A study on the diversity of sand-dwelling dinoflagellates at Pyoseon Beach on Jeju Island, Korea from spring to winter 2023

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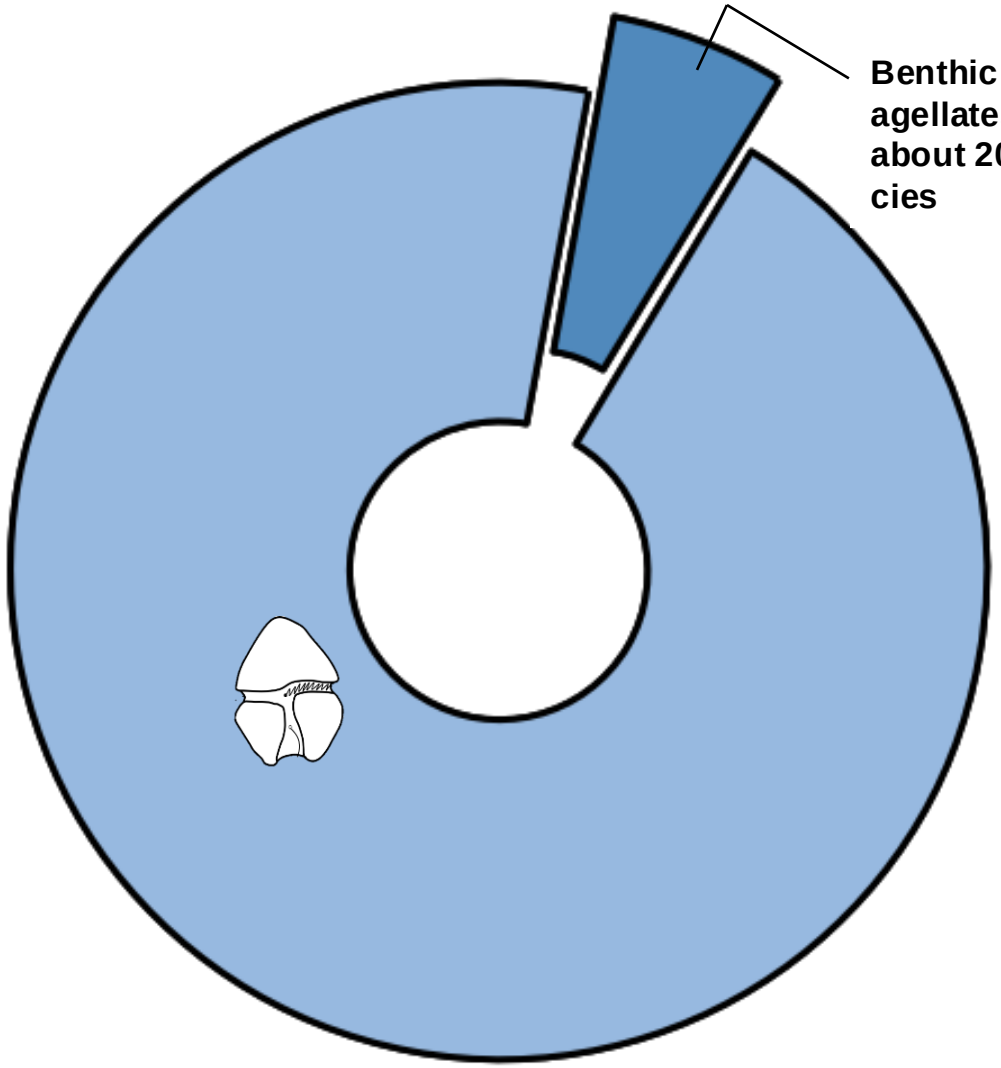
Introduction

The reported number of dinoflagellate species



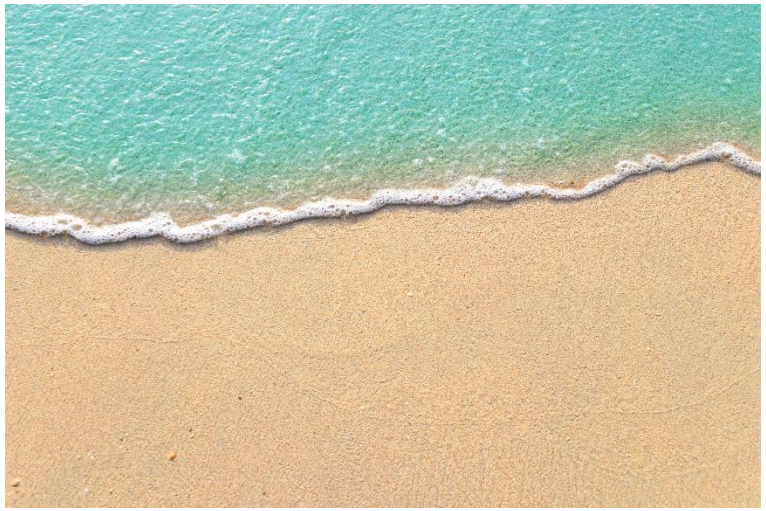
- Globally, over 3,500 species have been reported
  (Guiry and Guiry 2023)

Habitats

Corals

Seaweeds

Sand sediments



Introduction

- Recently, there has been an increasing interest in their ecological importance and diversity, leading to the continuous reporting of new genera and species.
- Some benthic dinoflagellates produce toxins that cause economic, health, and ecological damage.

