

Lipids as trophic biomarkers: use and inputs in a food web study of Antarctic benthic ecosystems.

Anthony VOISIN

Martin Dogniez, Camille Moreau, Léa Jeunet, Enora Jaffrezic, Fabienne Le Grand, Gilles Lepoint, Loïc Michel, Julien Thébault and Gauthier Schaal

Lipids in the Ocean

June 10th, 2024

COLLEGE SCIENCES
DOCTORAL DE LA MER
BRETAGNE ET DU LITTORAL

UBO
Université de Bretagne Occidentale



LEMAR
laboratoire des sciences
de l'environnement marin
UBO | CNRS | IRD | Ifremer

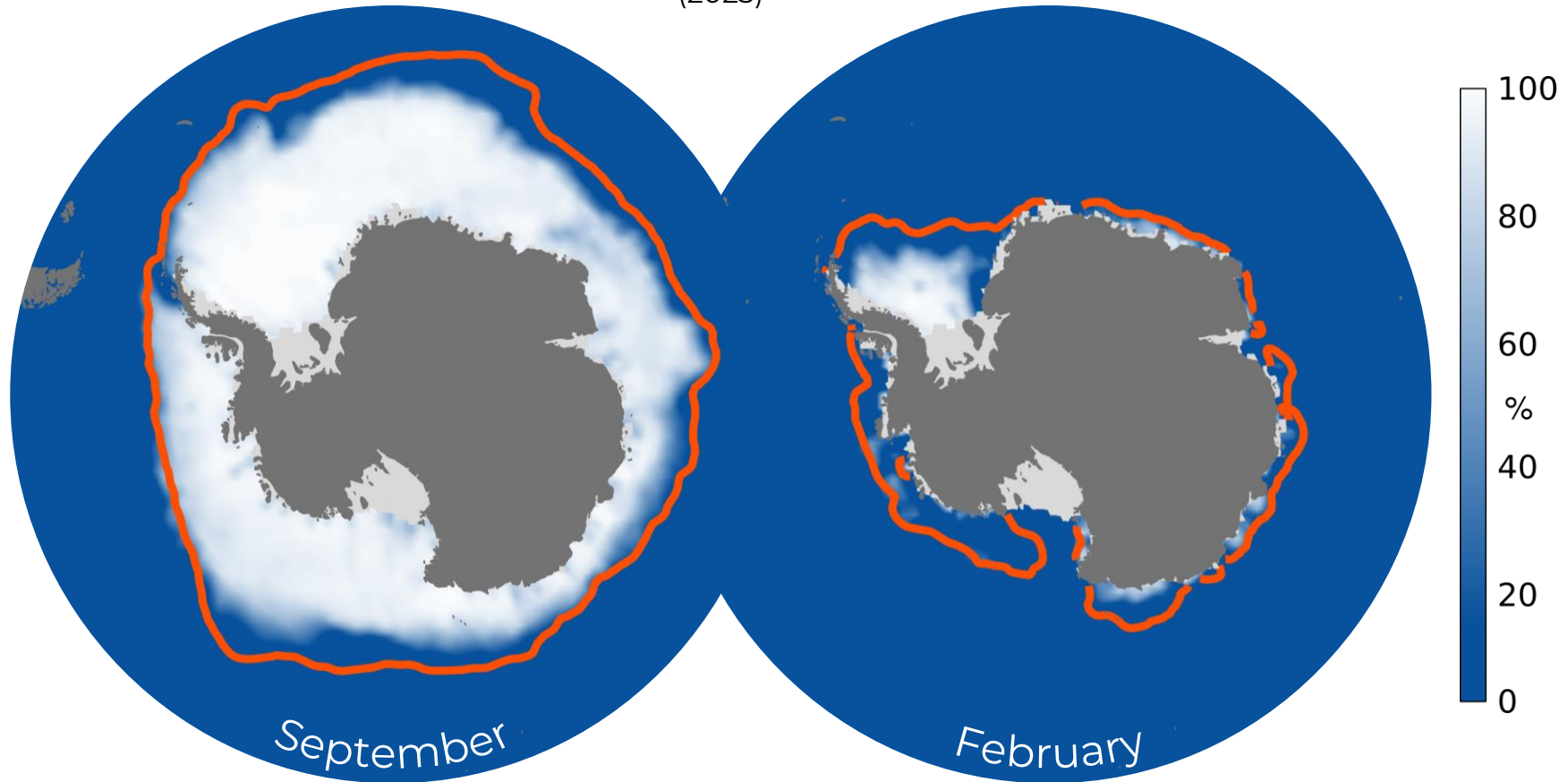
LIÈGE
université

Context

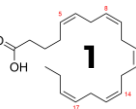
Southern Ocean

⇒ Ice cycle dynamics

Antarctic sea ice cover
(2023)



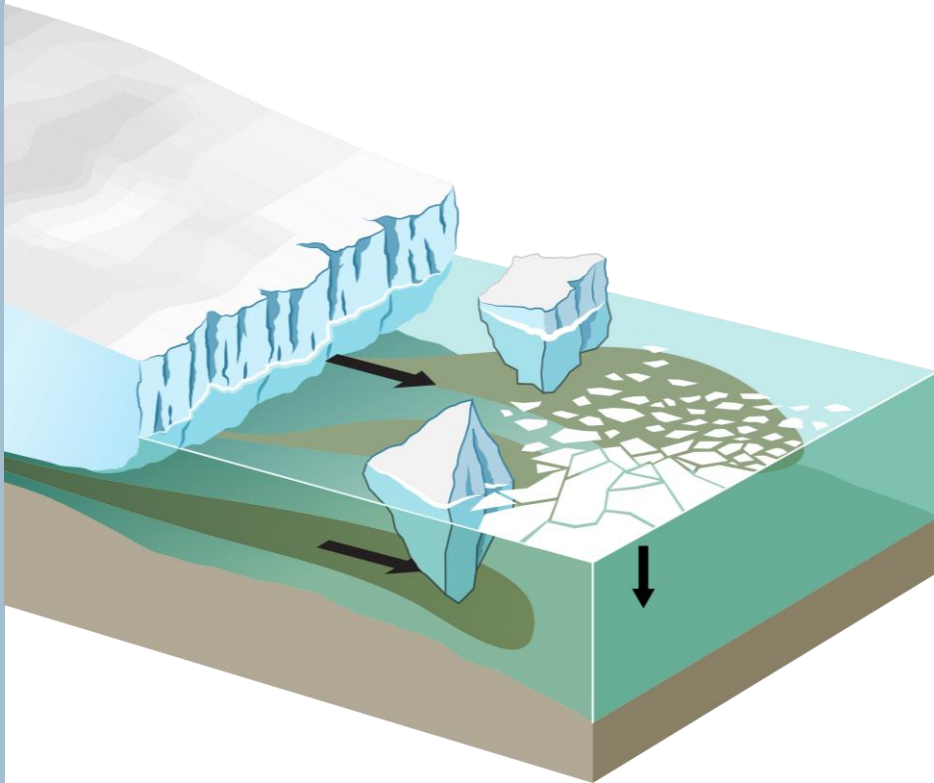
— Average ice edge (1991-2020)



Context

Southern Ocean

⇒ Ice cycle dynamics

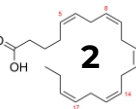


(Meredith et al., 2019 – IPCC Special Report)

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Lipids in the Ocean 2024

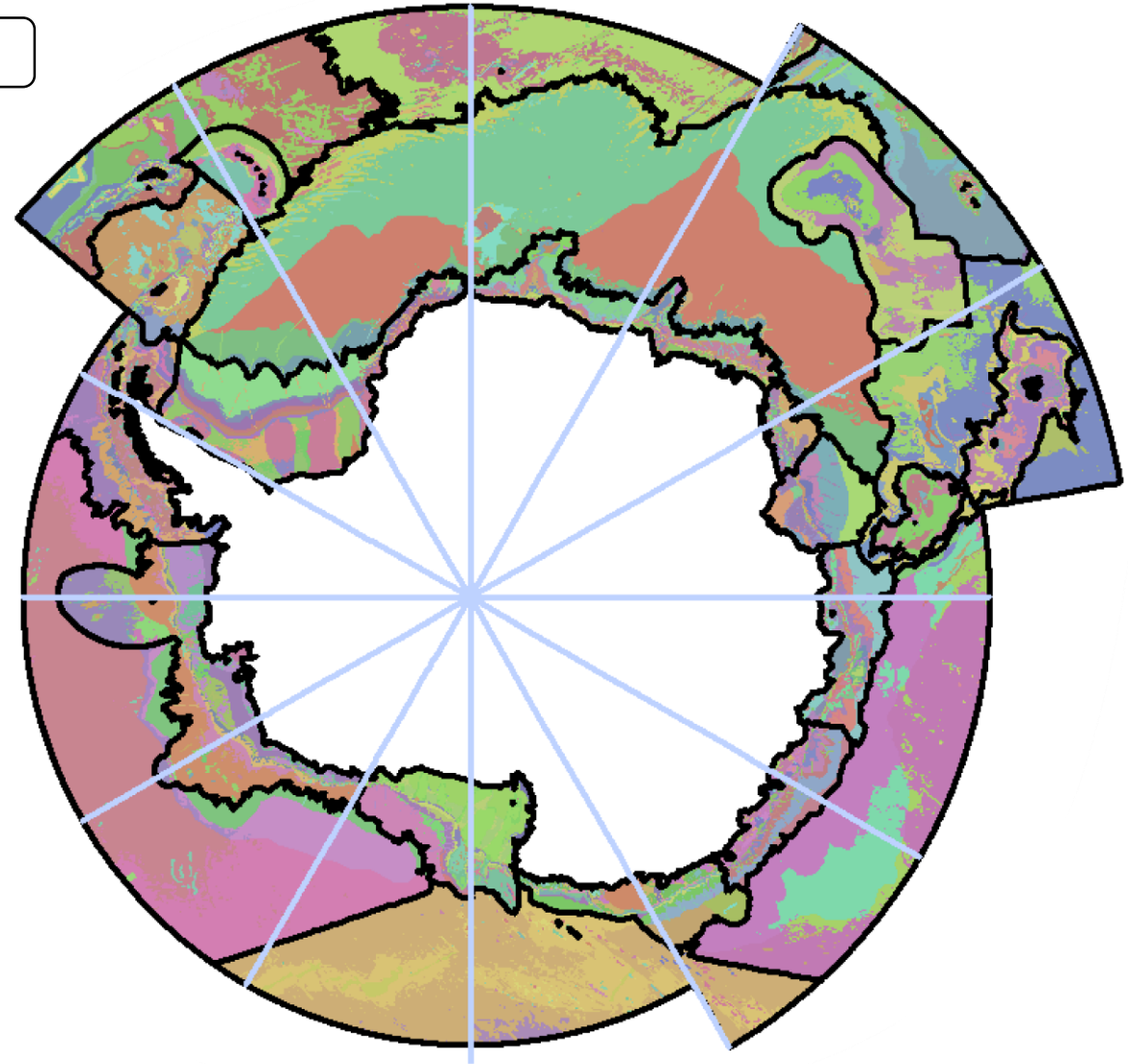
June 10th, 2024



Context

Southern Ocean

- ⇒ Ice cycle dynamics
- ⇒ Contrasting environments



Benthic environmental types classification

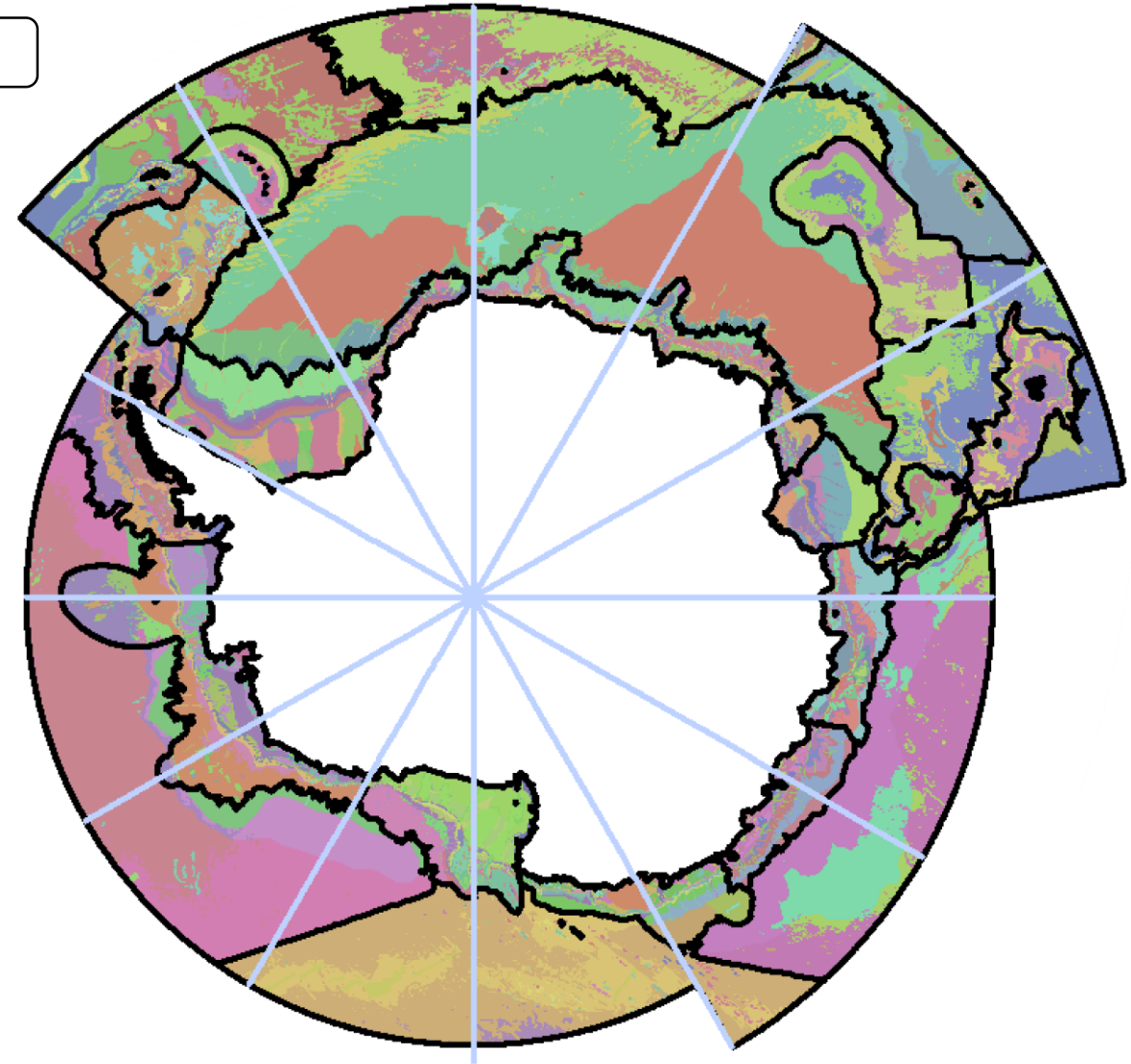
(Douglas et al., 2014)

Context

Southern Ocean

⇒ Ice cycle dynamics

⇒ Contrasting environments



Benthic environmental types classification

(Douglas et al., 2014)

