{C}_{\text{Bulk}}</math>, <math>\delta^{15}\text{N}_{\text{Bulk}}</math>)</p>	<ul style="list-style-type: none"> <li>Fractionation occurs during metabolic processes (<b>C: 1‰, N: 3.4‰</b>)</li> <li>Whole tissue is used to investigate the overall food web structure</li> <li>Less time consuming and cheap</li> </ul>	<ul style="list-style-type: none"> <li><b>Trophic position</b></li> <li>Proportion of the <b>diet sources</b></li> </ul>



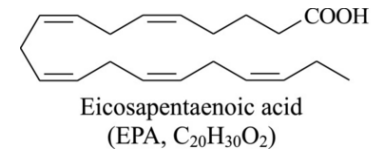
- ❖ Christianen, M. J., Middelburg, J. J., Holthuijsen, S. J., Jouta, J., Compton, T. J., van der Heide, T., ... & Olf, H. (2017). Benthic primary producers are key to sustain the Wadden Sea food web: stable carbon isotope analysis at landscape scale. *Ecology*, 98(6), 1498-1512.

# Materials & methods **Fatty acid**

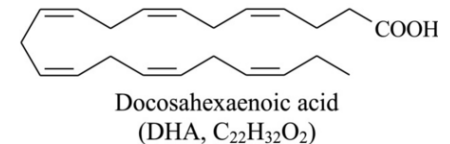
Research approach	Characteristics	Information
Fatty acid composition analysis	<ul style="list-style-type: none"> <li>Differing biosynthetic pathways for each taxon (algae, plant, bacteria..)</li> <li><b>Essential fatty acid</b> in primary producers transfer to the consumers by trophic transfer</li> </ul>	<ul style="list-style-type: none"> <li><b>Basal resources</b></li> </ul>



Diatom



Dinoflagellate



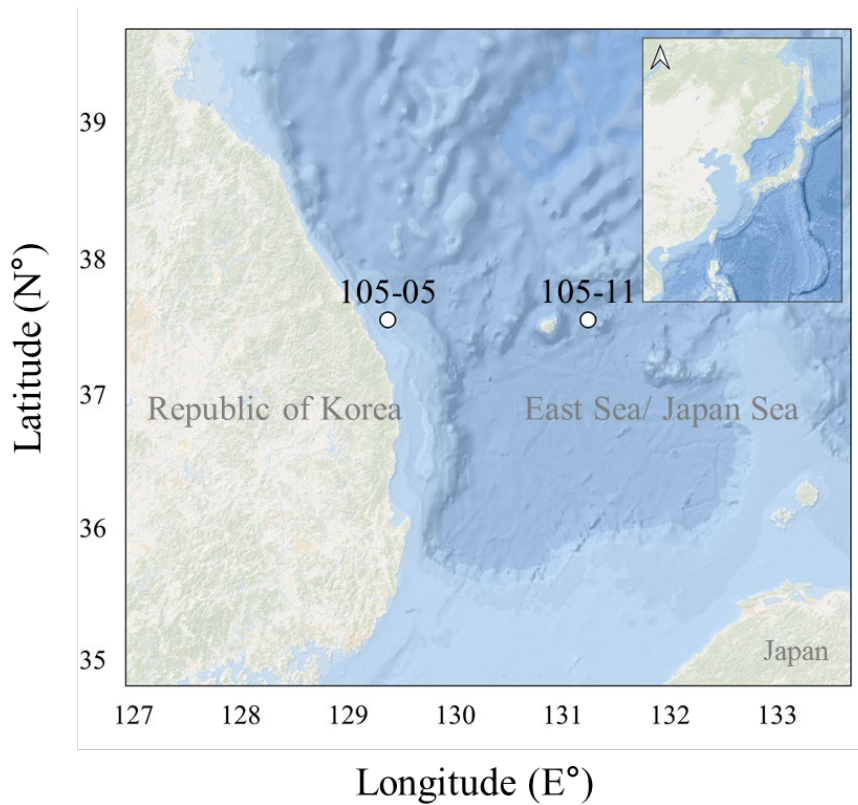


Figure. Sampling site of this study

- Season: August 2020 ~ August 2021
- Site: 105-05(Coastal region, 37.56°N, 129.37°E), 105-11(Offshore region, 37.56°N, 131.29°E)
- Analysis items
  1. Carbon stable isotope ( $\delta^{13}\text{C}$ ): Diet source
  2. Nitrogen stable isotope( $\delta^{15}\text{N}$ ): Trophic position, nitrogen source
  3. Fatty acid: Diet source