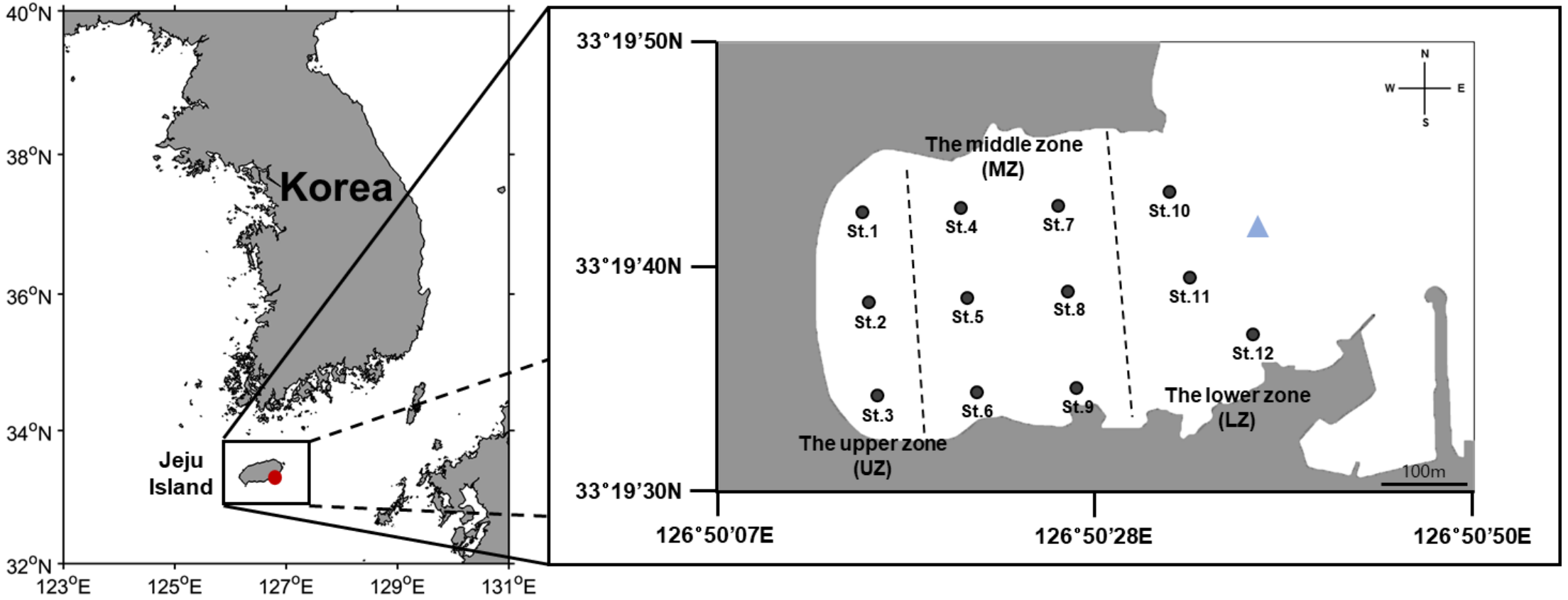
- **Toxic dinoflagellates,** which were mainly reported in **tropical/subtropical regions,** have recently been observed in t**emperate regions** due to global warming (eg. Selina and Levchenko 2011; Pistocchi et al. 2011; Shah et al. 2013).
- However, in Korea, research on benthic dinoflagellates has primarily focused on the taxonomy of some toxic species. Most of these studies have concentrated on epiphytic dinoflagellates attached to seaweeds.
- Basic investigations, such as time-series monitoring of benthic dinoflagellates inhabiting the intertidal zones in Korea, have rarely been conducted. Consequently, there is a lack of methodologies and information on the species inhabiting these areas.

Introduction

To aim

1. **Establishing methodologies for investigating benthic dinoflagellates inhabiting intertidal zones.**
2. **This includes conducting a study on the species diversity and seasonal occurrence characteristics of benthic dinoflagellates in Jeju, a frontline region of climate change.**

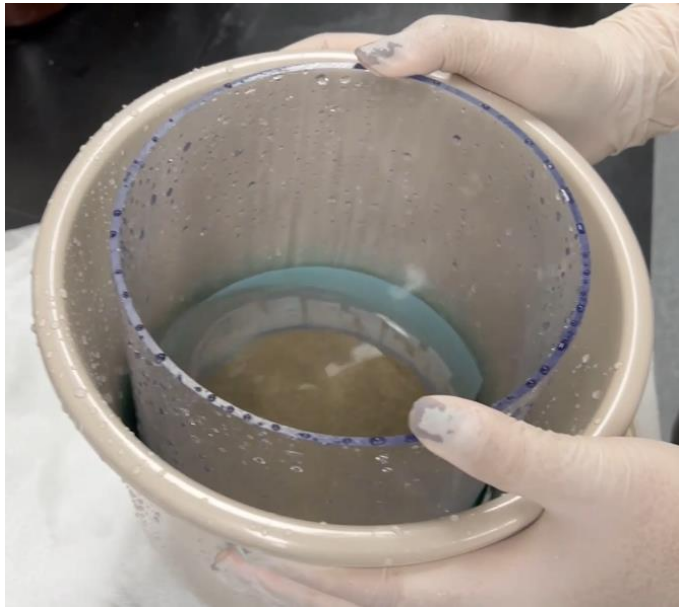
Sampling sites and periods



- Sampling station: Pyoseon Beach
- Sampling periods: Form January to November (2023)