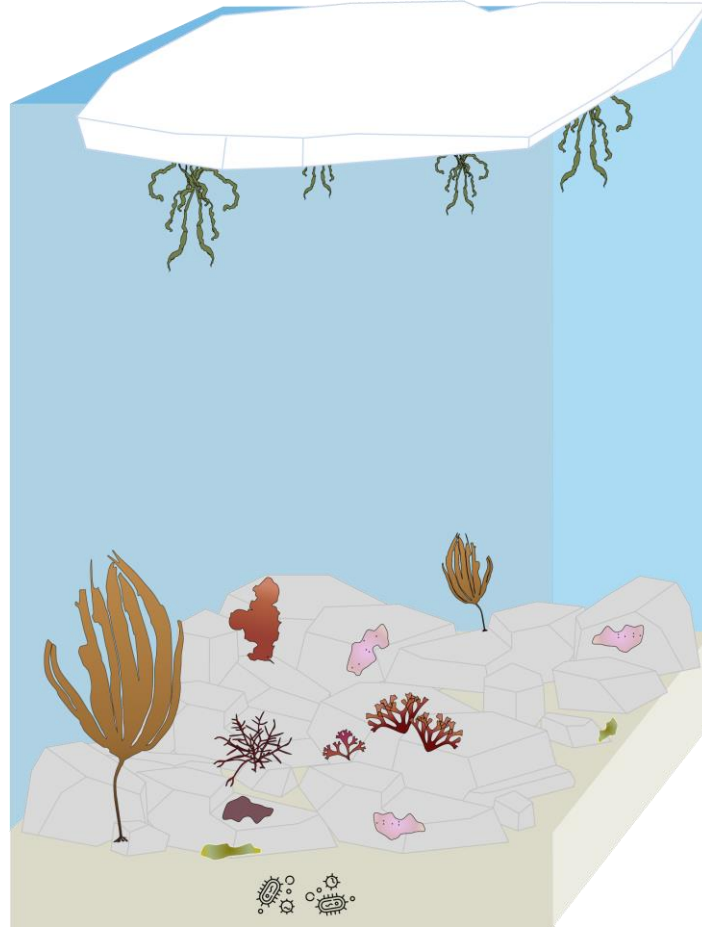
Context

Winter 

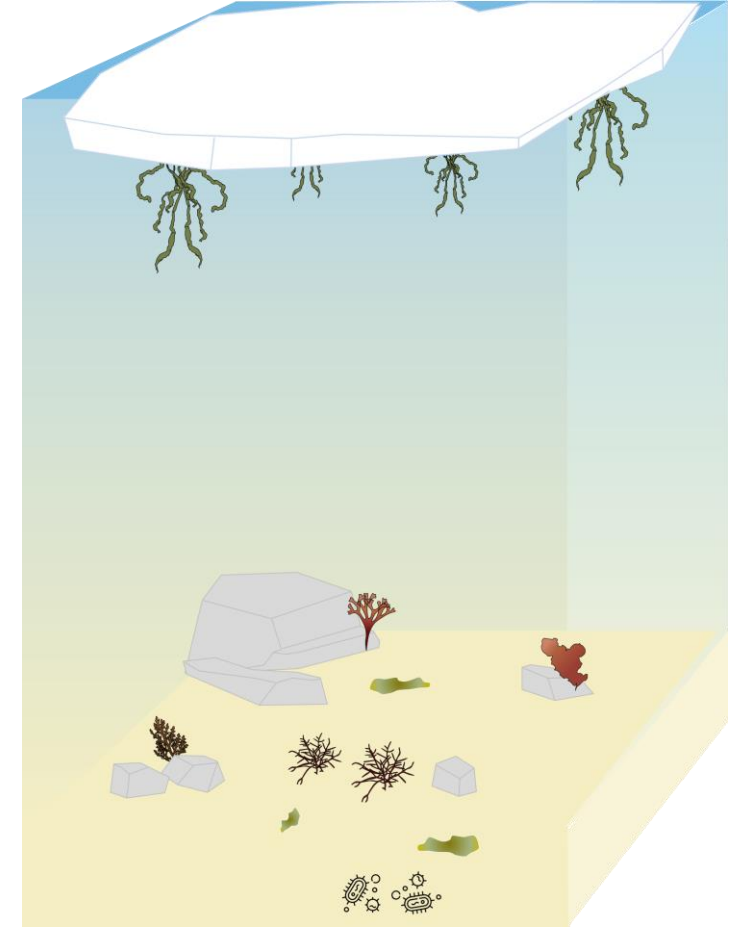
Ecosystem functioning

⇒ Primary production

- Sea ice
- Pelagic
- Benthic



Rocky substrate



Soft sediments

(Ducklow et al., 2012; Constable et al., 2014)

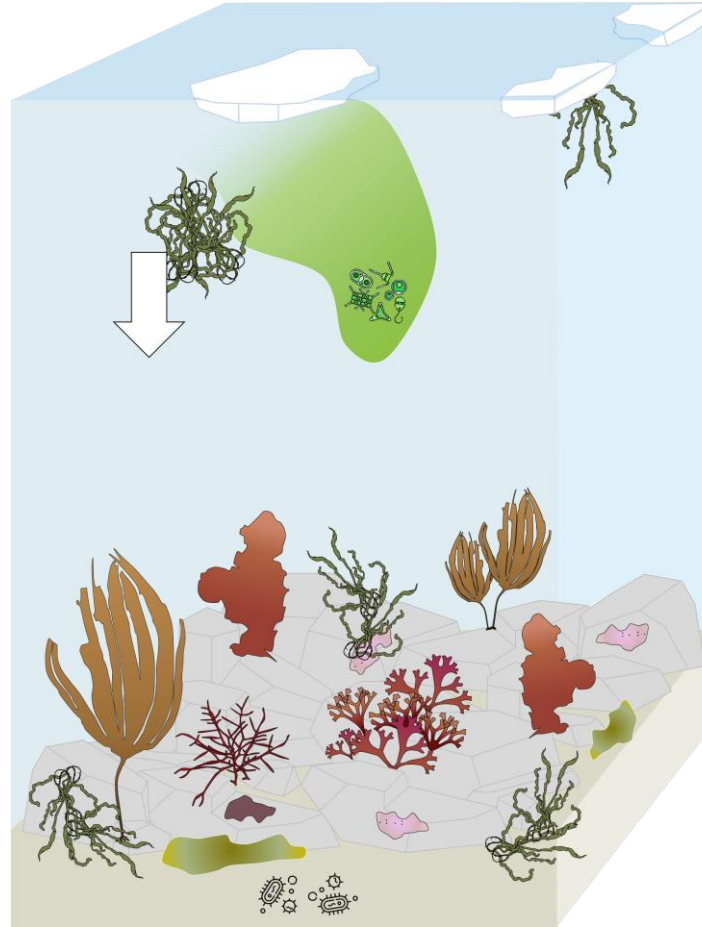
Context

Summer 

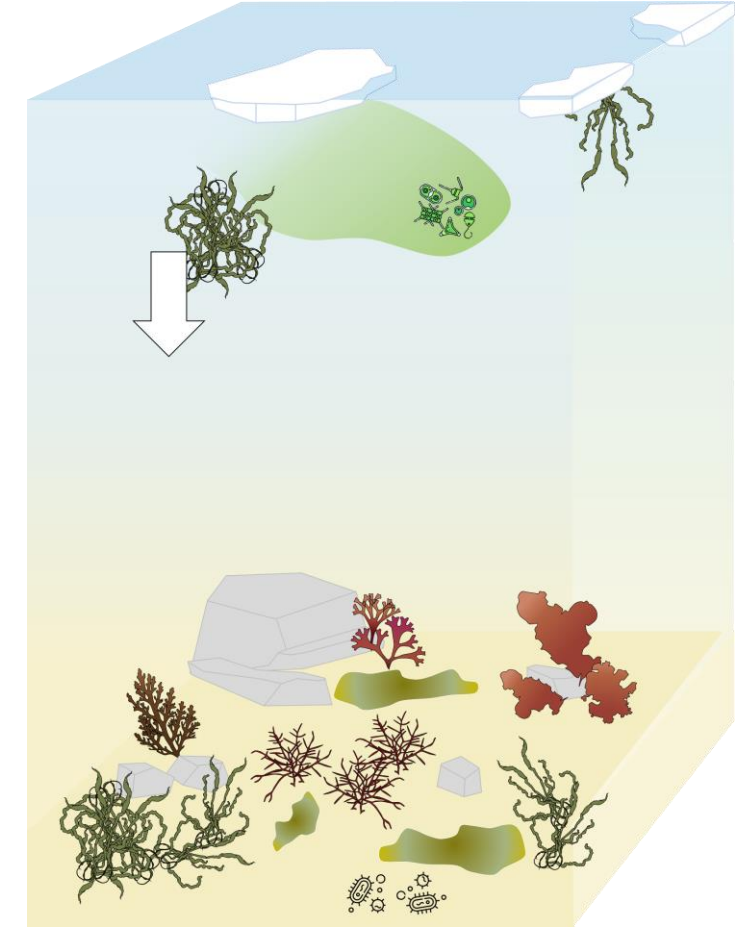
Ecosystem functioning

⇒ Primary production

- Sea ice
- Pelagic
- Benthic



Rocky substrate



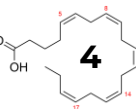
Soft sediments

(Ducklow et al., 2012; Constable et al., 2014)

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Lipids in the Ocean 2024

June 10th, 2024



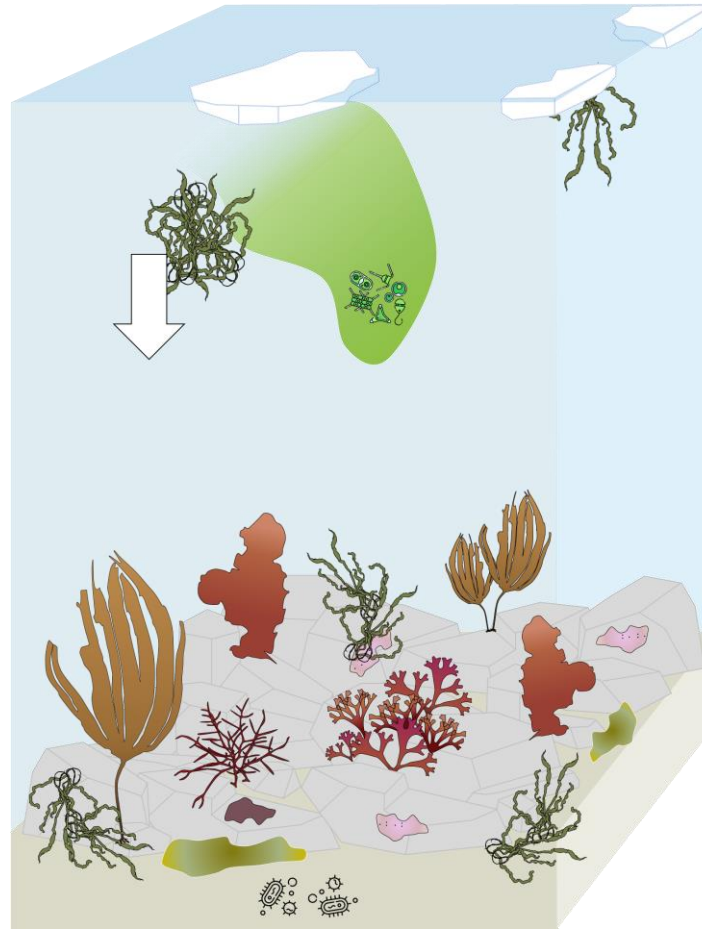
Context

Ecosystem functioning

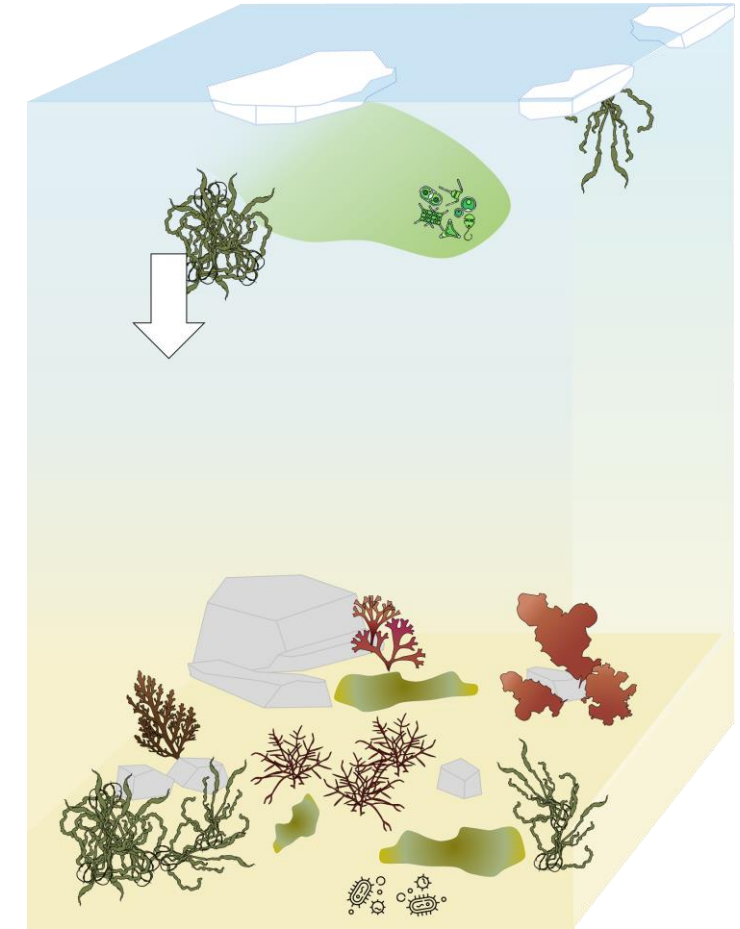
⇒ Primary production


- Sea ice
- Pelagic
- Benthic

Does the diet of benthic consumers change according to their habitat?



 Rocky substrate



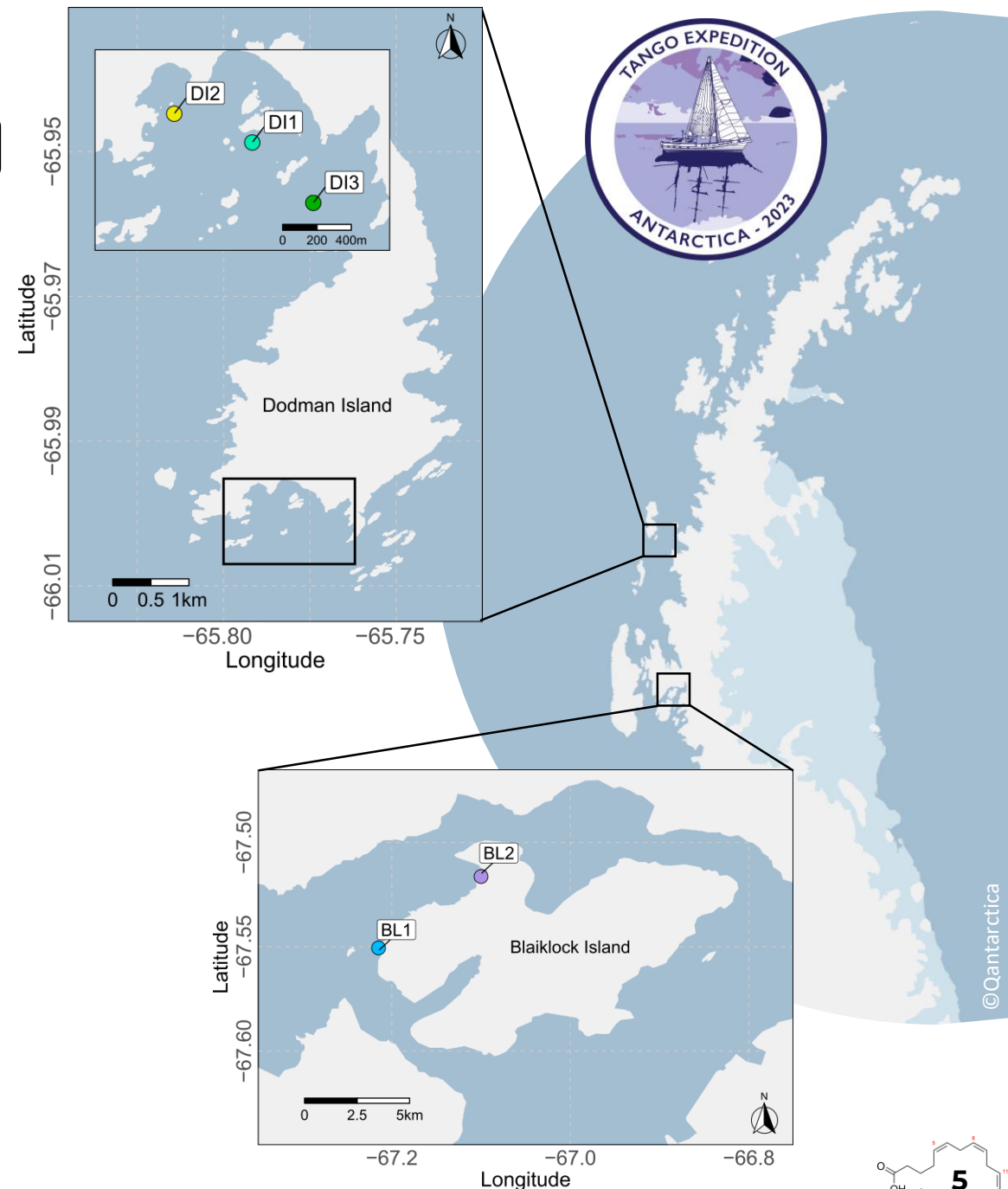
 Soft sediments

(Ducklow et al., 2012; Constable et al., 2014)