Euchaetidae



Chaetognatha



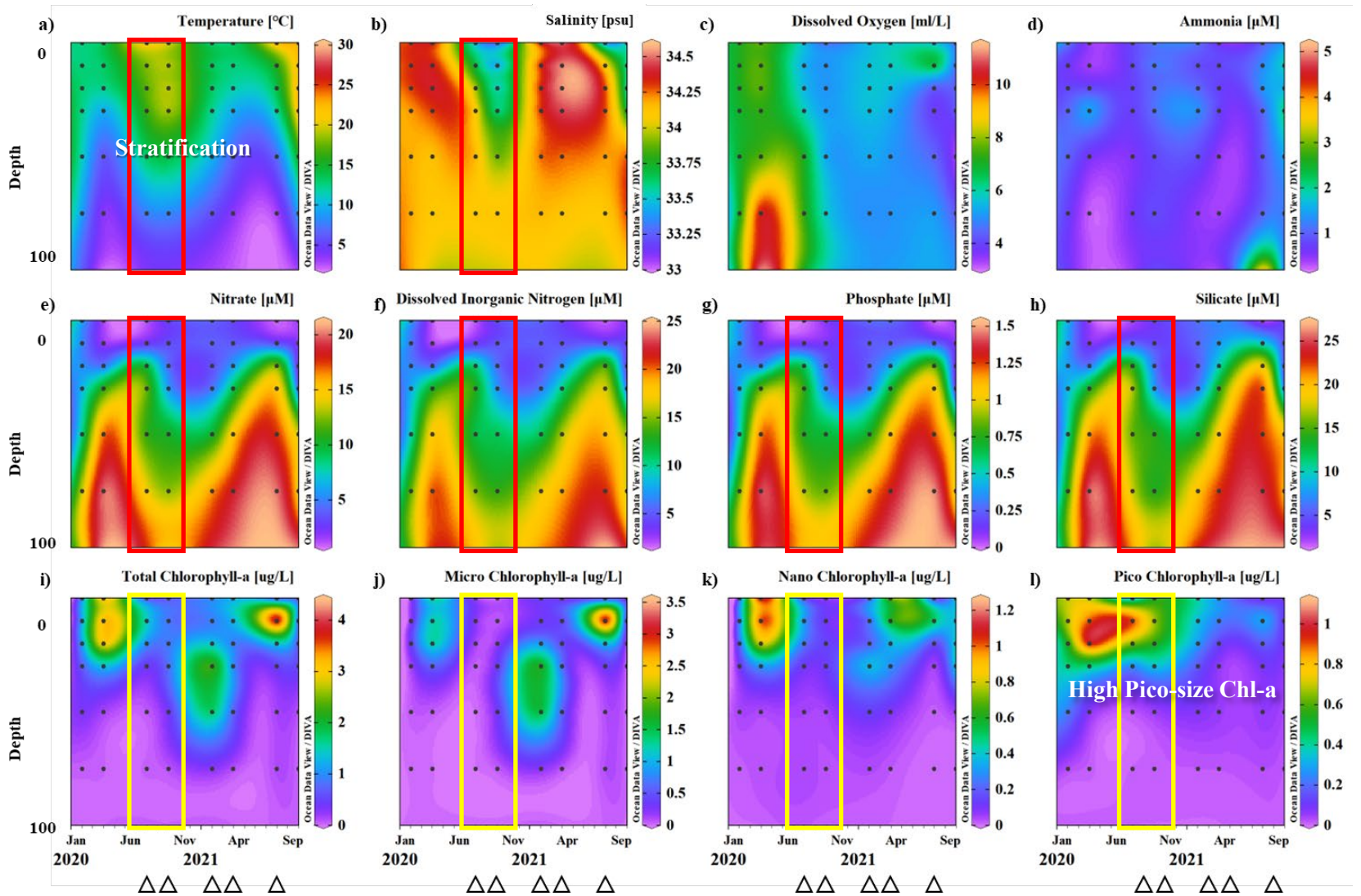
Euphausiid



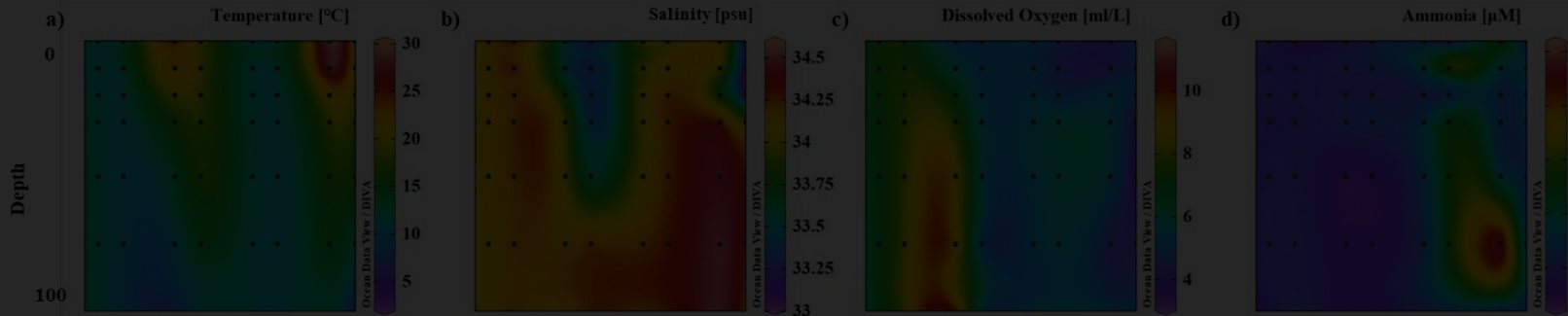
Amphipod

Template made by Jieun Kim

# Background Environmental condition



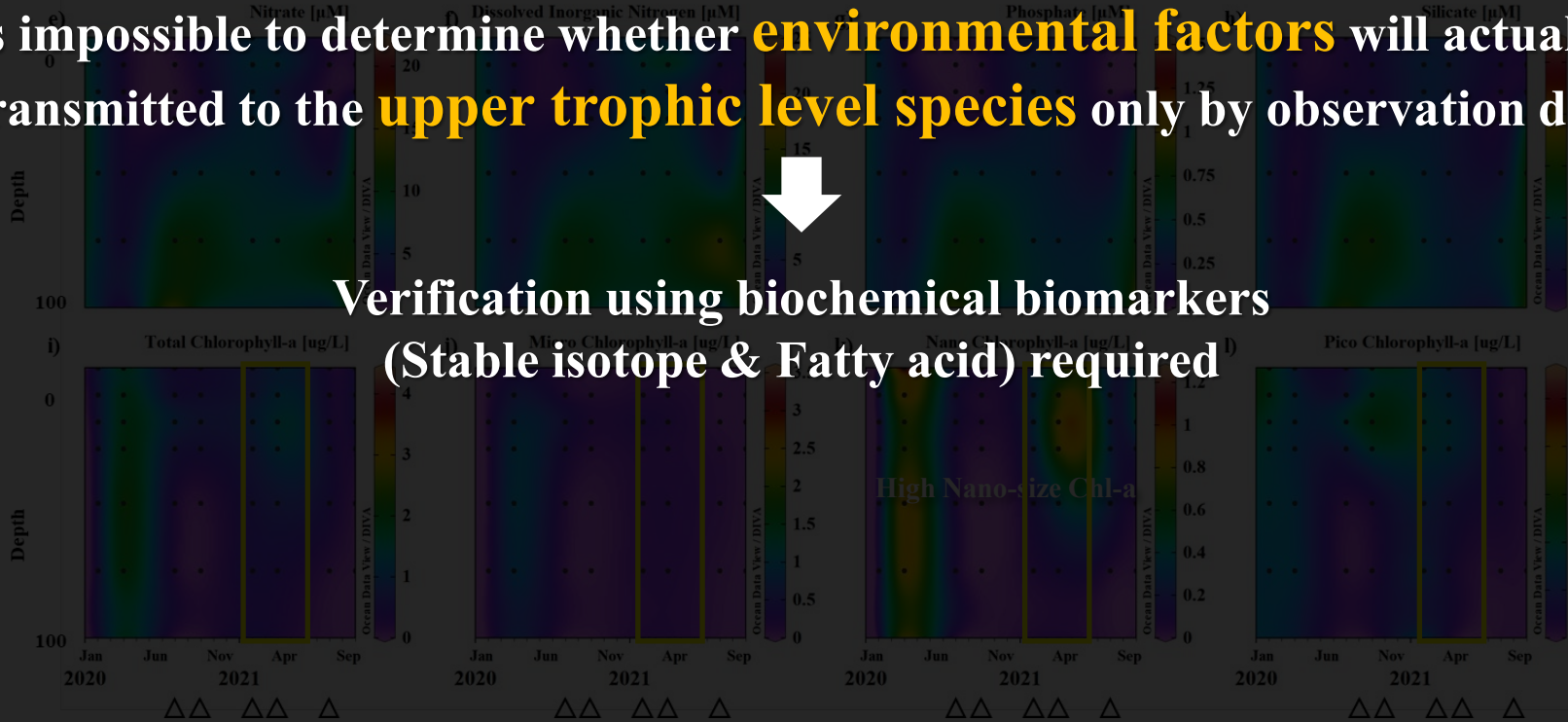