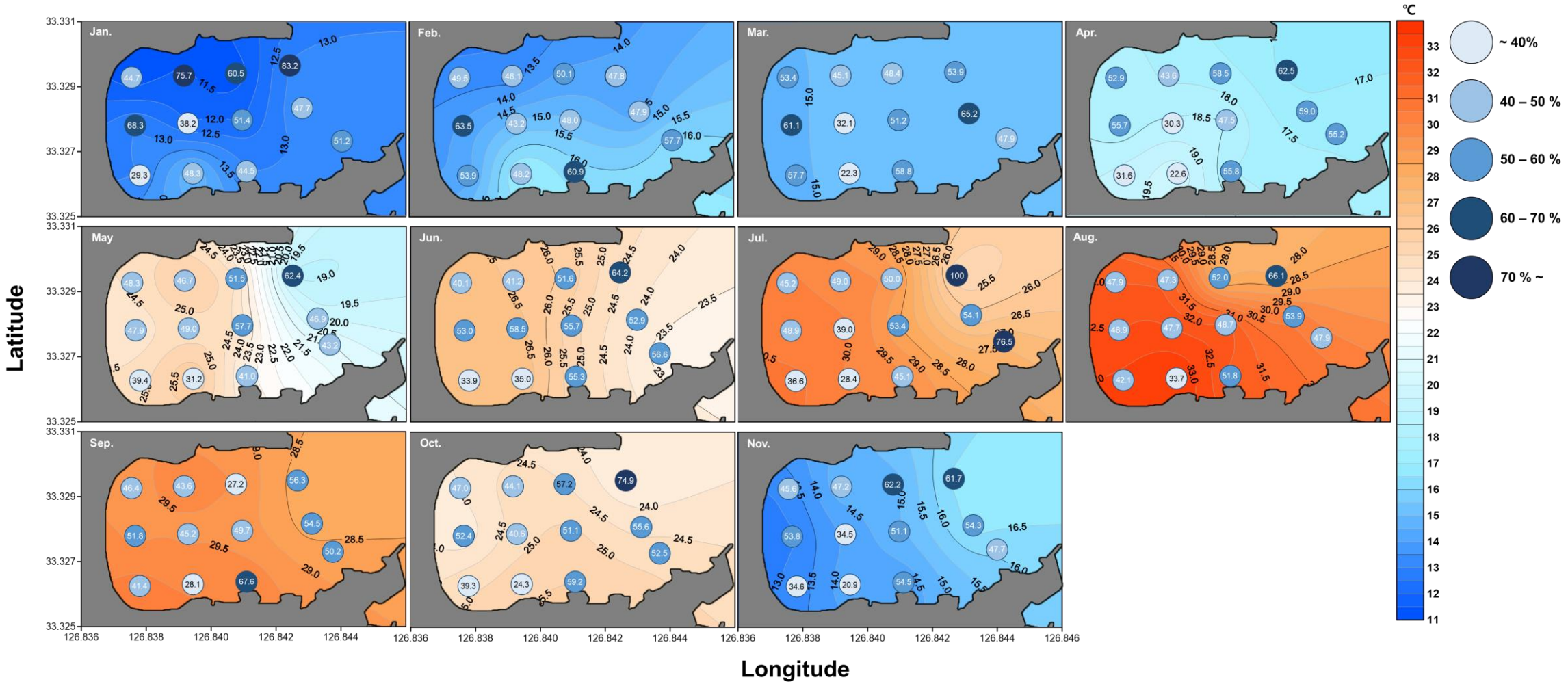
Sampling and analysis methods





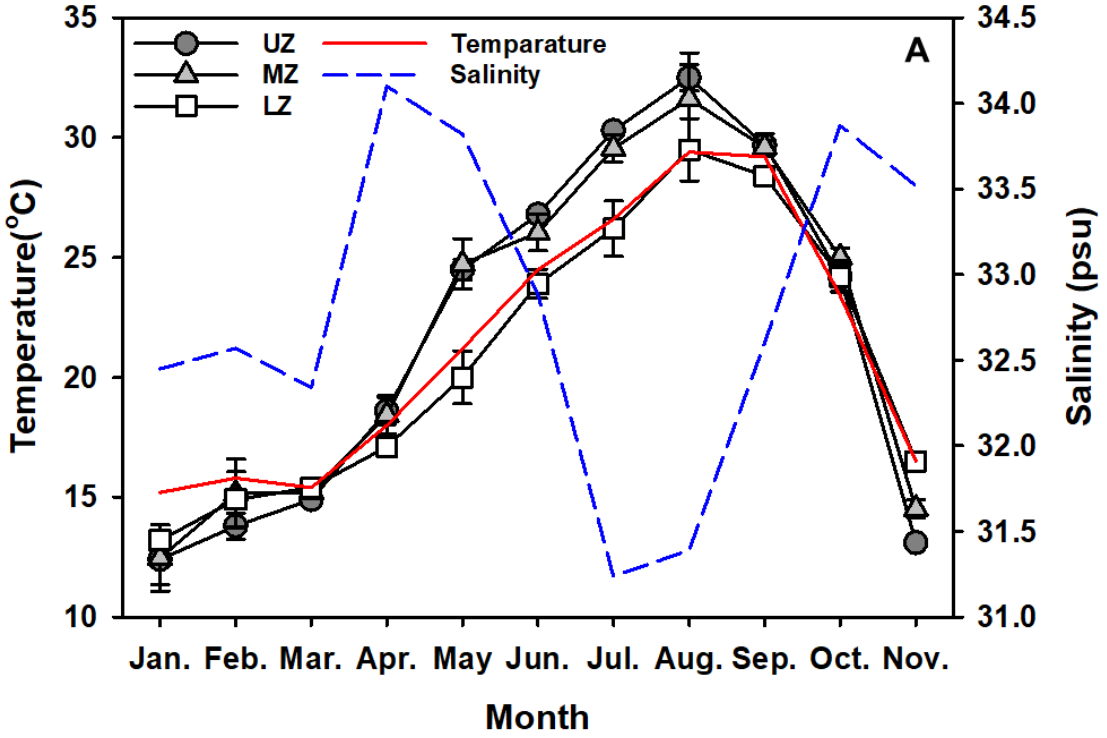

- At each sampling site, sand sediment samples were collected using a core sampler with a diameter of 4 cm and a length of 20 cm, sampling the top 5 cm of sediment.
- The collected sand sediment samples were sieved through a 100 μm mesh, and the filtered samples were fixed with Lugol's solution.
- The fixed samples were then examined under a light microscope to count the abundance and identify the species of dinoflagellates.
- Field measurements included seawater temperature, salinity, and sediment temperature. The moisture content of the sediment was also calculated.
- Additionally, seawater samples were filtered for nutrient analysis (N, P, Si).