Materials & Methods

Study area

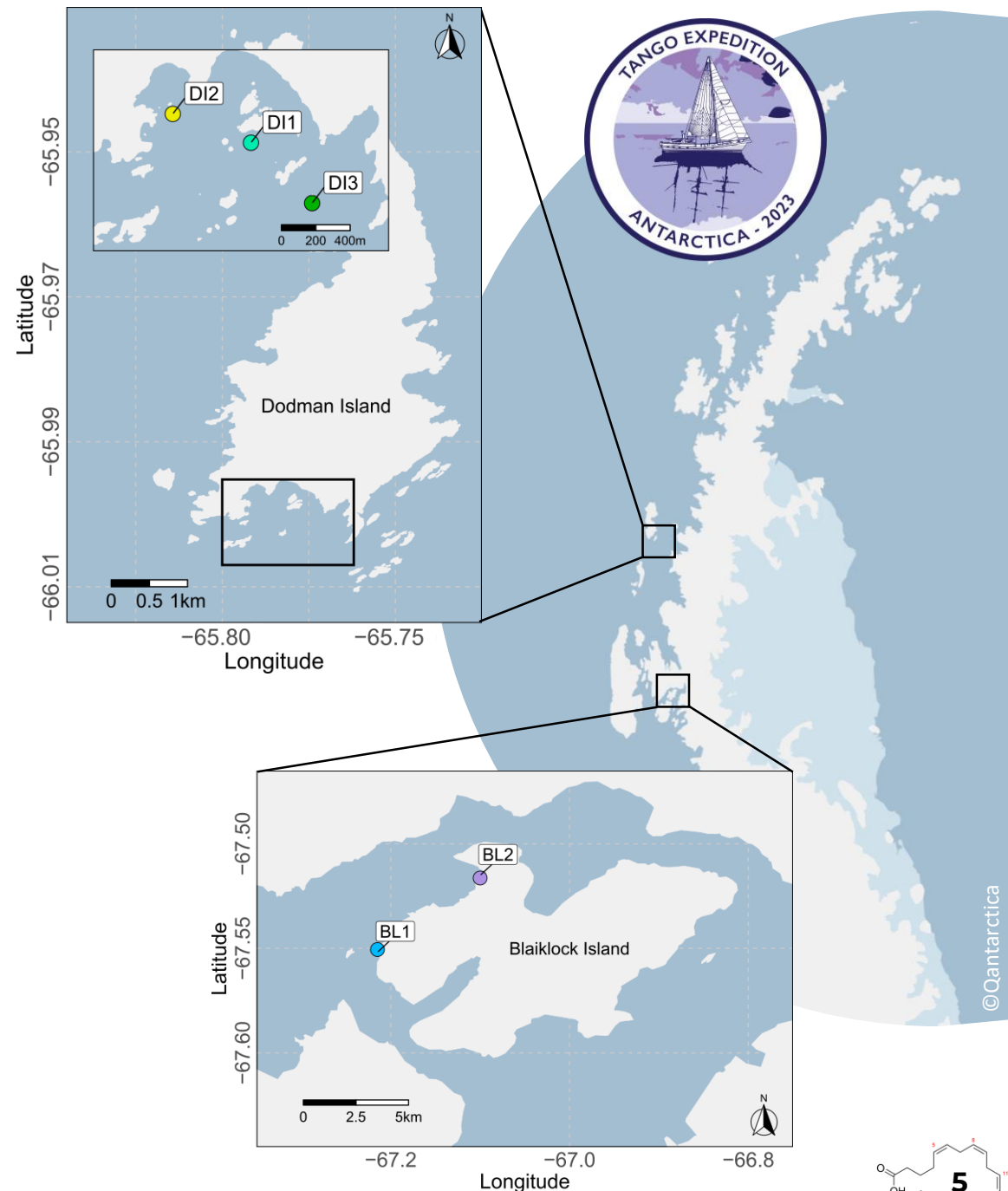
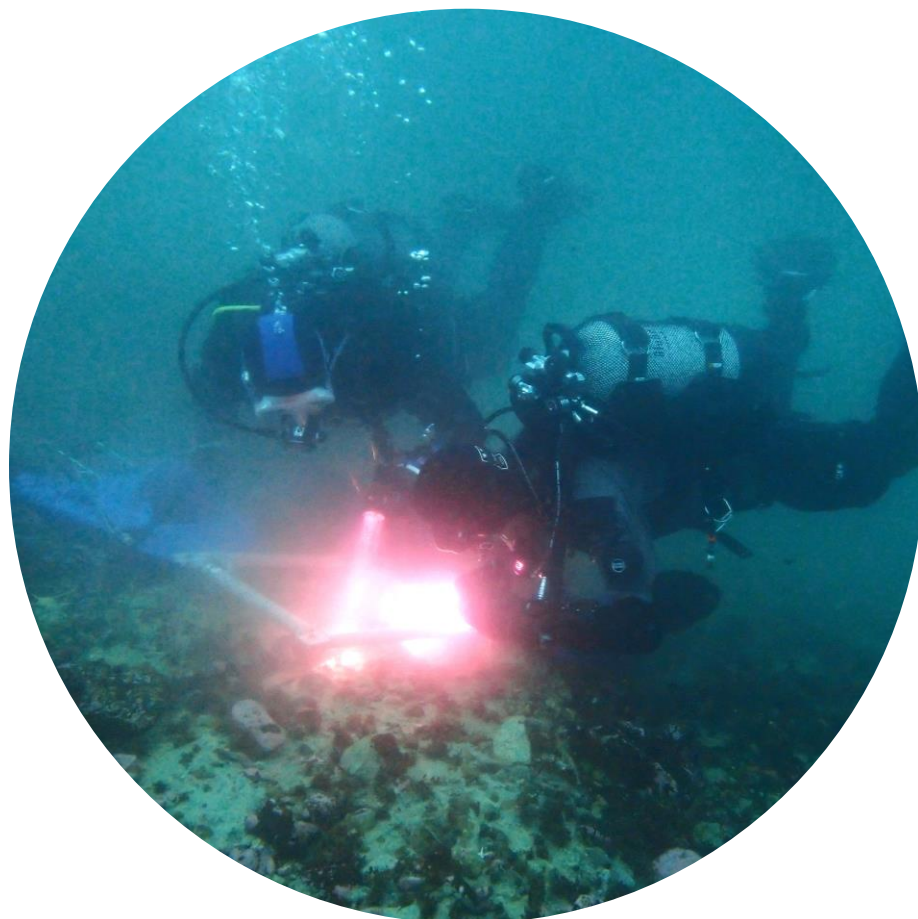
⇒ TANGO 1 expedition (2023)



Materials & Methods

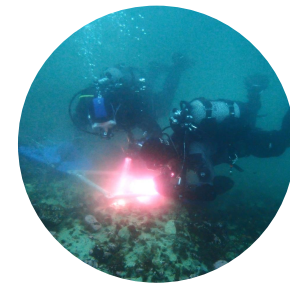
Study area

⇒ TANGO 1 expedition (2023)