# Background Environmental condition

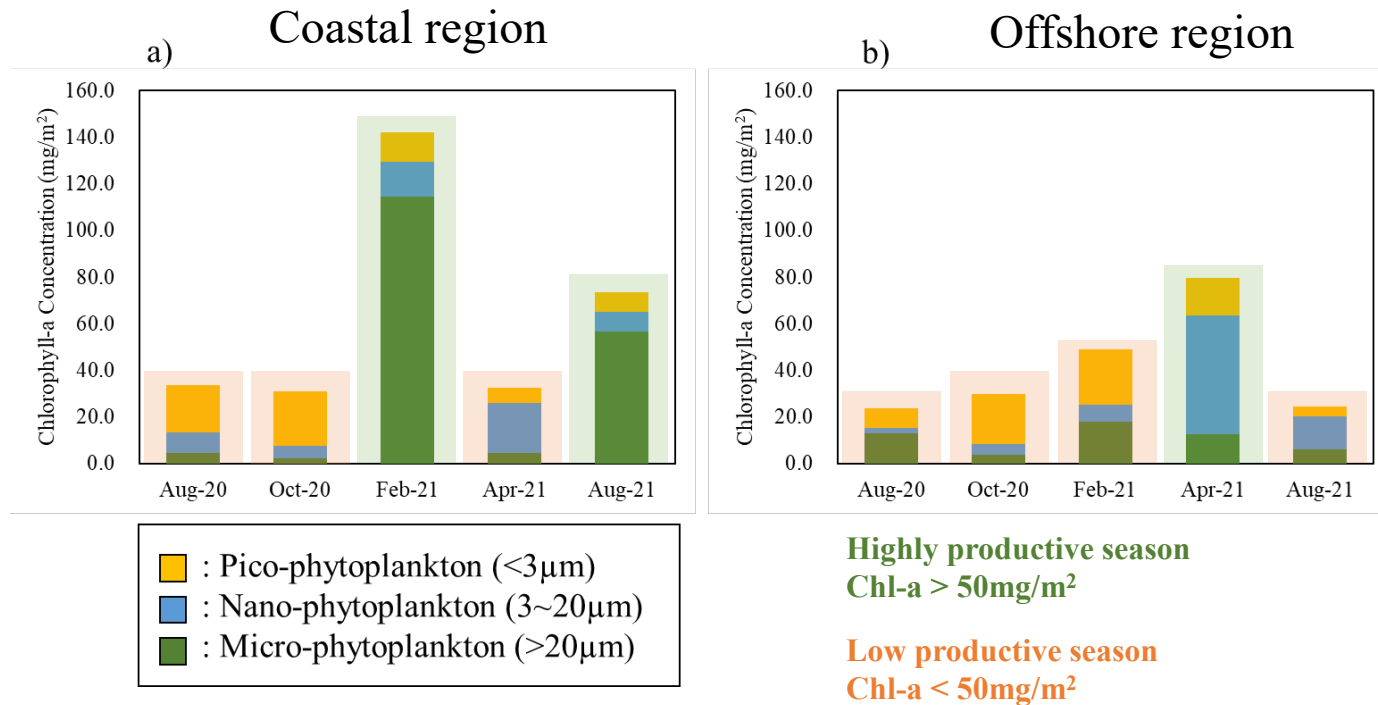


It is impossible to determine whether **environmental factors** will actually be transmitted to the **upper trophic level species** only by observation data



Verification using biochemical biomarkers  
(Stable isotope & Fatty acid) required