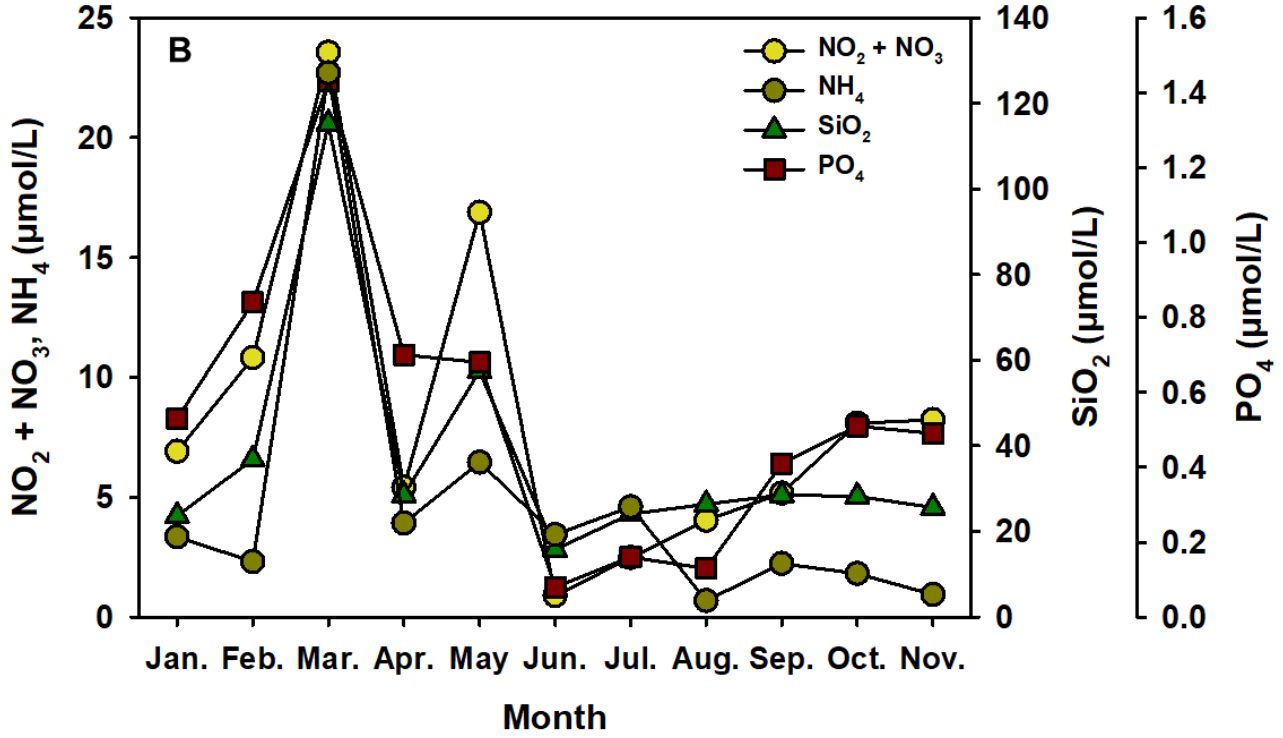
Environmental factors



- The sediment temperature at the upper intertidal zone, where exposure time to air during low tide is longer, shows larger fluctuations.
- Regarding the moisture content, generally, the lower intertidal zone shows higher values, but station 2, where a waterway exists, shows notably high values.