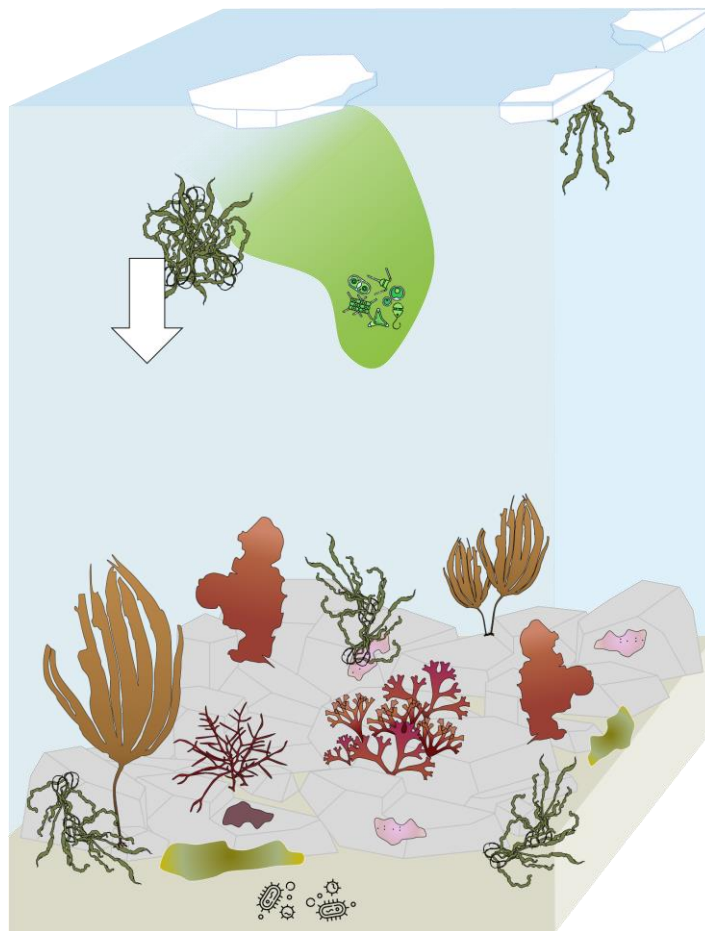


Materials & Methods

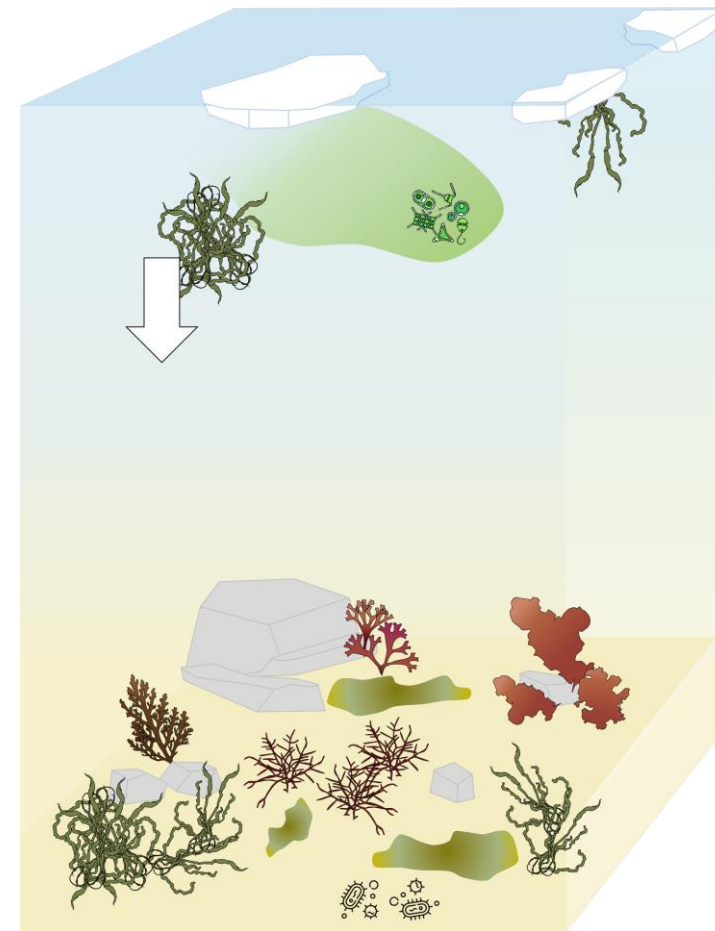
Samples



⇒ Food sources



Rocky substrate

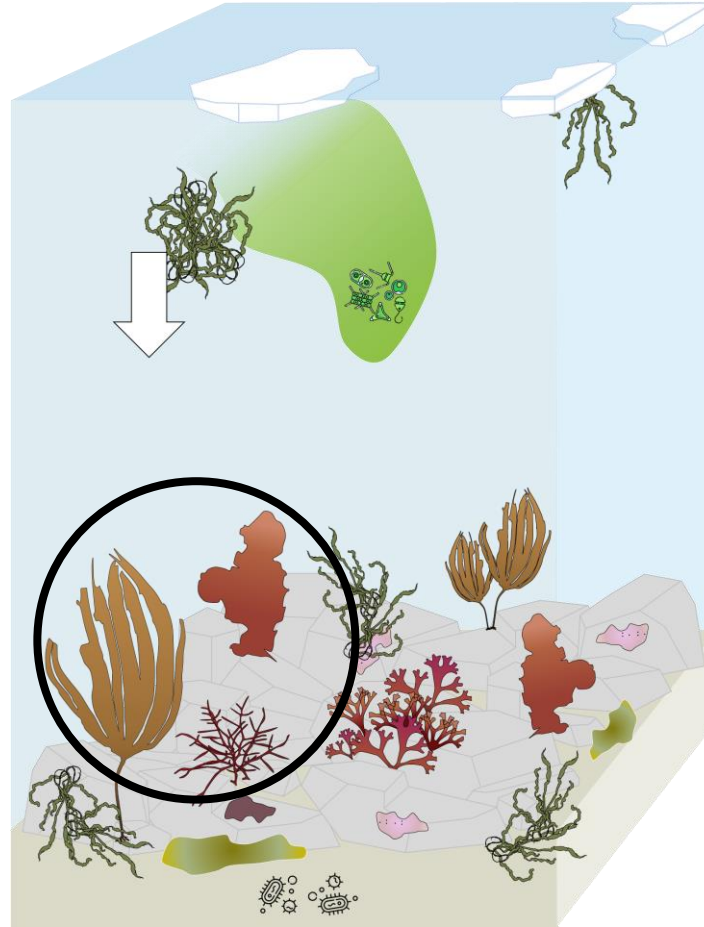


Soft sediments

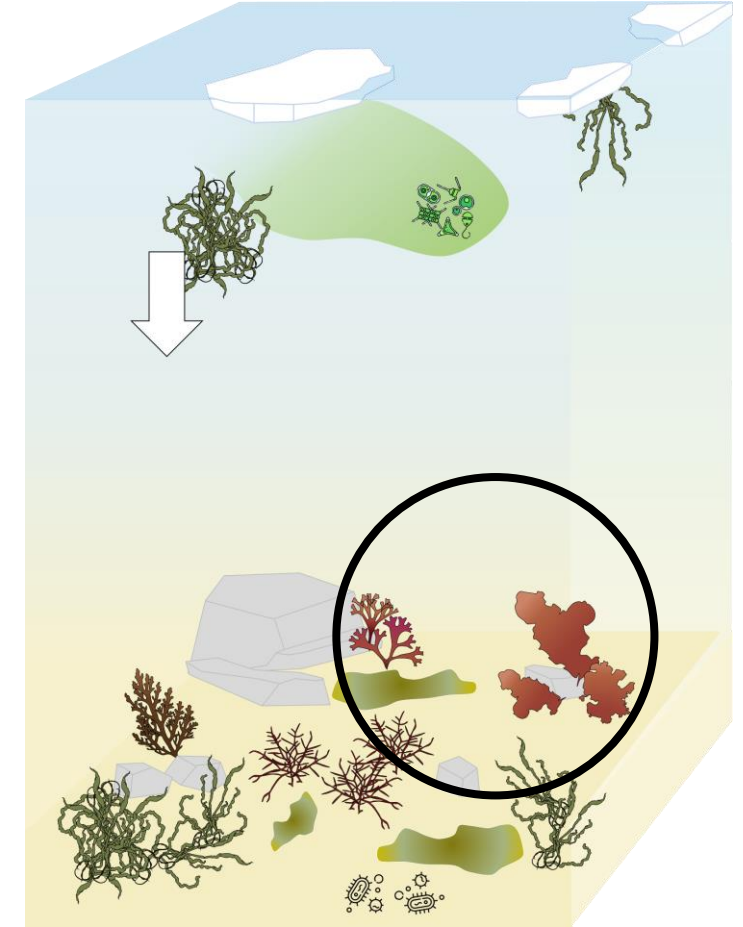
Materials & Methods

Samples

⇒ Food sources



Rocky substrate

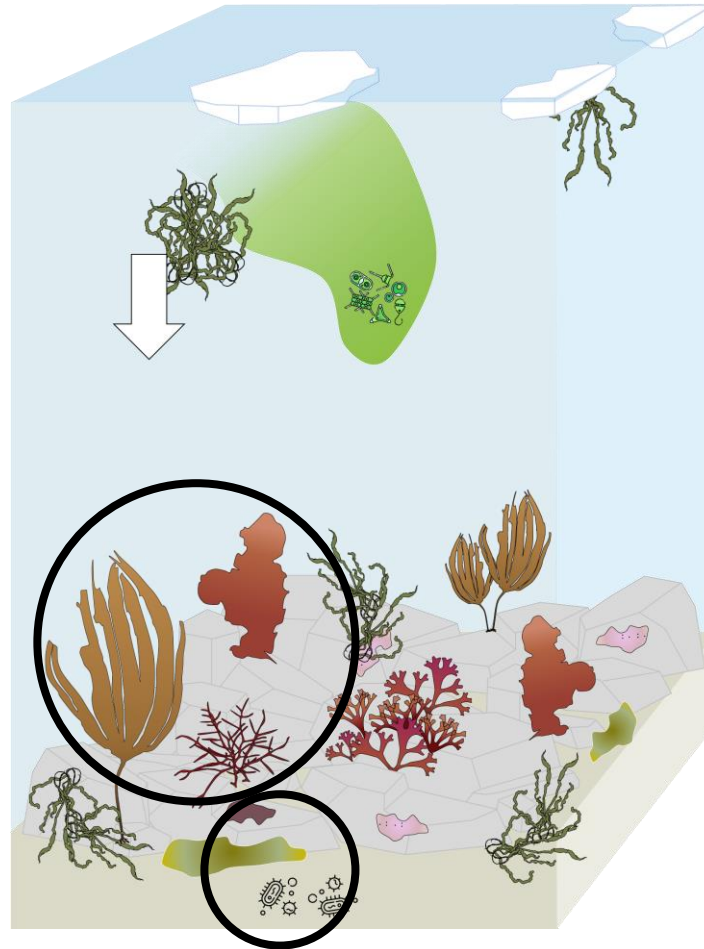
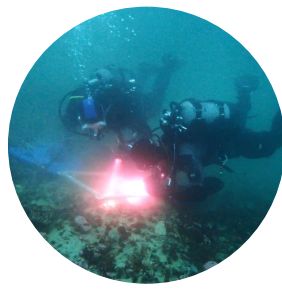


Soft sediments

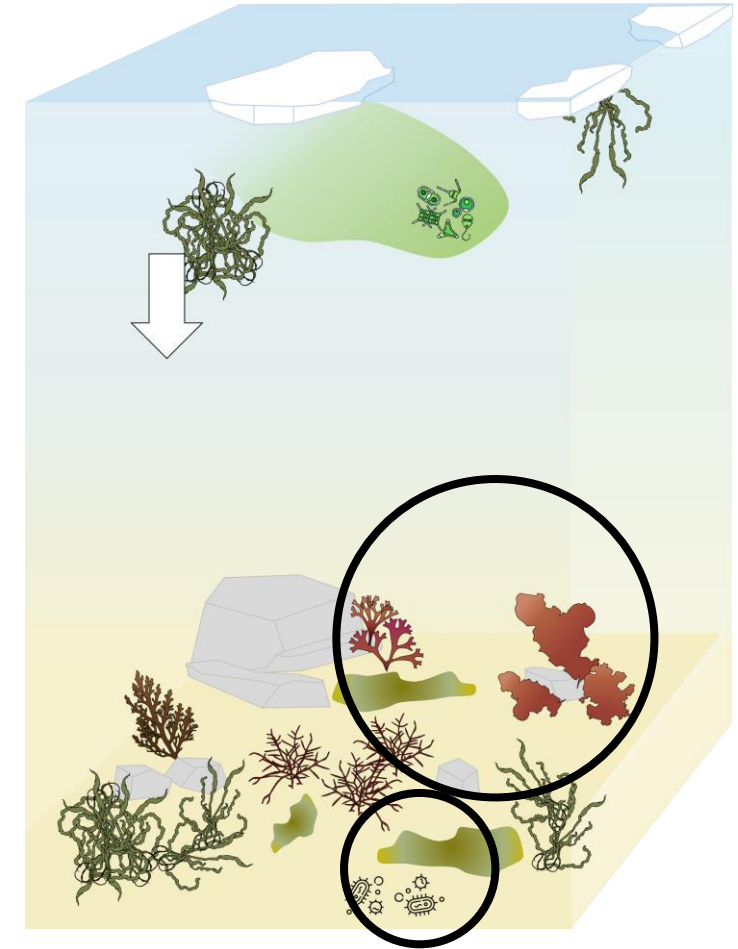
Materials & Methods

Samples

⇒ Food sources



Rocky substrate

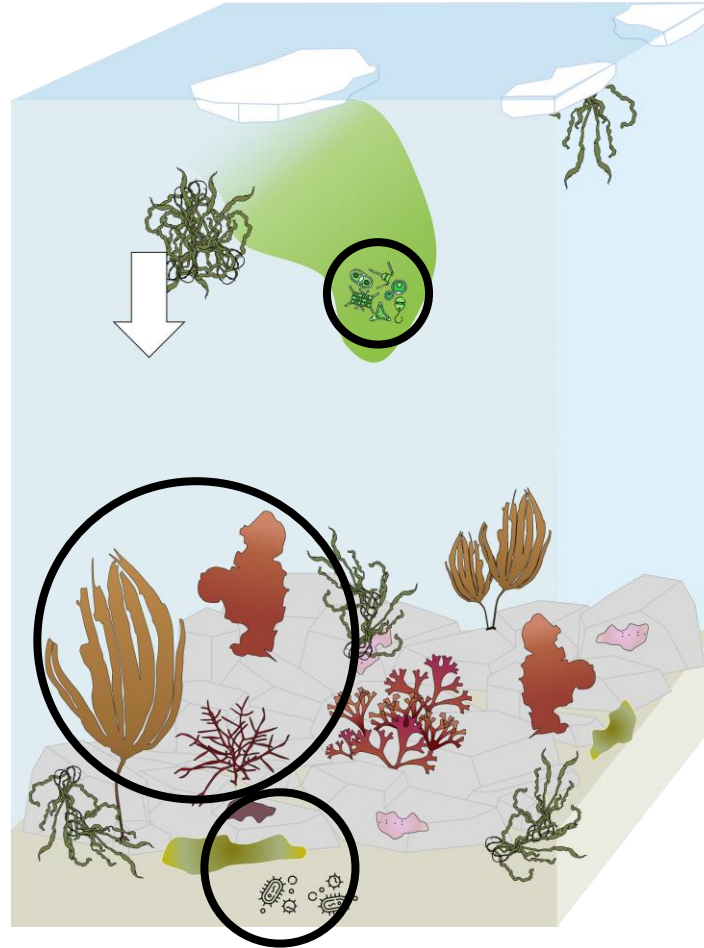


Soft sediments

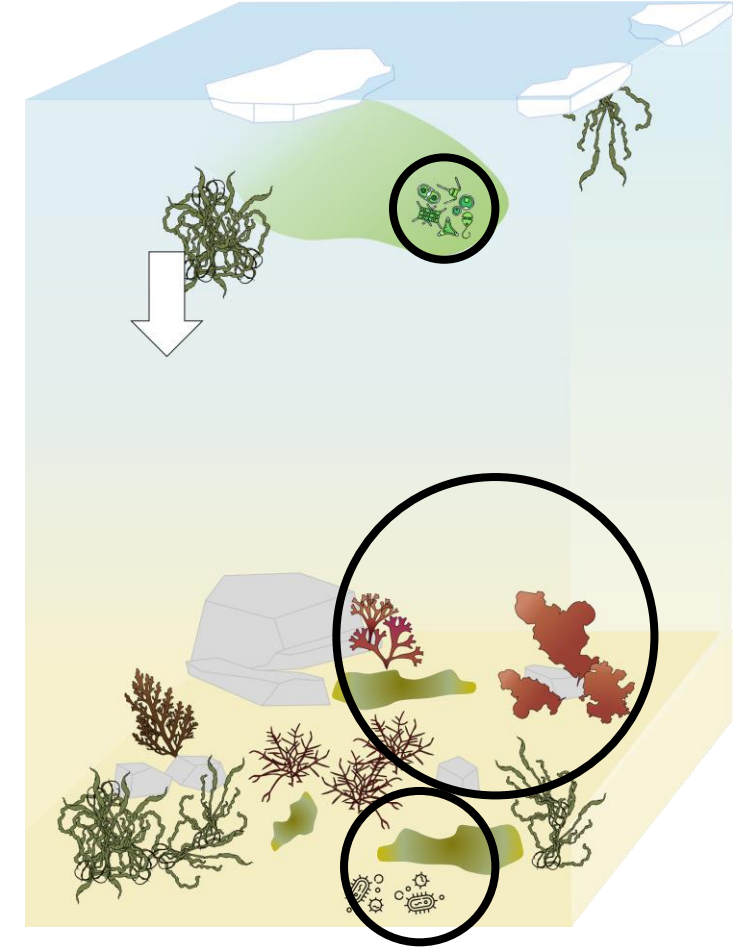
Materials & Methods

Samples

⇒ Food sources



Rocky substrate

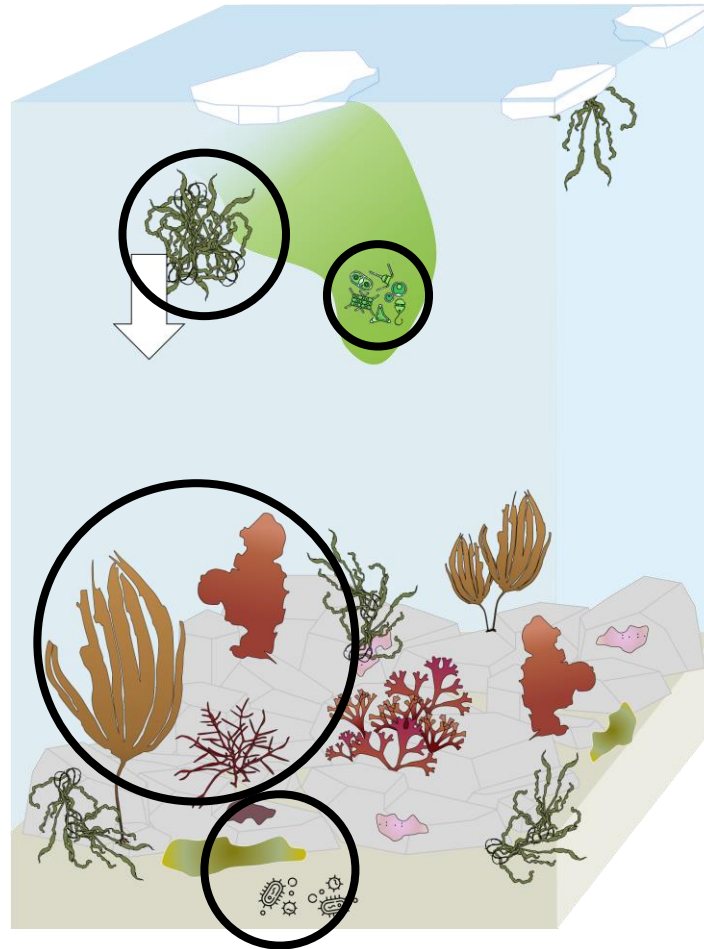
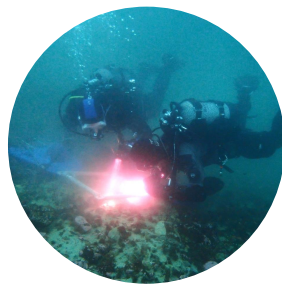


Soft sediments

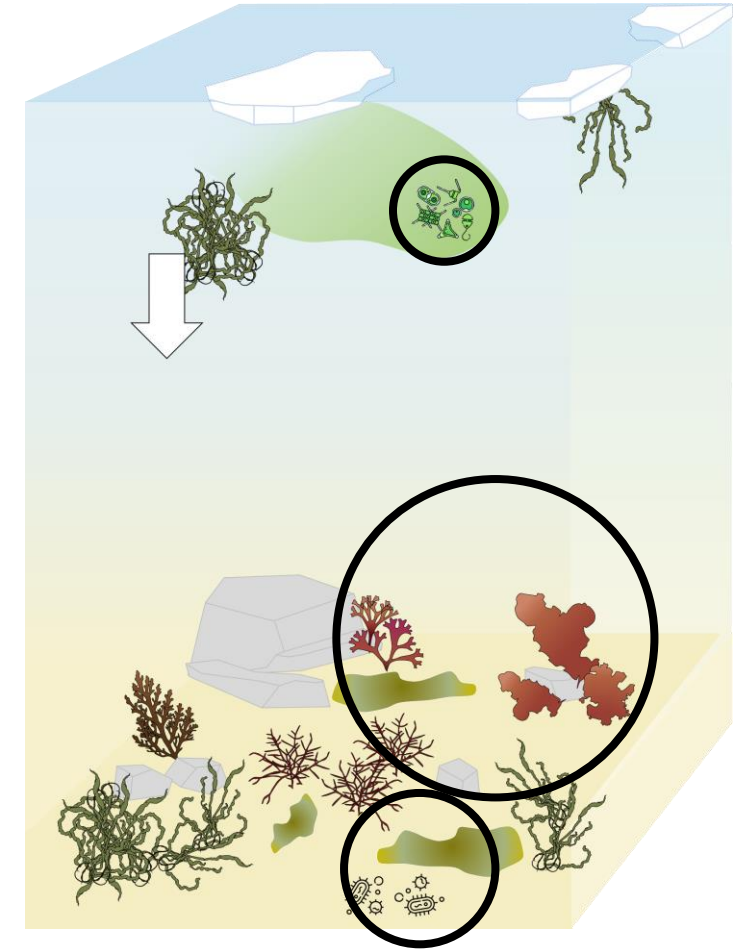
Materials & Methods

Samples

⇒ Food sources



Rocky substrate



Soft sediments

Materials & Methods

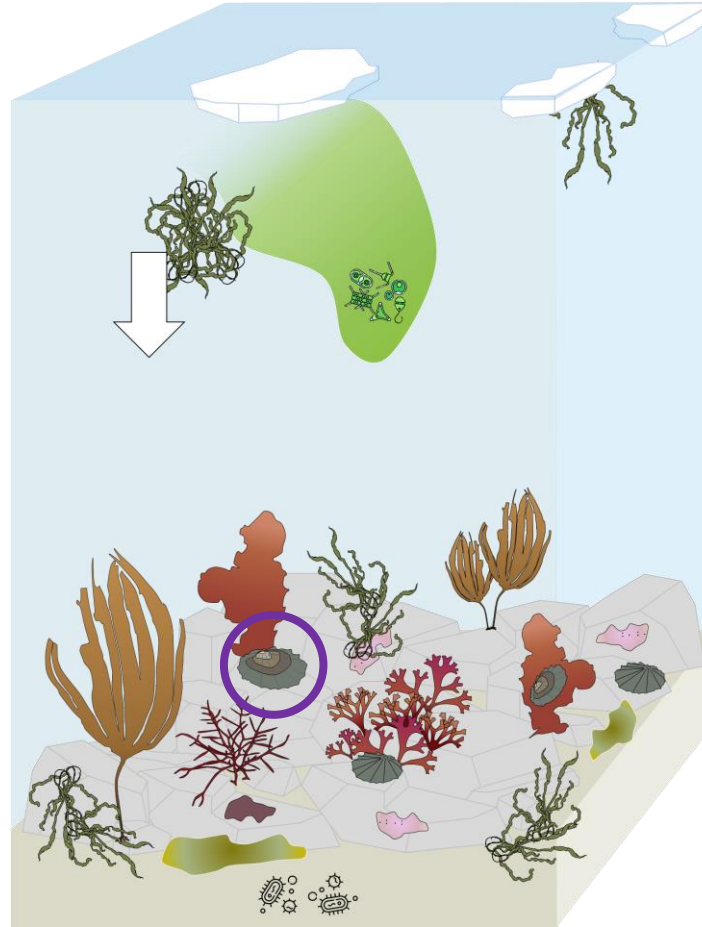
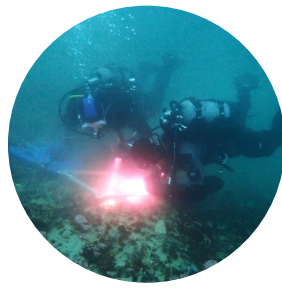
Samples