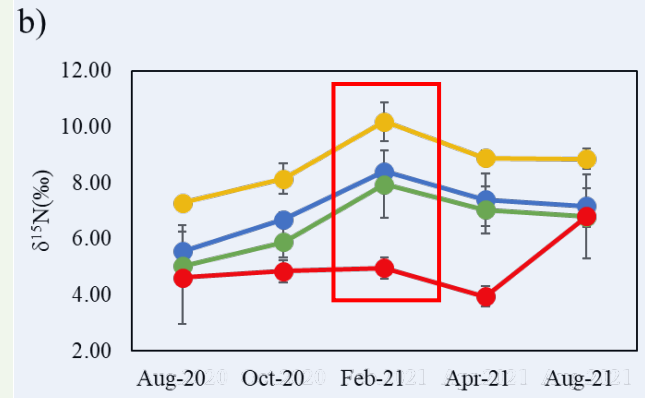
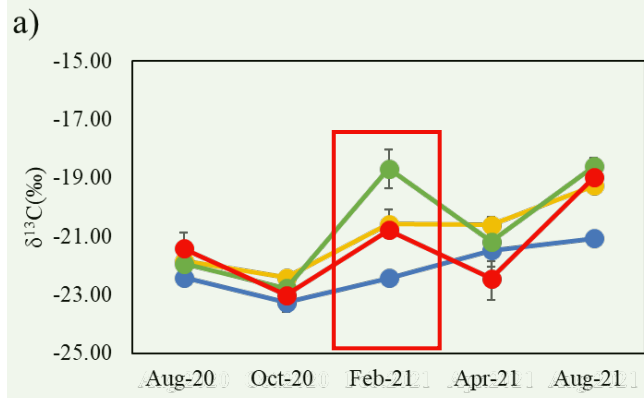
- In coastal region, total and micro-size chlorophyll-a concentrations peaked in Feb 2021 and Aug 2021
- In offshore region, the total and nano-size chlorophyll-a concentration reaches its peak in Apr 2021
- Zooplankton community comparison was performed during highly productive season and low productive season

Figure. Seasonal variations in different size fractioned chlorophyll-a concentrations in 105-05 a) and 105-11 b) Template made by Jieun Kim