Environmental factors

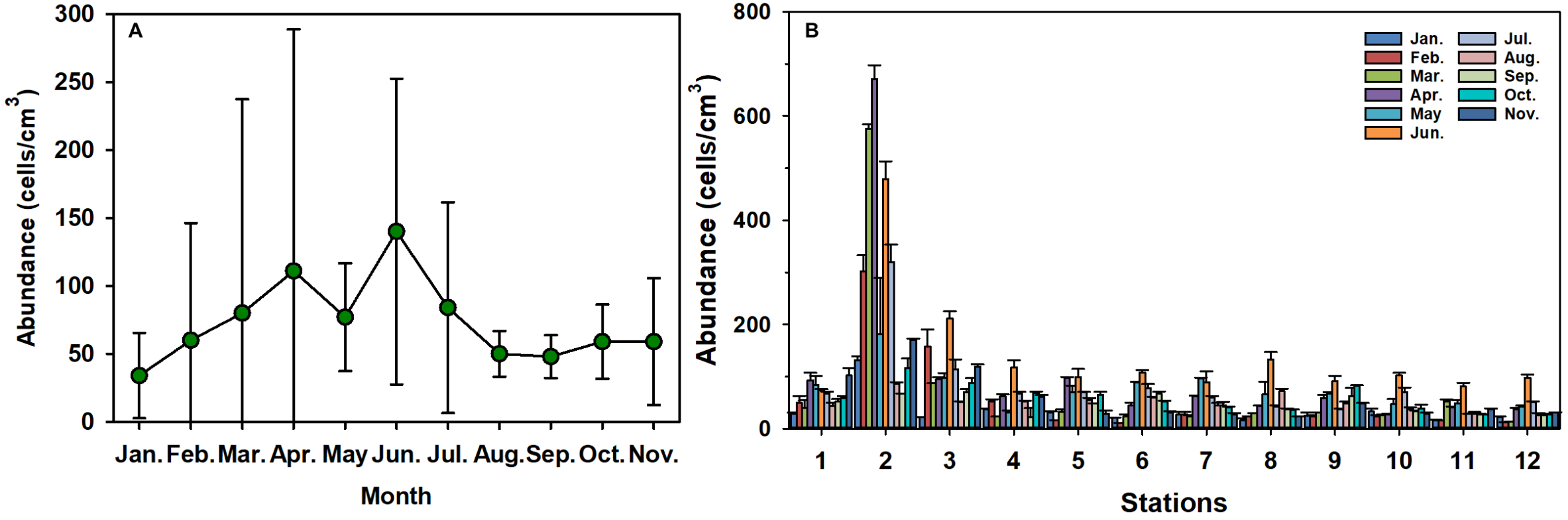




- **Tempearture range:** 15.2 – 29.4 ℃
- **Salinity range:** 31.24 – 34.1 psu
- **Montly average sediment temperature range**
  - **Upper inter tidal zone (UZ)** : 12.4 – 32.5 ℃
  - **Middel intertidal zone (MZ)** : 12.5 – 31.6 ℃
  - **Lower intertidal zone (LZ)** : 13.2 – 29.5 ℃

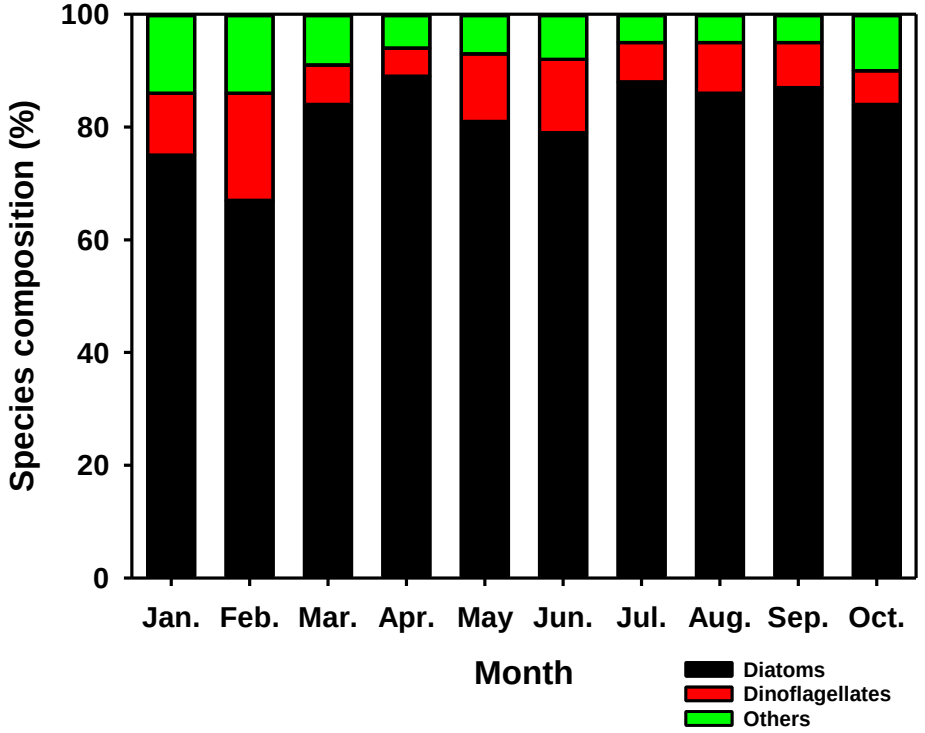
- **Nitrate and nitrite range :** 0.89 – 23.56 µmol/L
- **Ammonium range :** 0.69 – 22.70 µmol/L
- **Silicate range :** 15.80 – 115.27 µmol/L
- **Phosphate range :** 0.08 – 1.43 µmol/L