⇒ Food sources

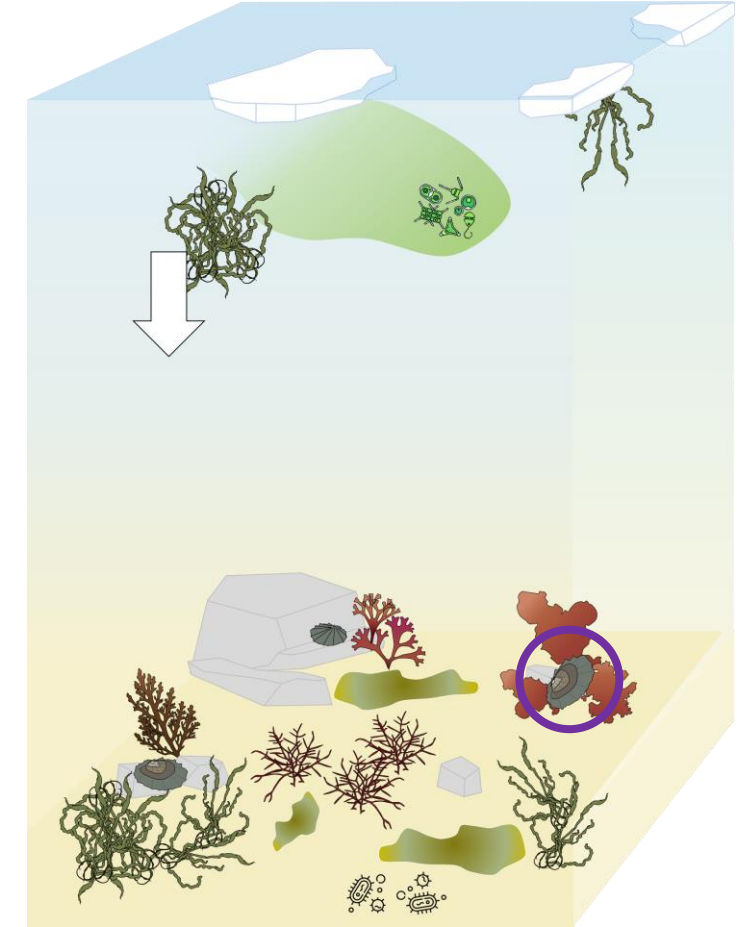
⇒ Consumers



Nacella concinna
(Strebel, 1908)



 Rocky substrate



 Soft sediments

(Corbisier et al., 2004; Clarke, 2008)

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Lipids in the Ocean 2024

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Materials & Methods

Samples

⇒ Food sources

⇒ Consumers



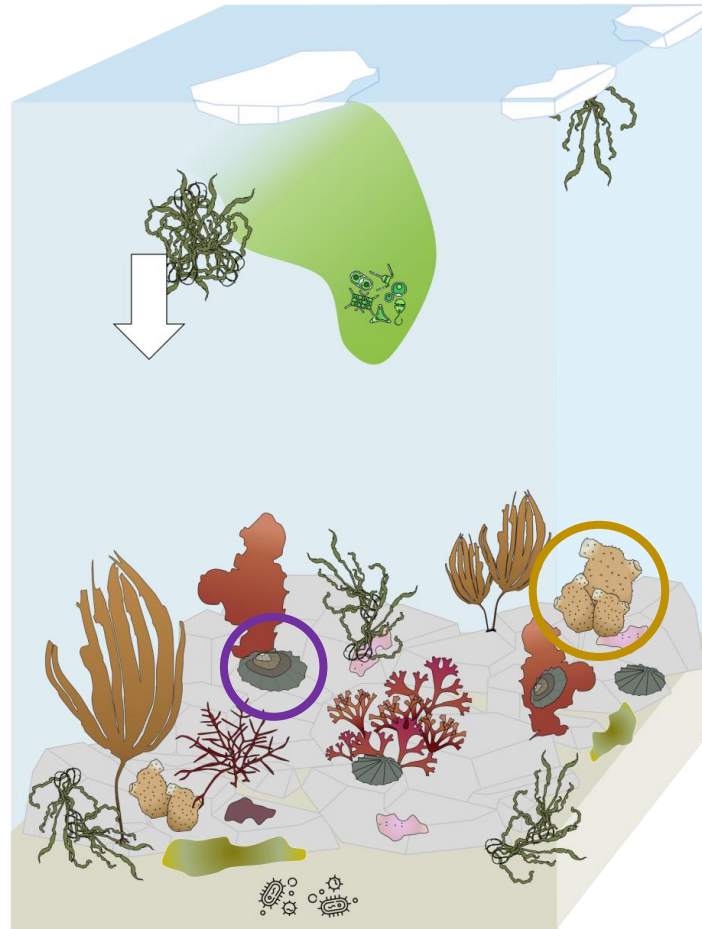
Nacella concinna
(Strebel, 1908)



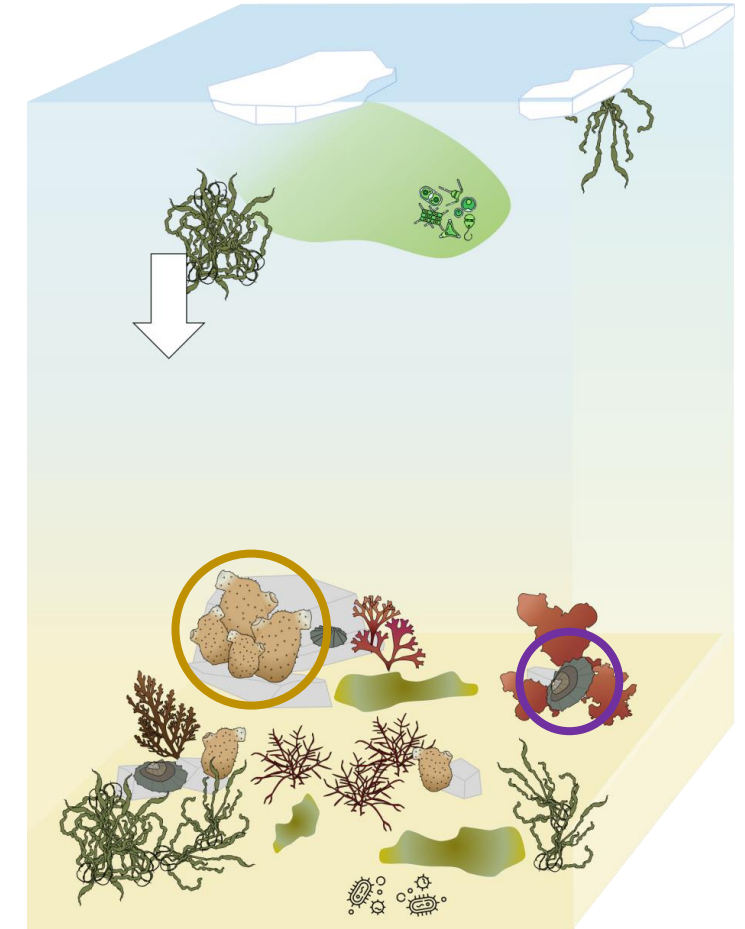
Cnemidocarpa verrucosa
(Lesson, 1830)

(Corbisier et al., 2004; Clarke, 2008)

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 Rocky substrate

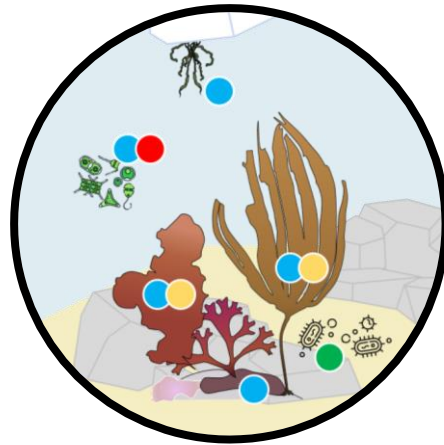



 Soft sediments

Materials & Methods

Analyses

⇒ Trophic biomarker: fatty acids



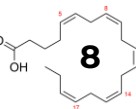
 Source synthesized FA

(Fry, 2006; Kelly and Scheibling, 2012)

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Lipids in the Ocean 2024

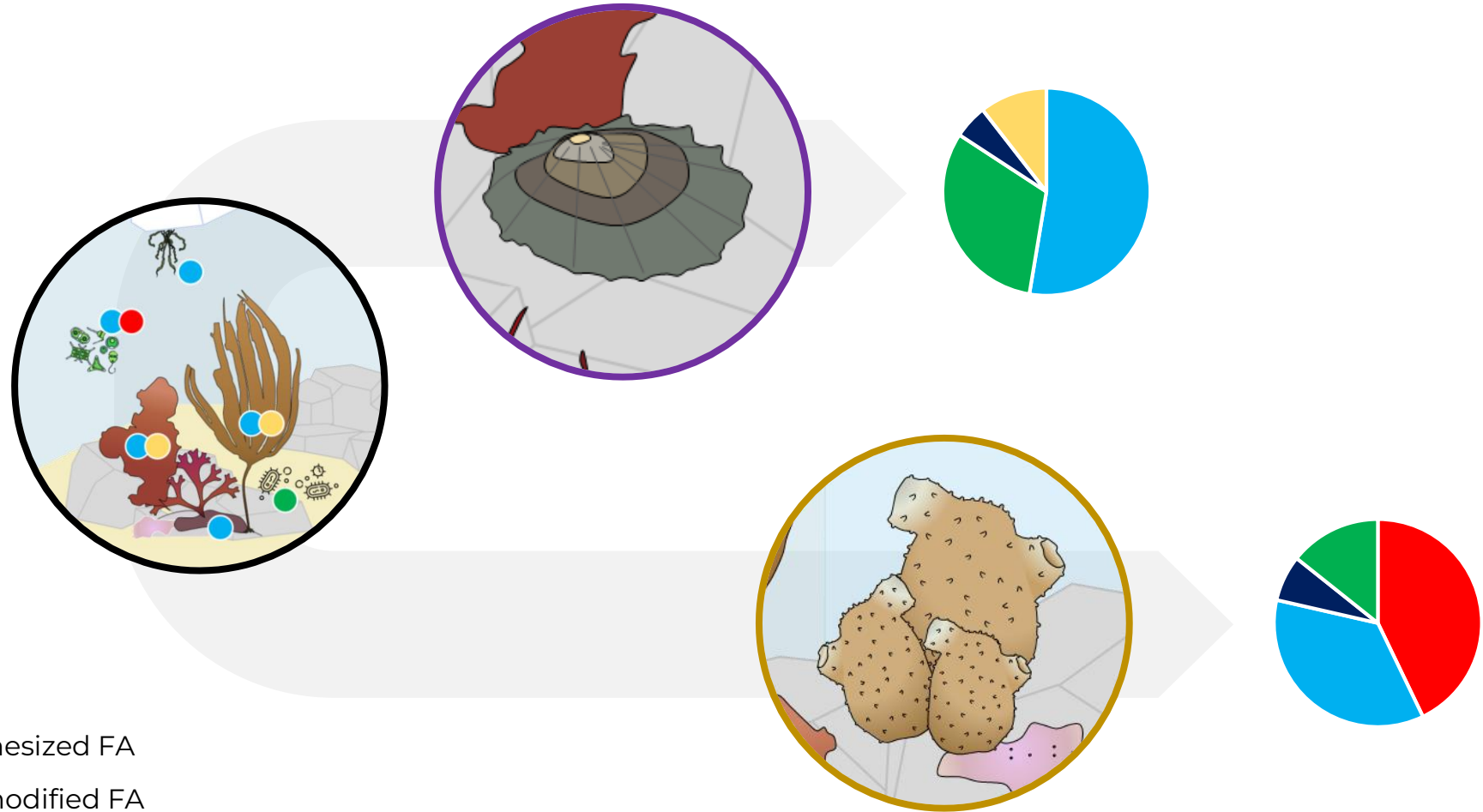
June 10th, 2024



Materials & Methods

Analyses

⇒ Trophic biomarker: fatty acids

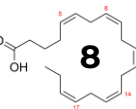


(Fry, 2006; Kelly and Scheibling, 2012)

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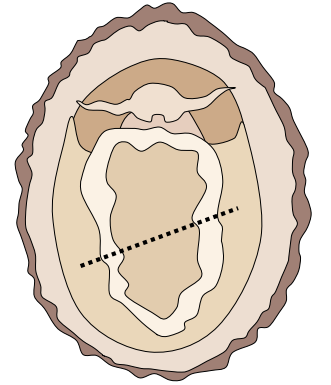
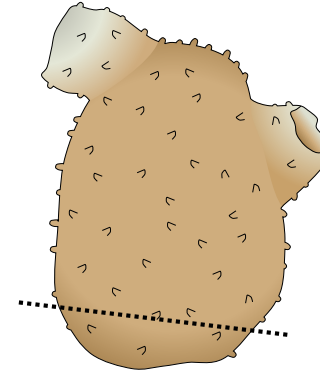


Materials & Methods

Analyses

⇒ Trophic biomarker: fatty acids

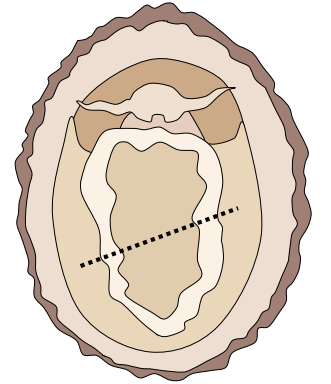
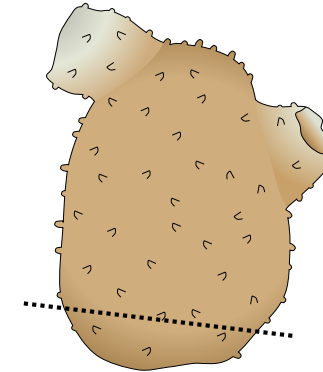
⇒ Conservation: $\text{CHCl}_3/\text{MeOH}$ mixture at -20°C



Materials & Methods

Analyses

- ⇒ Trophic biomarker: fatty acids
- ⇒ Conservation: $\text{CHCl}_3/\text{MeOH}$ mixture at -20°C
- ⇒ Gas Chromatography
Flame Ionization Detector (GC-FID)