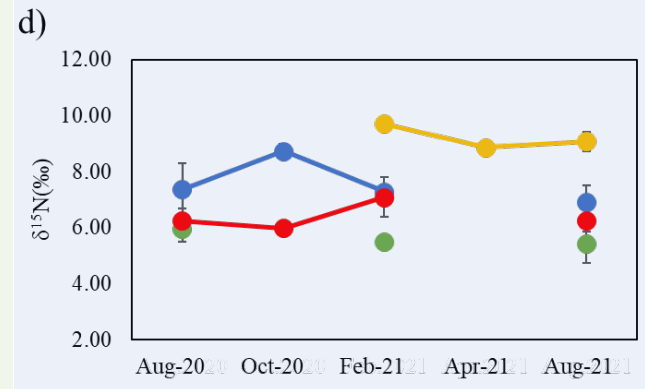
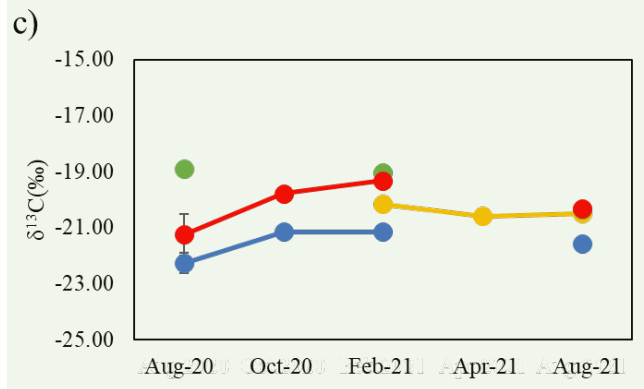
# Results & Discussions Bulk Stable Isotope

To investigate changes in the basal food web and relative trophic position of zooplankton according to the seasons

## Coastal region



## Offshore region



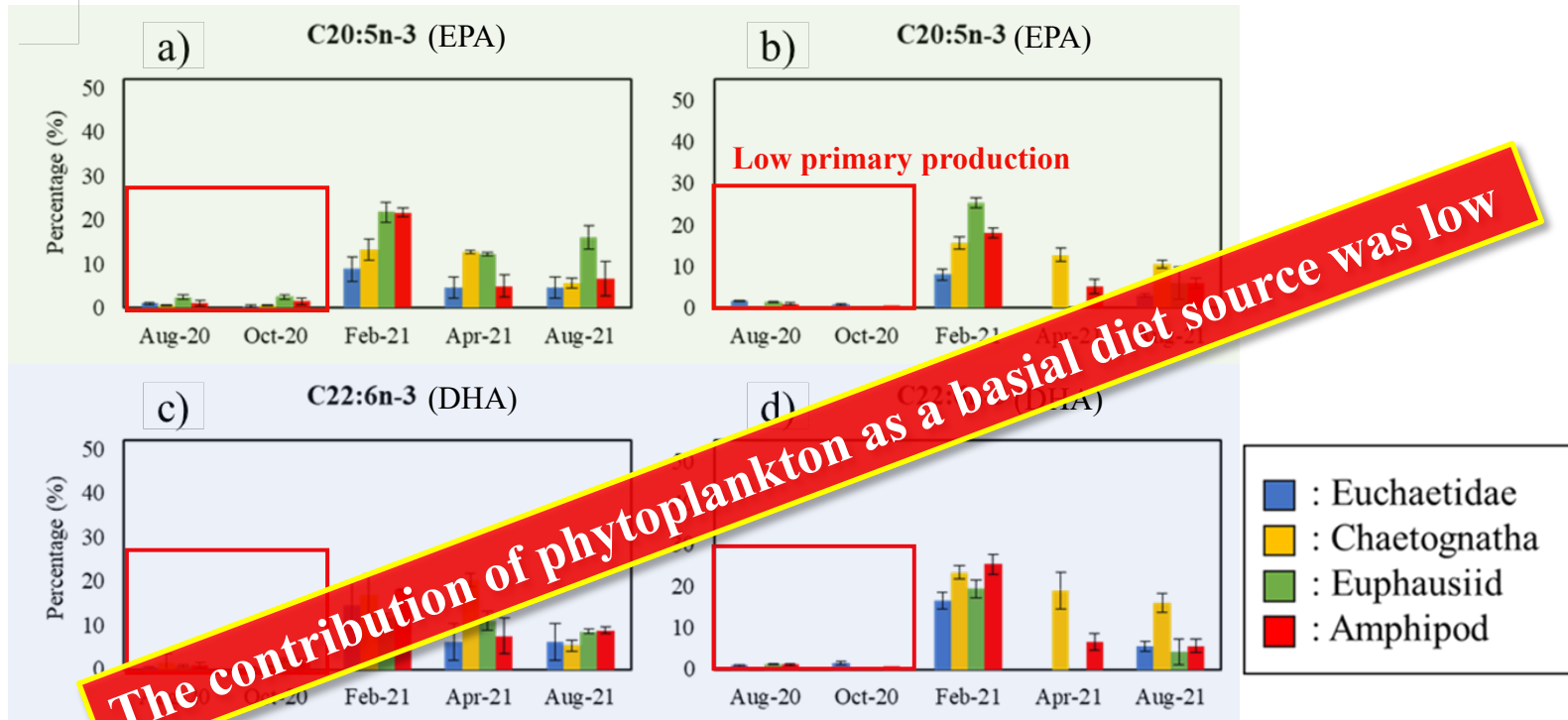
- : Euchaetidae
- : Chaetognatha
- : Euphausiid
- : Amphipod