Benthic microalgae abundance

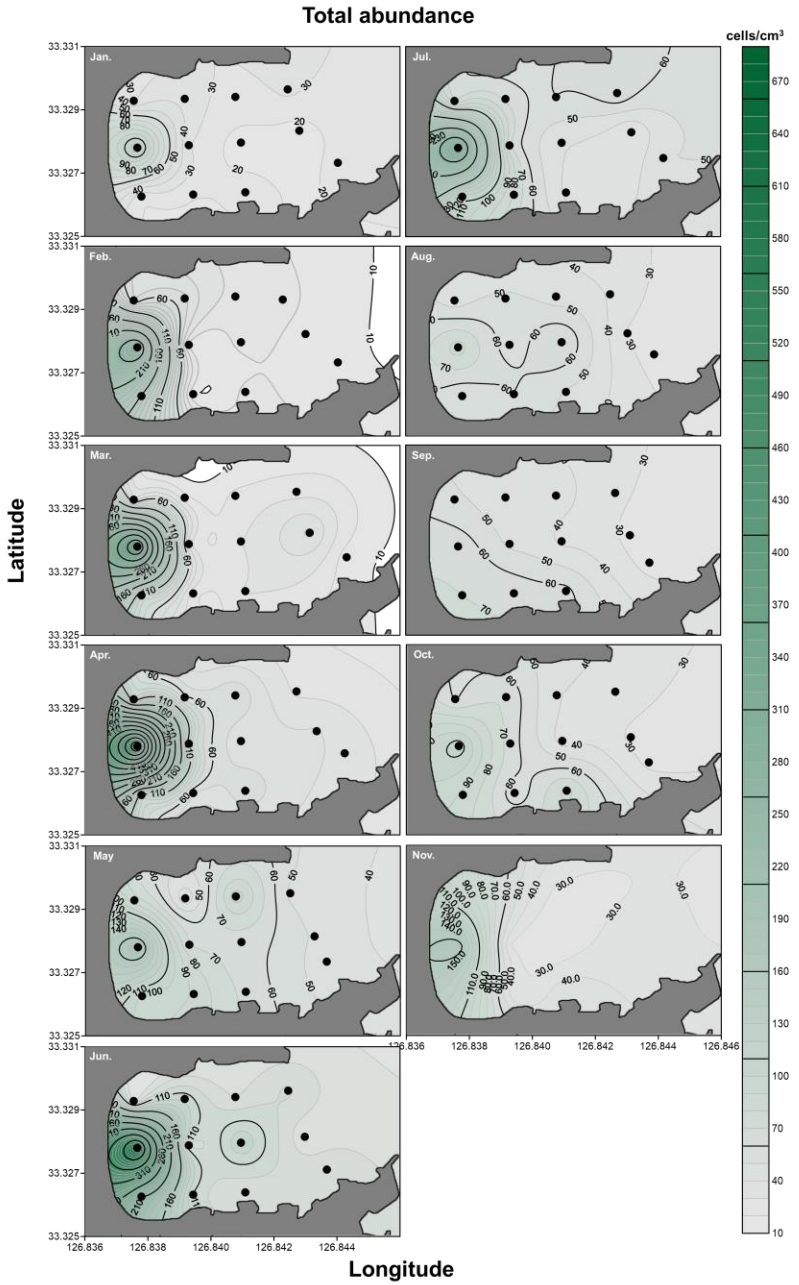


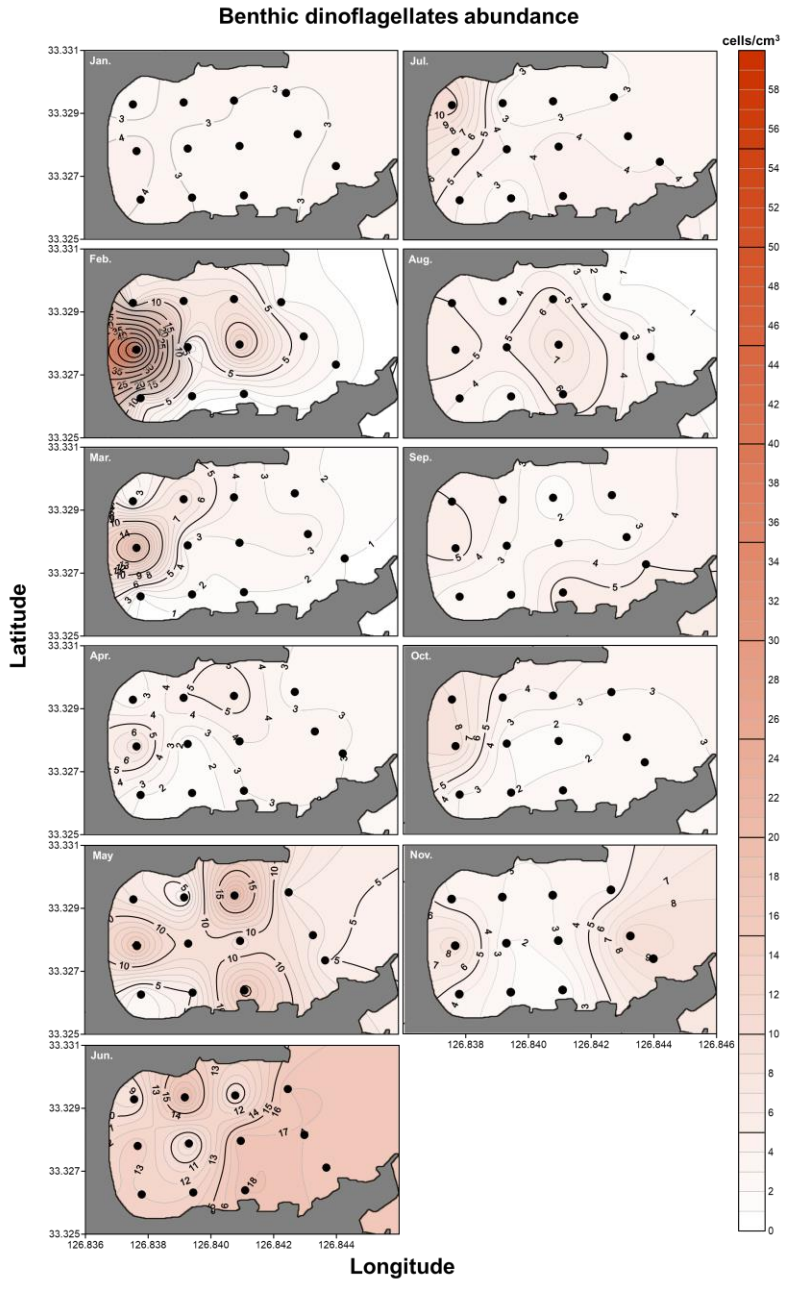
- The average number of total microalgae inhabiting the intertidal zone was highest in June.
- Among the sampling stations, Station 2, influenced by freshwater inflow, showed a notably high abundance of microalgae.
- The high abundance at Station 2 resulted in significant variability in the monthly average abundance.
- Generally, there was an increasing trend until June, followed by a decrease.

Benthic microalgae species composition



- Benthic algae are dominated by diatoms.
- Regarding dinoflagellates, except for Station 2 in February, relatively high numbers and composition rates were observed in June.