$\text{CHCl}_3/\text{MeOH}$
(2:1, v:v)

Saponification & Transmethylation
 KOH-MeOH (0.5M) & $\text{MeOH-H}_2\text{SO}_4$ (3.4%, v:v)

FAME
(Hexane fraction)

GC-FID

Materials & Methods

Analyses

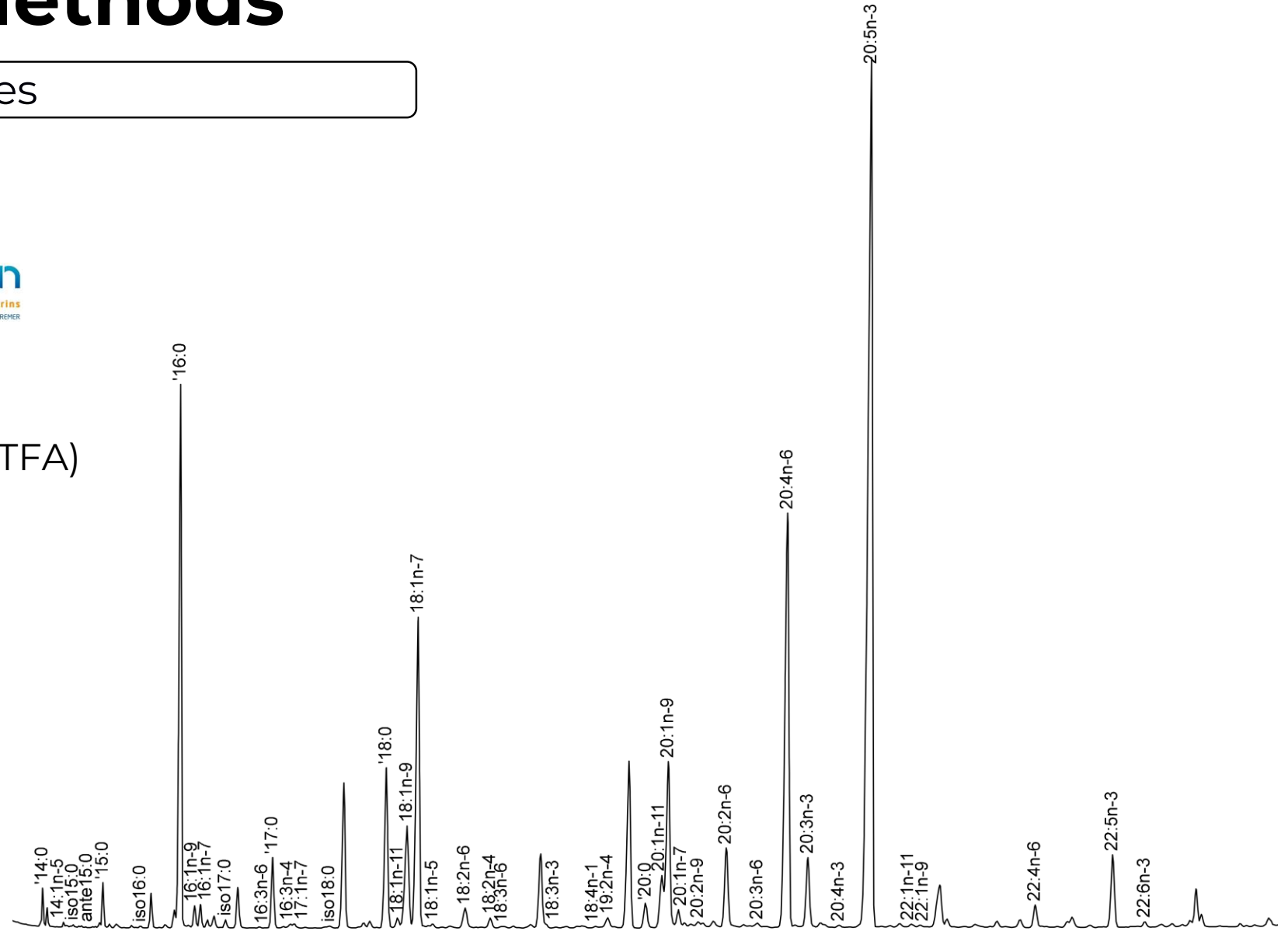
⇒ GC-FID



- Total lipids
- FA proportion (% of TFA)



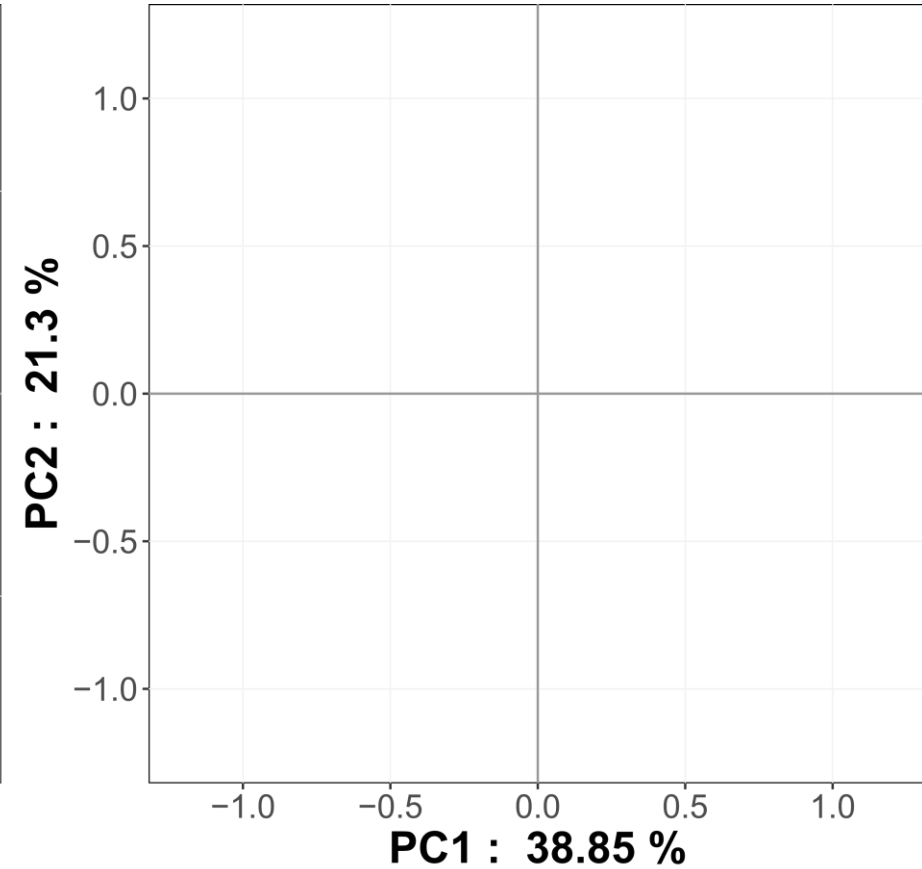
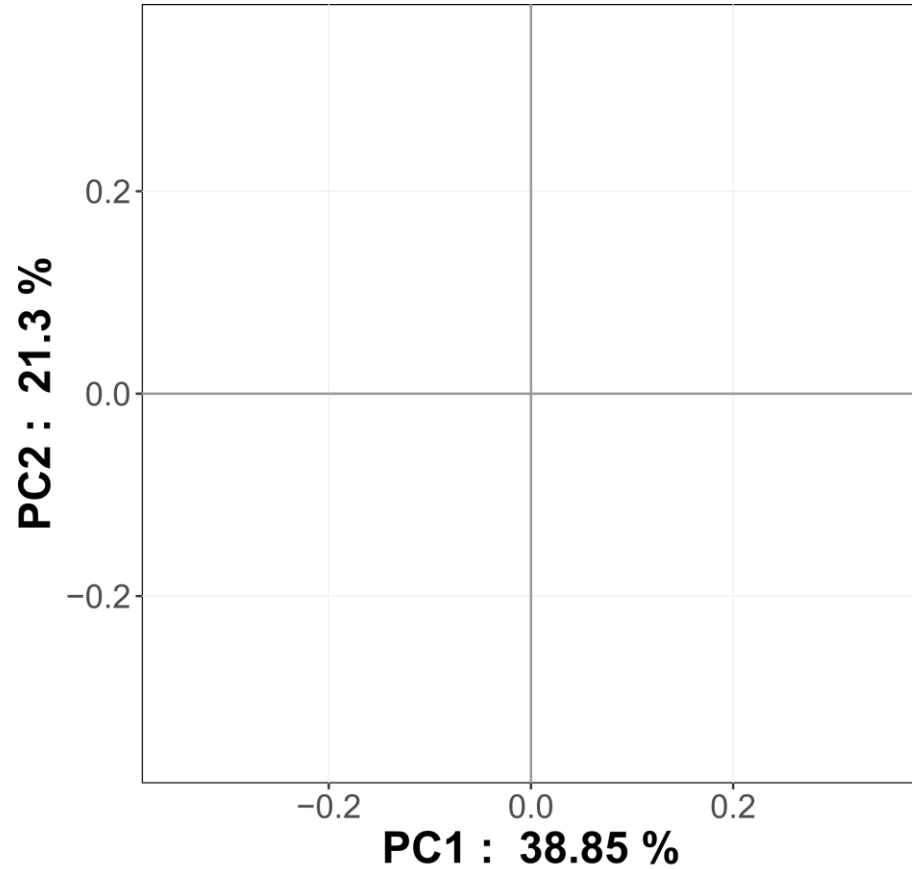
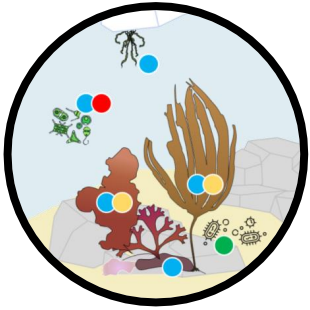
GC-FID



(e.g. *Nacella concinna* chromatogram)

Results & Discussion

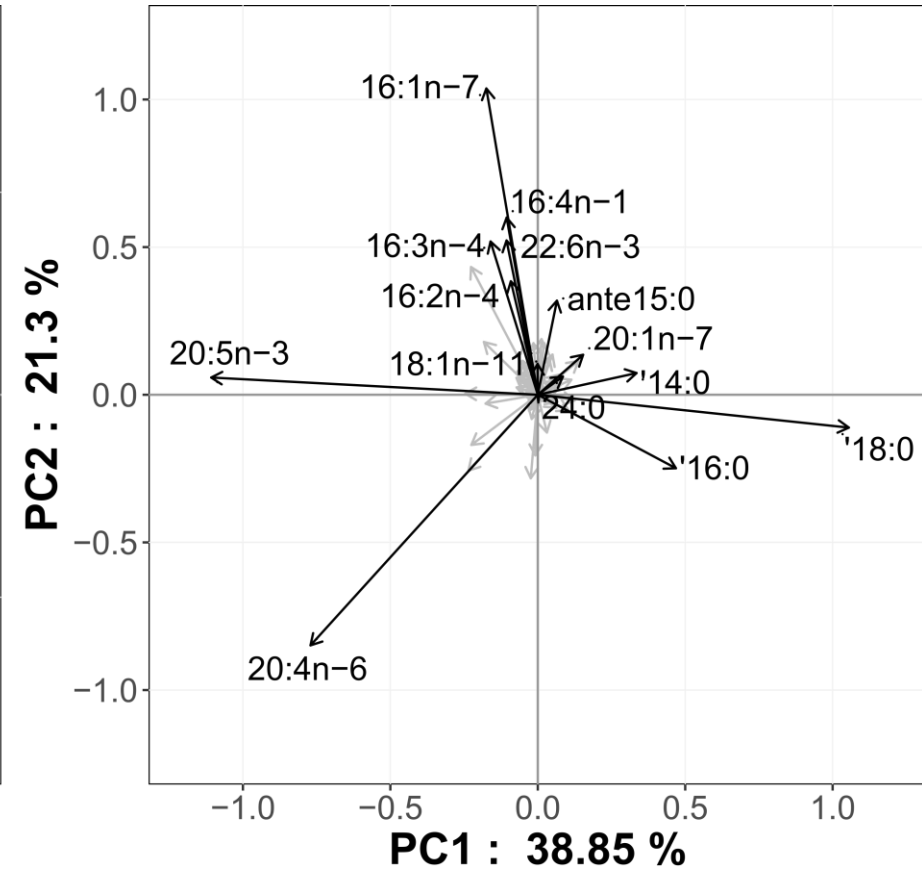
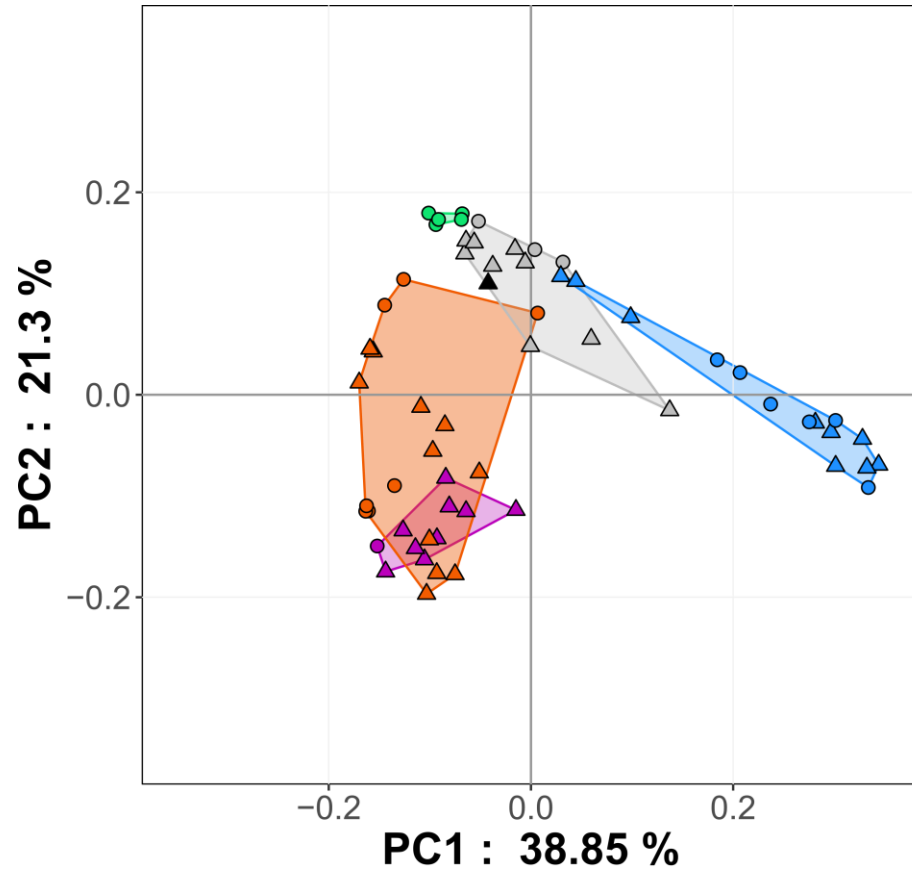
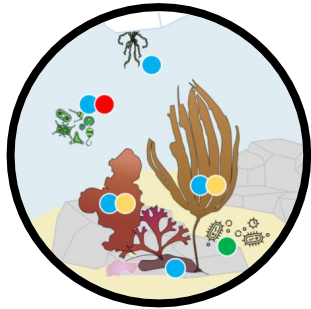
Fatty acid of dietary sources