**Diet source**

**Trophic position  
Nitrogen source**

## Coastal region

## Offshore region



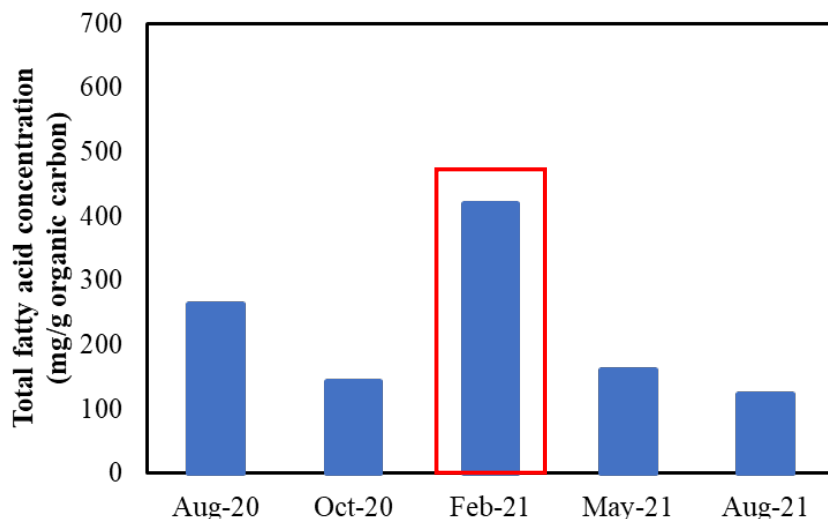
- The proportion ratio of **EPA (diatom)** and **DHA (dinoflagellate)**, which are indicators of phytoplankton in total fatty acids, was highest in February 2021
- The proportion of phytoplankton indicators was low during August 2020 and October 2020.

Figure. Seasonal variation of major poly unsaturated fatty acid of 4 zooplankton groups in coastal and open ocean of the East Sea. Jeon Kim

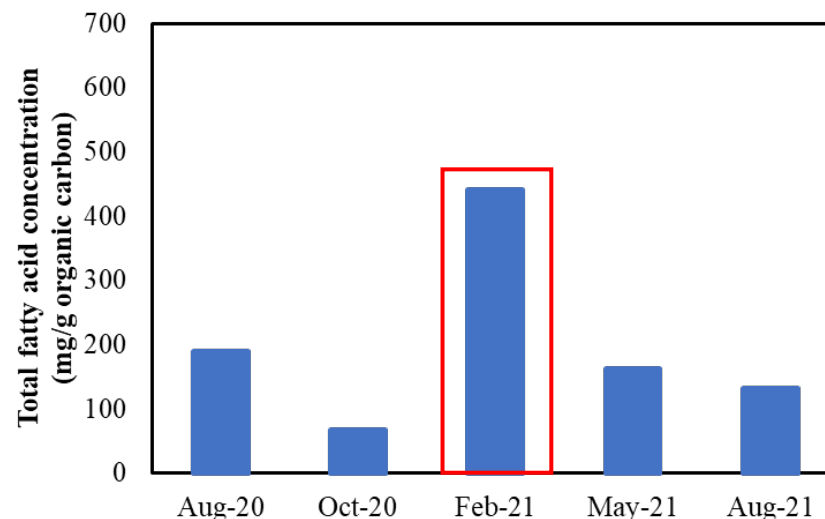


## Quantitative and qualitative changes in main dietary resource from zooplanktonic fatty acids occurred according to season