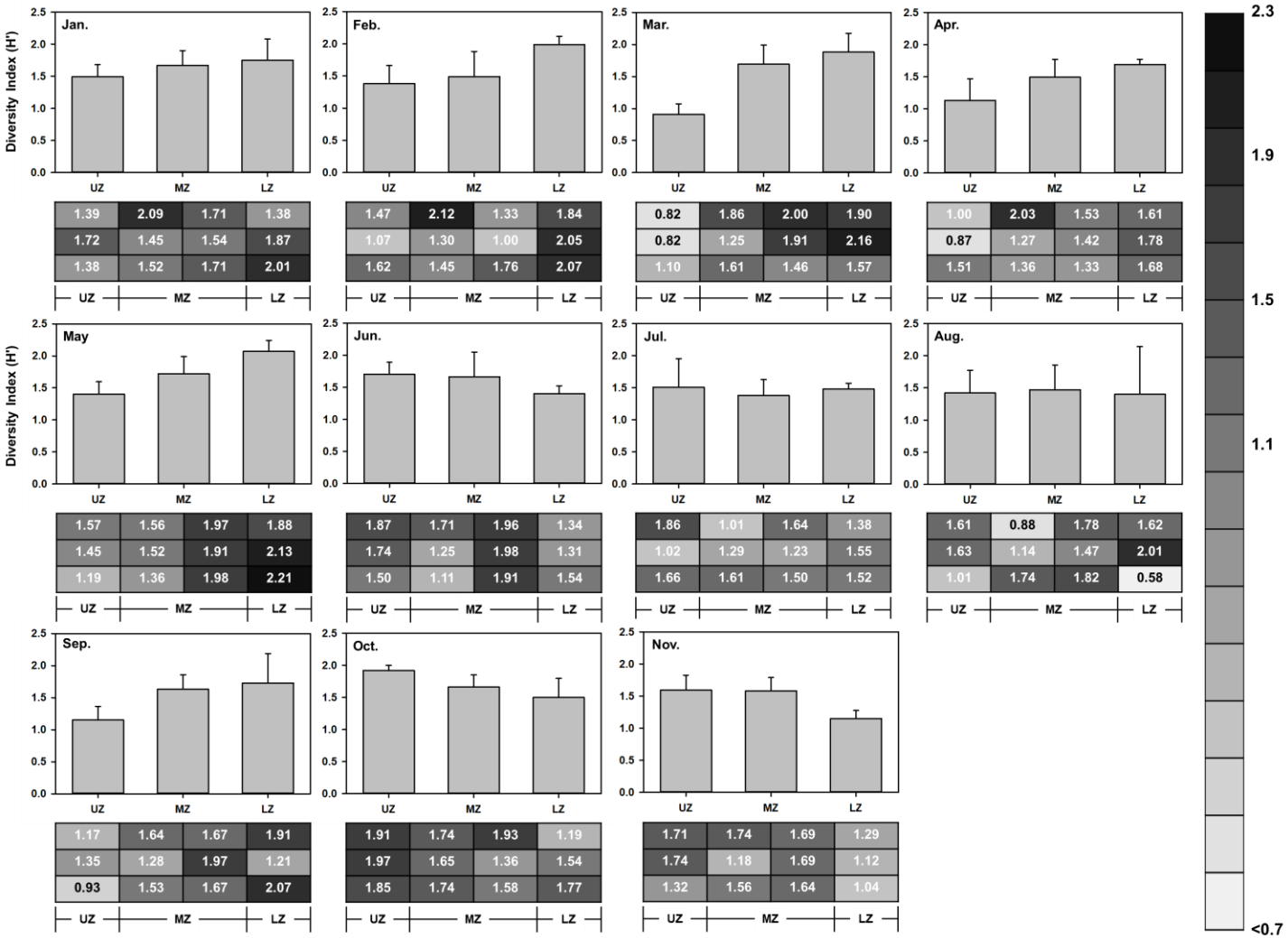
Occurrence species of benthic dinoflagellates

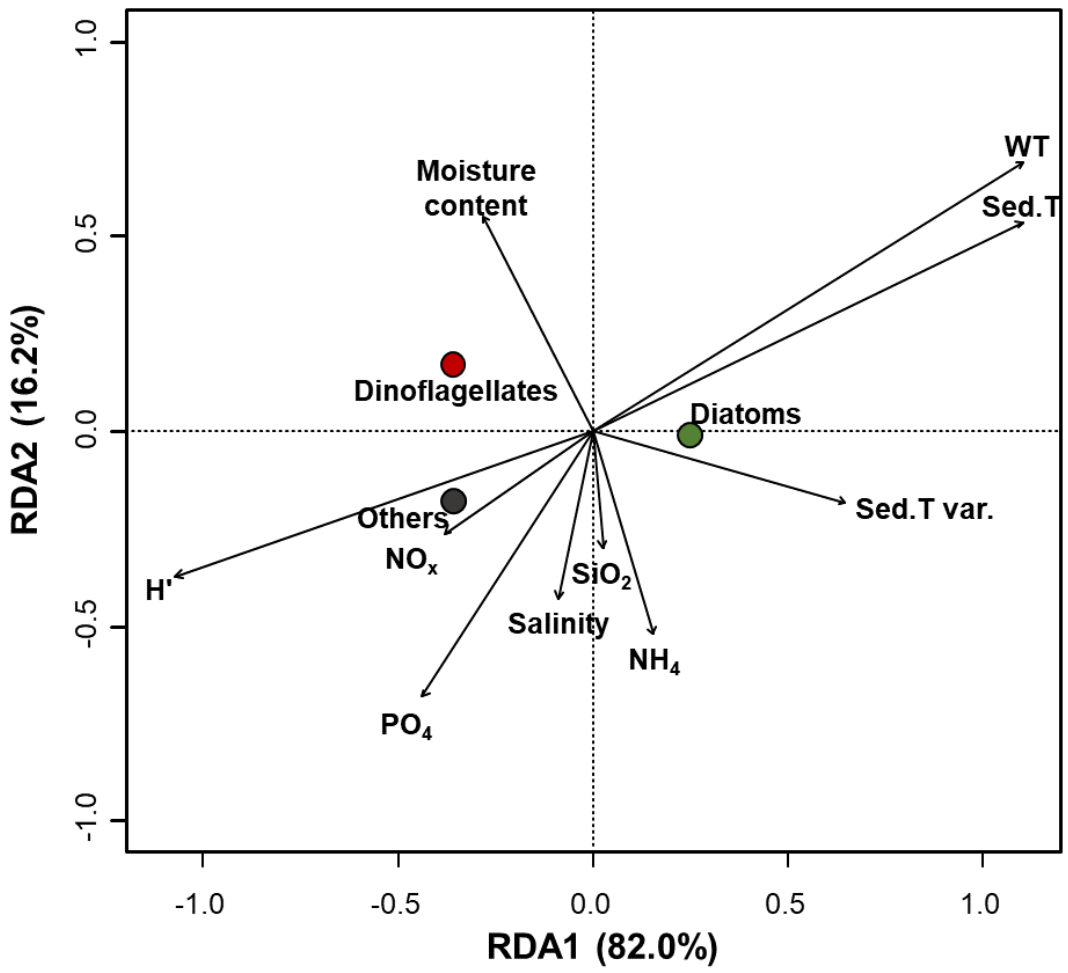
	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Adenoides eludens	+	++	++	++						+	+
Adenoides spp.		+	++	+							
Aduncodinium glandula					++						+++
Amphidiniopsis arenaria								+		+	+
Amphidiniopsis cristata			+		+	+	+	+			+
Amphidiniopsis elongata								+			
Amphidiniopsis hexagona	+		+		++	+					
Amphidiniopsis ovalis											+
Amphidiniopsis rotundata						+		+	++	+	
Amphidiniopsis striata								+			
Amphidiniosis swedmarkii							+			+	+
Amphidiniopsis spp.	+	+	+	+	+	+	+	+	++	++	++
Amphidinium bipes			+	+	+					+	+
Amphidinium carterae	+						+				
Amphidinium gibbosum						+	+				
Amphidinium herdmanii	+	++	+	+	+	+	+	+	+	++	+
Amphidinium incoloratum					+	+		+	+		
Amphidinium massartii	+	+	+	+	+	+	++	+		+	+
Amphidinium operculatum											+
Amphidinium steinii	+	+			+		+	+	+	+	
Amphidinium spp.	++	++	+	+	++	++	++	++	++	++	++
Ankistrodinium armigerum											+
Ankistrodinium semilunatum	+	+	++	++	++	++	++	++	++	++	+
Ankistrodinium spp.								+	+		
Apicoporus parvidiabolii	+	+	++	++	++	+	+		++	++	
Apicoporos spp.	++	++	++	+	++	++	++	++	++	+	++
Bispinodinium angelaceum	+										
Carinadinium ovatum		+	+			+		+	+		
Durinskia agilis			+	+	+						+
Durinskia spp.		+	+		++	++		+			
Gymnodinium spp.	++	+++	+	+	+	+	++	+	+	++	+
Gyrodinium spp.	+	+	+	+	+		+	+	++	+	+
Herdmania litoralis					+				+	+	
***Herdmania* spp.**											+