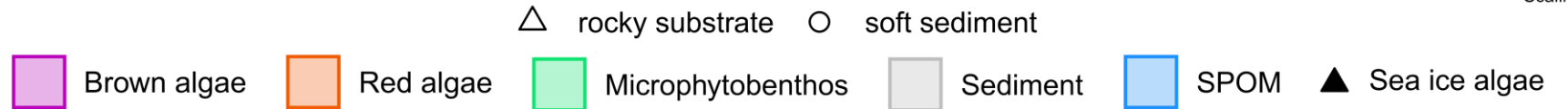
Scaling 1

Results & Discussion

Fatty acid of dietary sources



Scaling 1

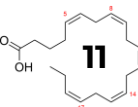


(Smith et al., 1986; Graeve et al., 2002; Kelly and Scheibling, 2012)

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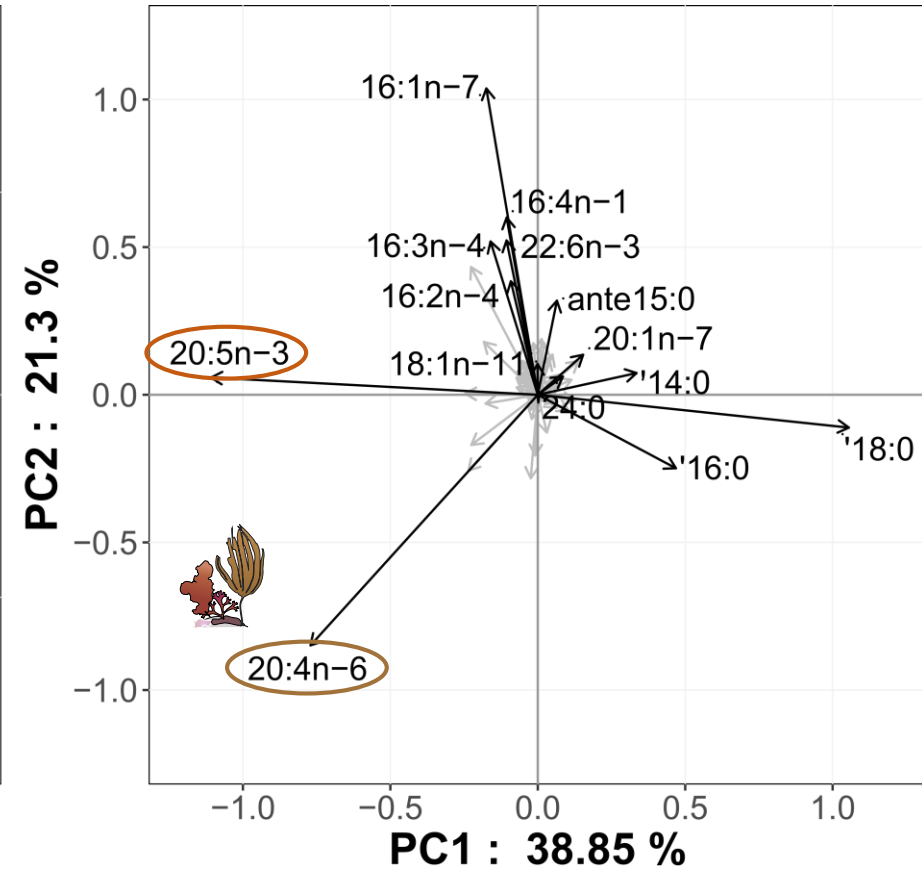
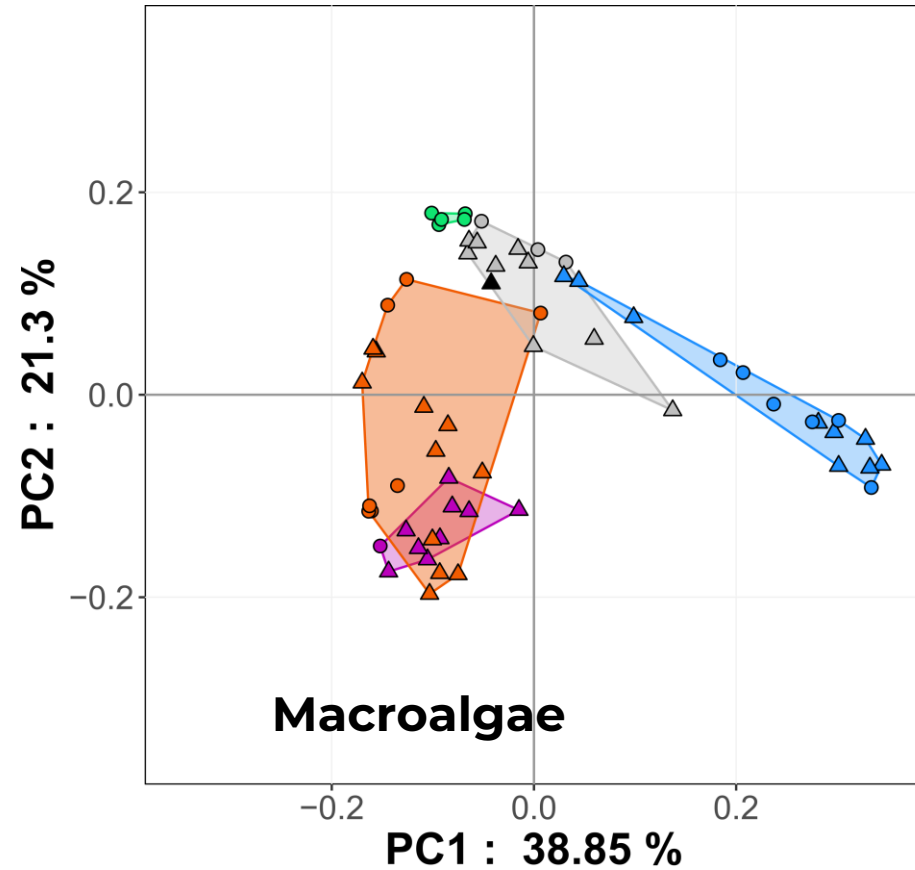
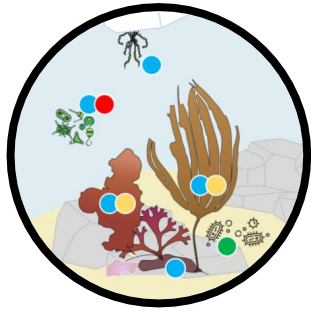
Lipids in the Ocean 2024

June 10th, 2024



Results & Discussion

Fatty acid of dietary sources



Scaling 1

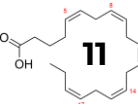
- △ rocky substrate
- soft sediment
- Brown algae
- Red algae
- Microphytobenthos
- Sediment
- SPOM
- ▲ Sea ice algae

(Smith et al., 1986; Graeve et al., 2002; Kelly and Scheibling, 2012)

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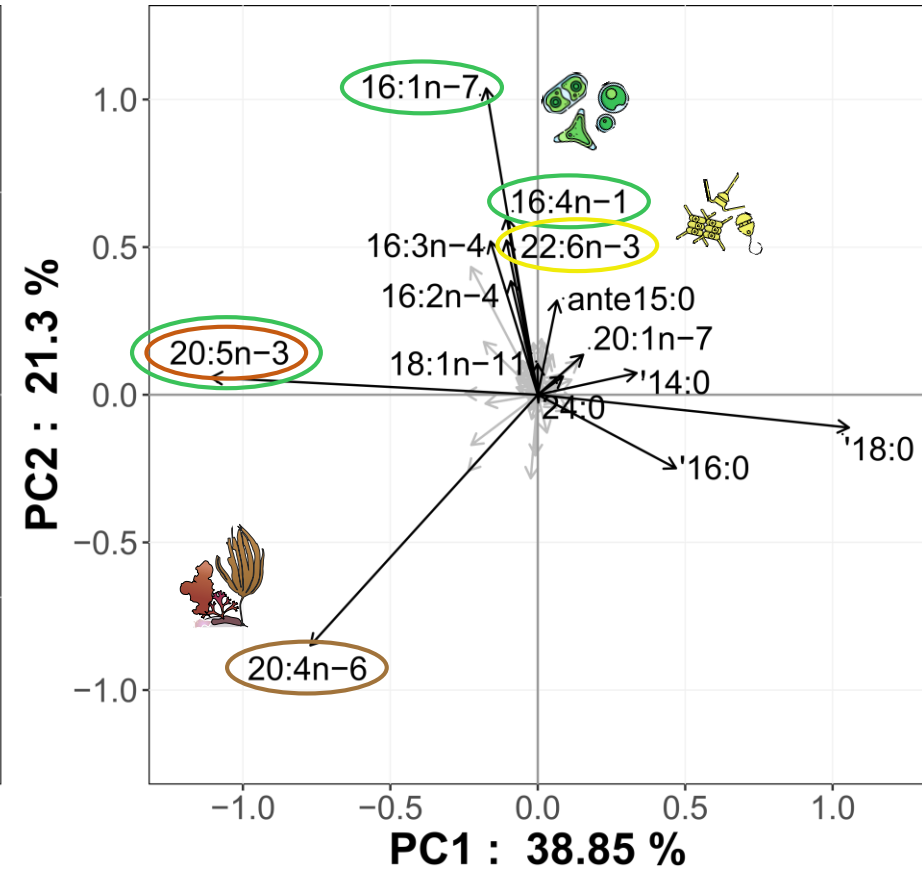
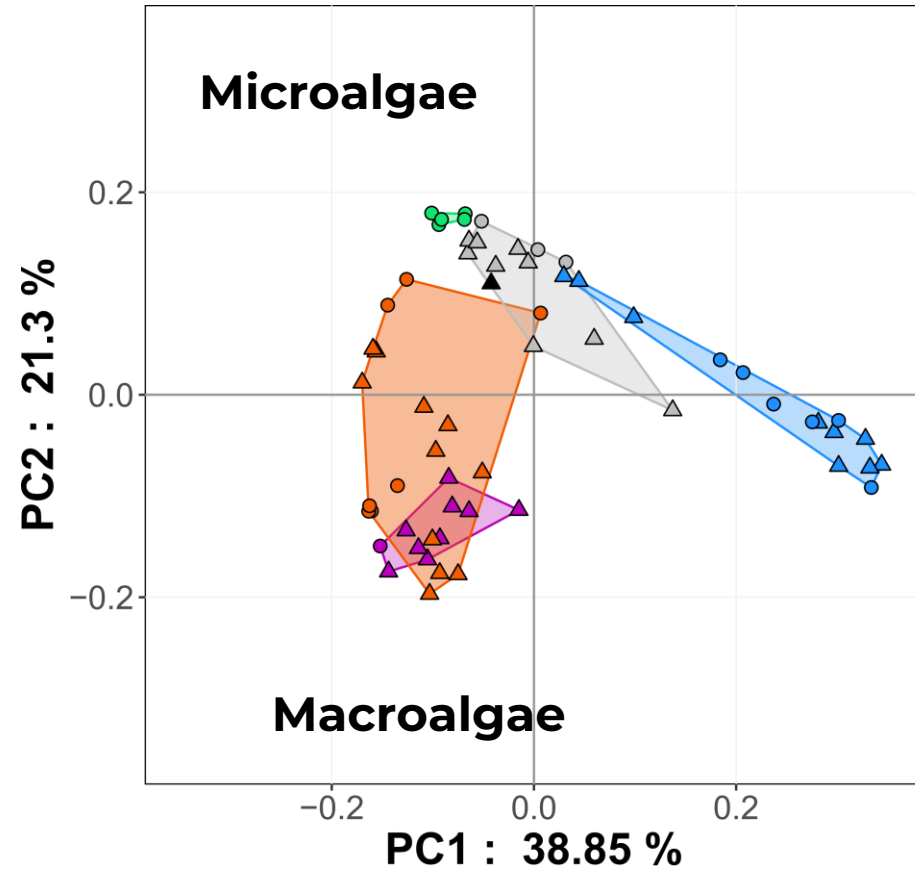
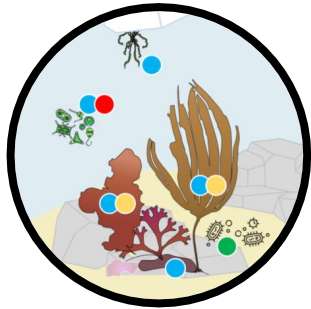
Lipids in the Ocean 2024

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Results & Discussion

Fatty acid of dietary sources



Scaling 1

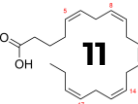
- △ Brown algae
- △ Red algae
- △ Microphytobenthos
- △ Sediment
- △ SPOM
- △ Sea ice algae
- rocky substrate
- soft sediment

(Smith et al., 1986; Graeve et al., 2002; Kelly and Scheibling, 2012)

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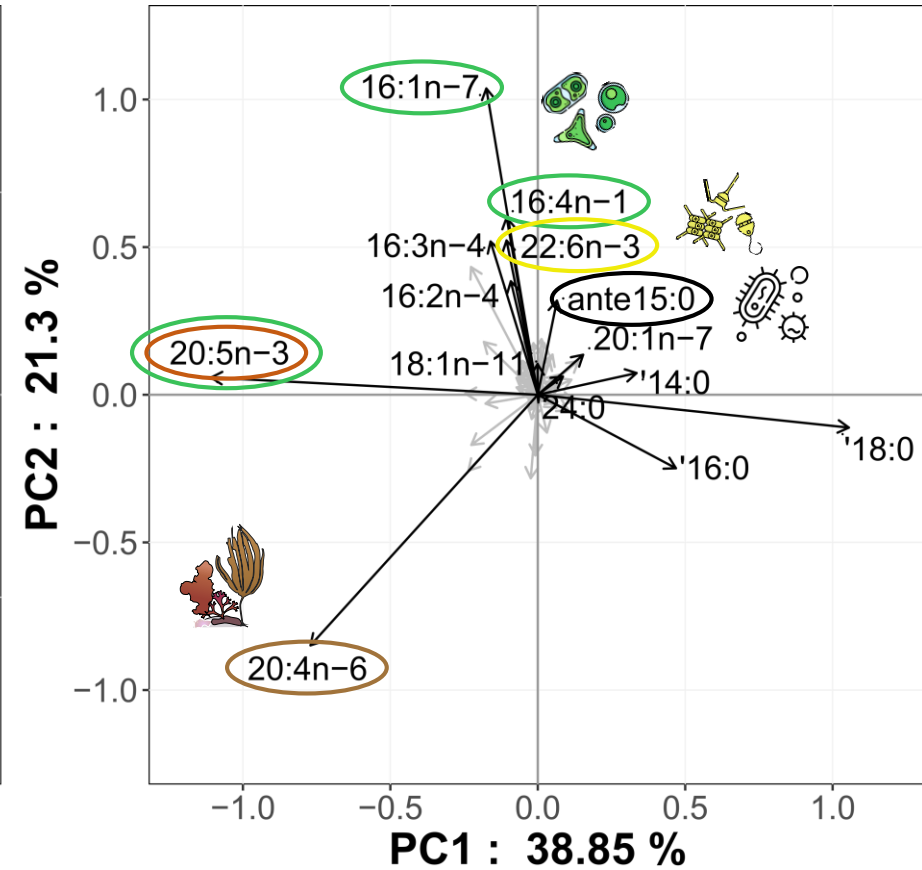
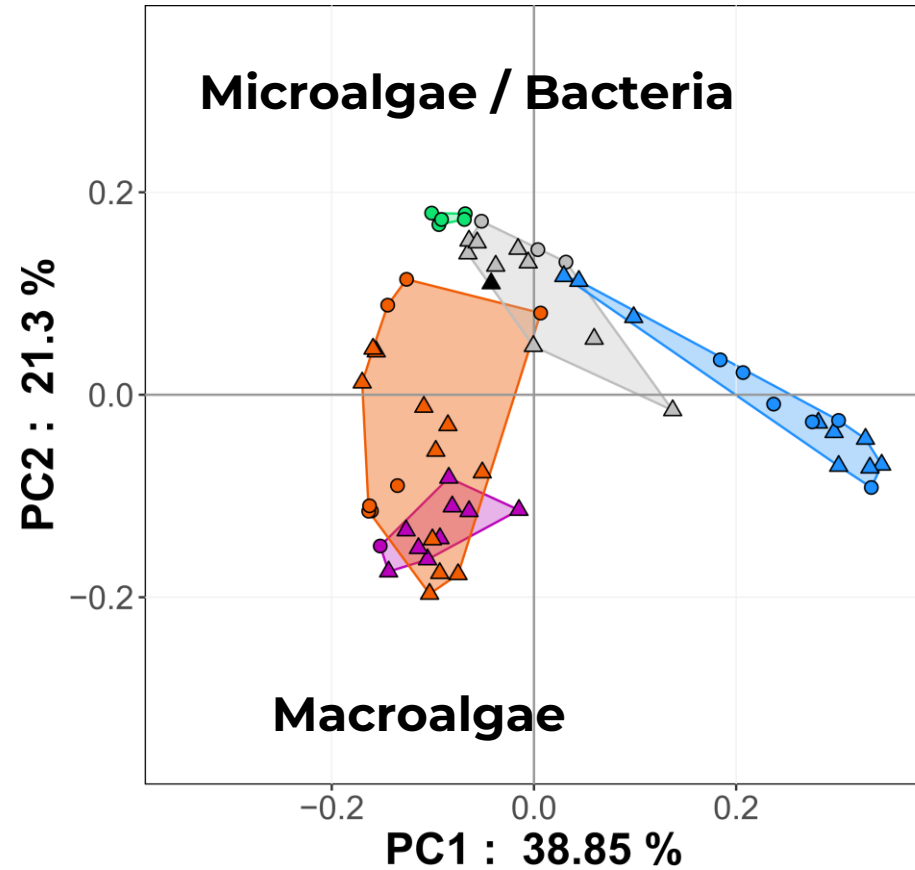
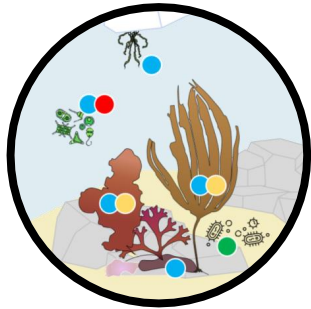
Lipids in the Ocean 2024