### Coastal region

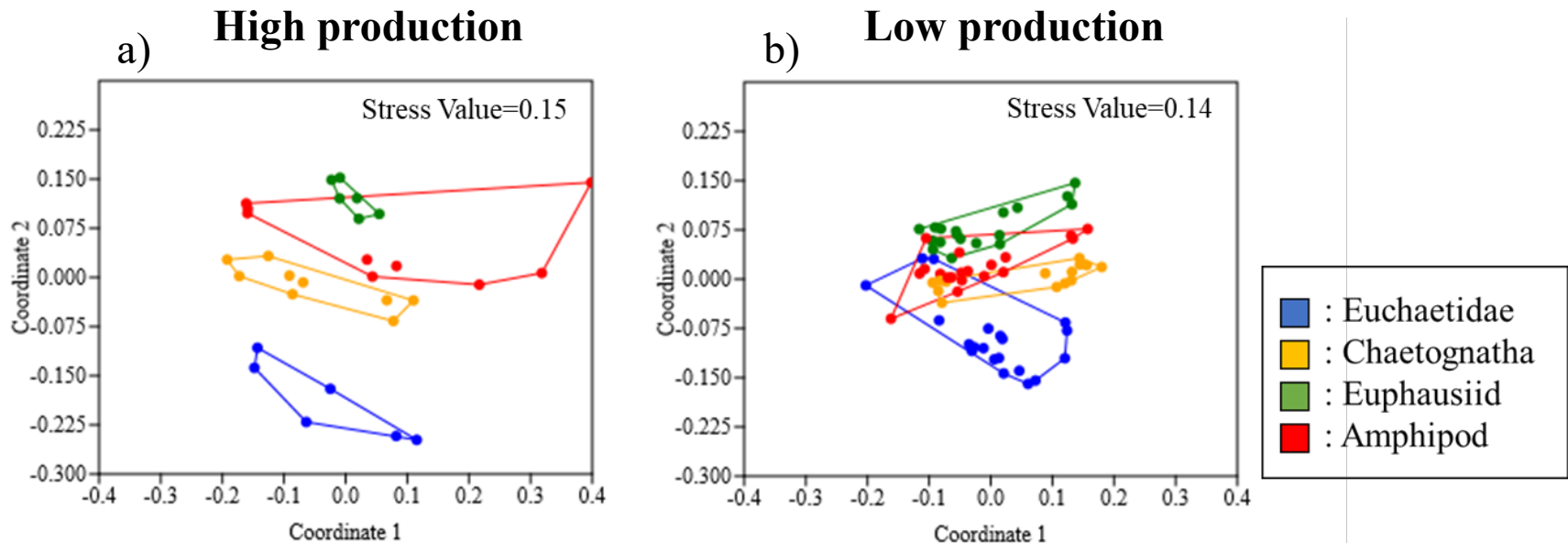


### Offshore region



1. The diet consumption of **zooplankton** decreases, and accordingly, fewer fatty acids might be stored in their tissue
2. The high temperature reduces the total fatty acid concentrations and changes the ratio of each fatty acid synthesized by **phytoplankton**

NMDS analysis was performed using the  $\delta^{13}\text{C}$ ,  $\delta^{15}\text{N}$ , and fatty acid composition to estimate the difference between zooplankton community according to productivity.



- Relatively simplified options of diet choice in environment during low productivity season
- Diversification of diet available caused by the proliferation of primary producers during Feb 2021 caused high dissimilarity between zooplankton taxa.

# Conclusion

- The diet intake of zooplankton can be reduced (restricted) due to the transition to small-sized plankton
- Long-term monitoring of the trophic dynamics of zooplankton is required