	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.
Heterocapsa horiguchii			+	+		+					
Heterocapsa psammophila	+	++	+		++	++	+			+	+
Heterocapsa spp.	++	++	++	++	++	++	++	++	++	++	++
Karenia spp.			+								
Katodinium asymmetricum	++	++	++	++	++	+++	++	++	++	++	+
Katodinium spp.	++	+	+	+	+	++	+				
Kryptoperidinium triquetrum											+
Prorocentrum bimaculatum								+			
Prorocentrum concavum					+						
Prorocentrum fukuyoi	+			+	+	+	+	+	+	+	+
Prorocentrum glenanicum									+		
Prorocentrum lima	+										
Prorocentrum micans						+++	+				
Prorocentrum spp.	++	++	+	+	+	+	++	++	+	+	+
Protoperidinium acutum						++					
Protoperidinium mite						+					
Protoperidinium pellucidum				+		+		+			
Protoperidinium spp.	+	+	+	+	+	++	++	+	+	+	+
Psammodinium inclinatum		+	+		+						
Roscoffia capitata	+	+	+	+	+	+	+		+		
Roscoffia minor			+		+	+	+			+	+
Roscoffia spp.		+	+		+	+				+	
Scrippsiella spp.				+					+		
Sinophysis ebriola										+	+
Sinophysis grandis			+	+	+		+	+	+		+
Sinophysis microcephala	+	+	+	+			+			+	
Sinophysis minima		+	+	+			+	+	+		+
Sinophysis vespertilio									+		
***Sinophysis* spp.**											+
Speroidium fungiforme	+					+					
Testudodinium corrugatum	+				+			+			+
Testudodinium testudo		+					+				
Testudodinium spp.	+	+					+				
Thecadinium kofoidii	+	++	+	+	+	+	+		+		+

- During the survey period, a total of over 68 species from 25 genera were observed, including 16 unrecorded species in Korea and 4 potentially toxic species.

The diversity of benthic dinoflagellates





- The RDA result shows that the composition rate of dinoflagellates had a positive correlation with moisture content and was temperature fluctuation of sediment after low tide.
- Additionally, there was a negative correlation with the dominant taxon, diatoms.

Summary and conclusion

- Through this study, ecological survey methodologies for benthic dinoflagellates were established.
- In 2023, a total of 68 species from 25 genera of benthic dinoflagellates were observed at Pyoseon Beach, Jeju Island. Major genera include *Amphidiniopsis*, *Amphidinium*, *Prorocentrum*, *Sinophysis*, and *Heterocapsa*.
- Species such as *Amphidinium carterae, Amphidinium operculatum, Prorocentrum concavum*, and *P. lima* were identified as potentially toxic species.
- composition rates of benthic dinoflagellates:
  - Positive correlation with sediment moisture content
  - Negative correlation with dominant algal taxa such as benthic diatoms
  - Negative correlation with temperature fluctuation of sediment after low tide
- In conclusion, fundamental information on the community dynamics of benthic dinoflagellates in response to seasonal marine environmental changes has been obtained.
- Since most dinoflagellates are mixotrophic or heterotrophic, future studies should consider other biological factors such as bacterial prey and factors related to DOM/POM.

Thank you!

Q&A