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Results & Discussion

Fatty acid of dietary sources



Scaling 1

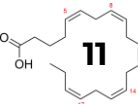
- △ rocky substrate
- soft sediment
- Brown algae
- Red algae
- Microphytobenthos
- Sediment
- SPOM
- ▲ Sea ice algae

(Smith et al., 1986; Graeve et al., 2002; Kelly and Scheibling, 2012)

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Lipids in the Ocean 2024

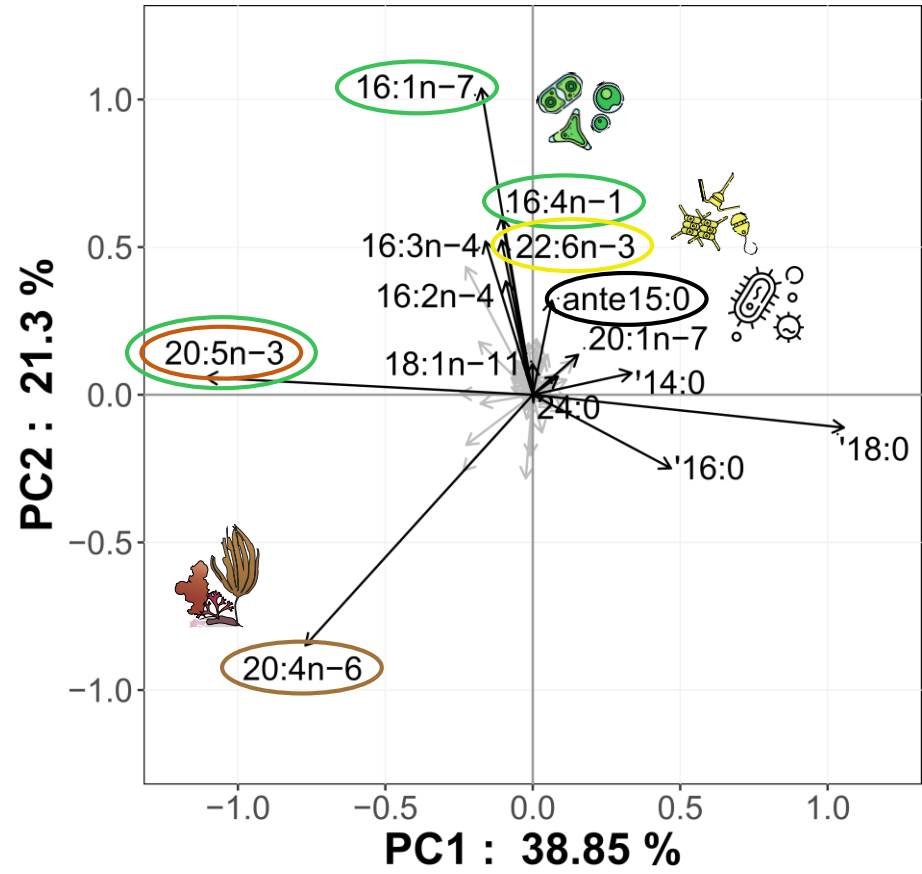
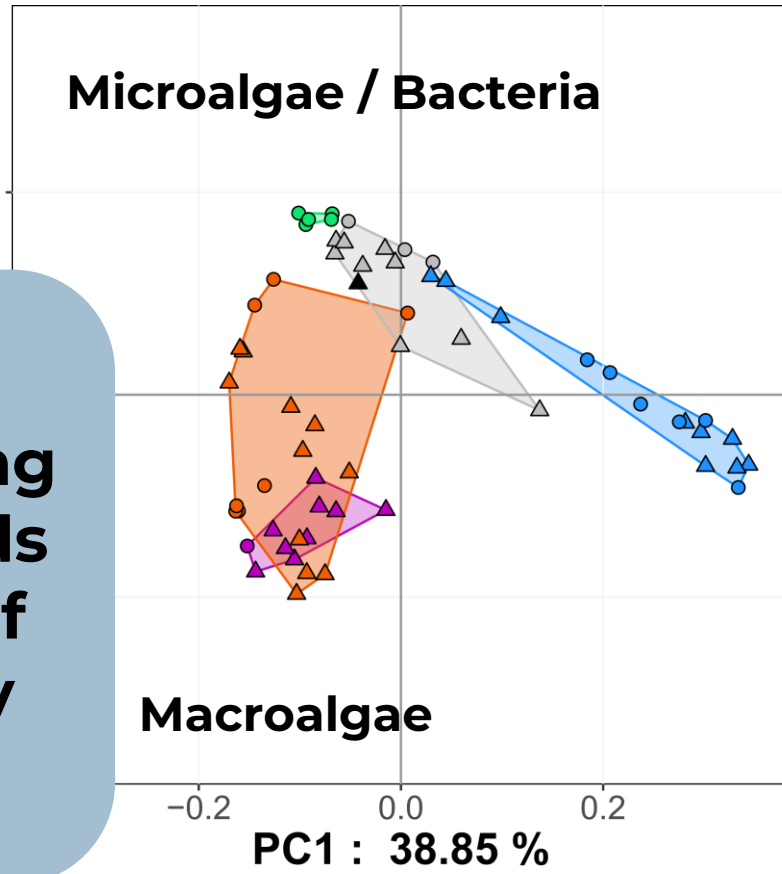
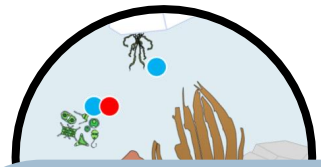
June 10th, 2024



Results & Discussion

Fatty acid of dietary sources

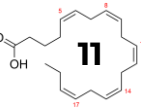
Support of the literature on using certain fatty acids as biomarkers of specific primary production



- △ rocky substrate
- soft sediment
- Brown algae
- Red algae
- Microphytobenthos
- Sediment
- SPOM
- ▲ Sea ice algae

(Smith et al., 1986; Graeve et al., 2002; Kelly and Scheibling, 2012)

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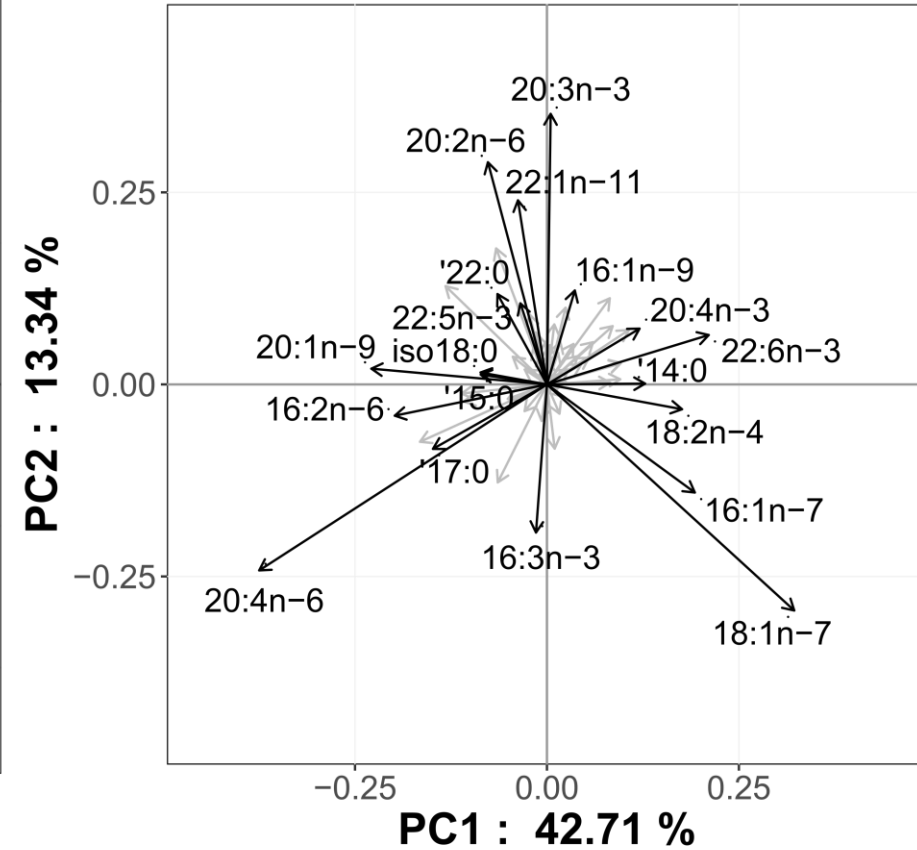
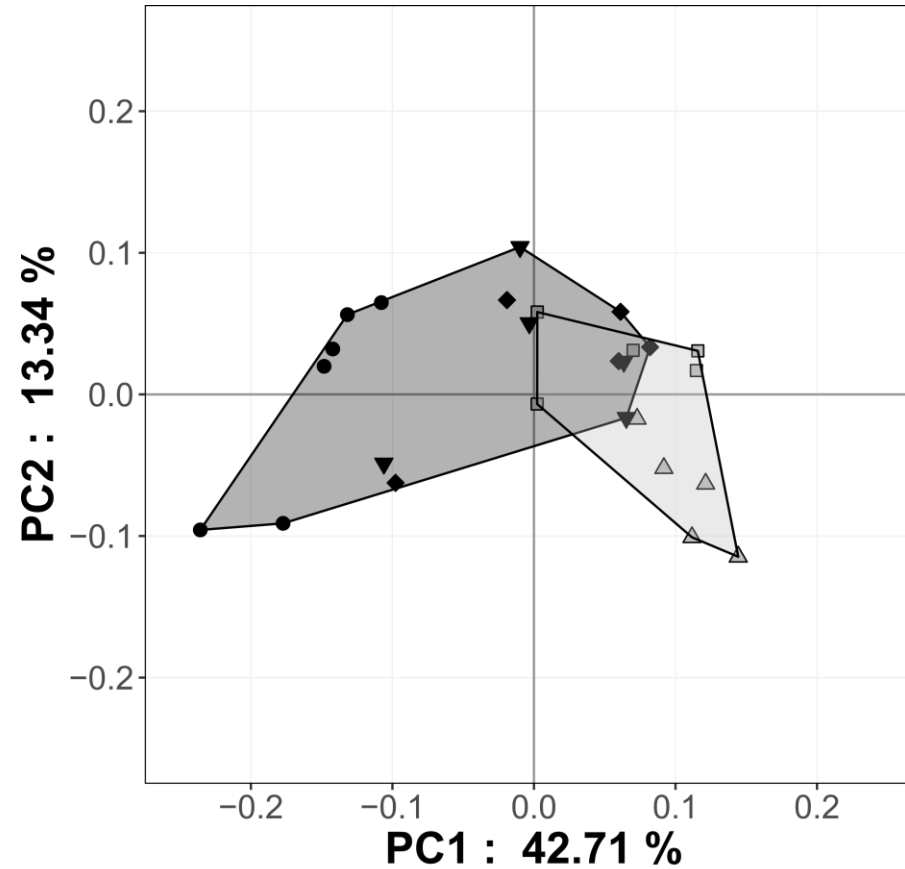


Results & Discussion

Fatty acid of consumers



Nacella concinna



rocky substrate
 soft sediment
 ○ DI1
□ DI2
◇ DI3
△ BL1
▽ BL2

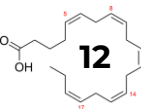
Scaling 1

(Smith et al., 1986; Kelly and Scheibling, 2012; Santos et al., 2017; Paar et al., 2019)

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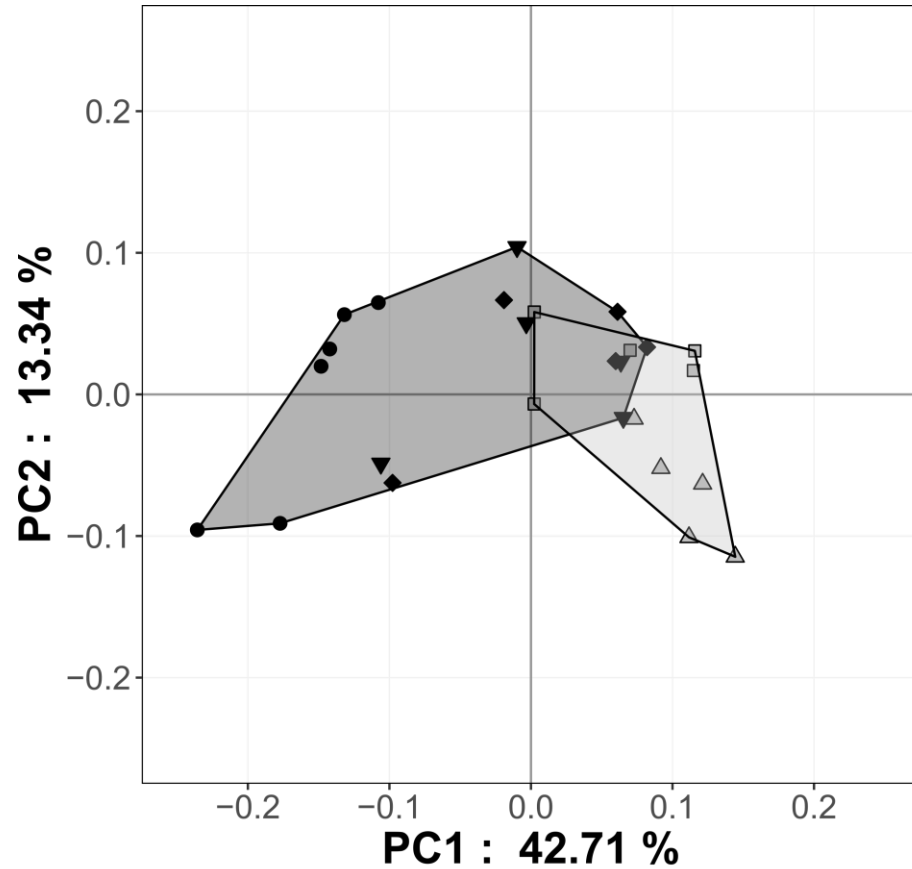


Results & Discussion

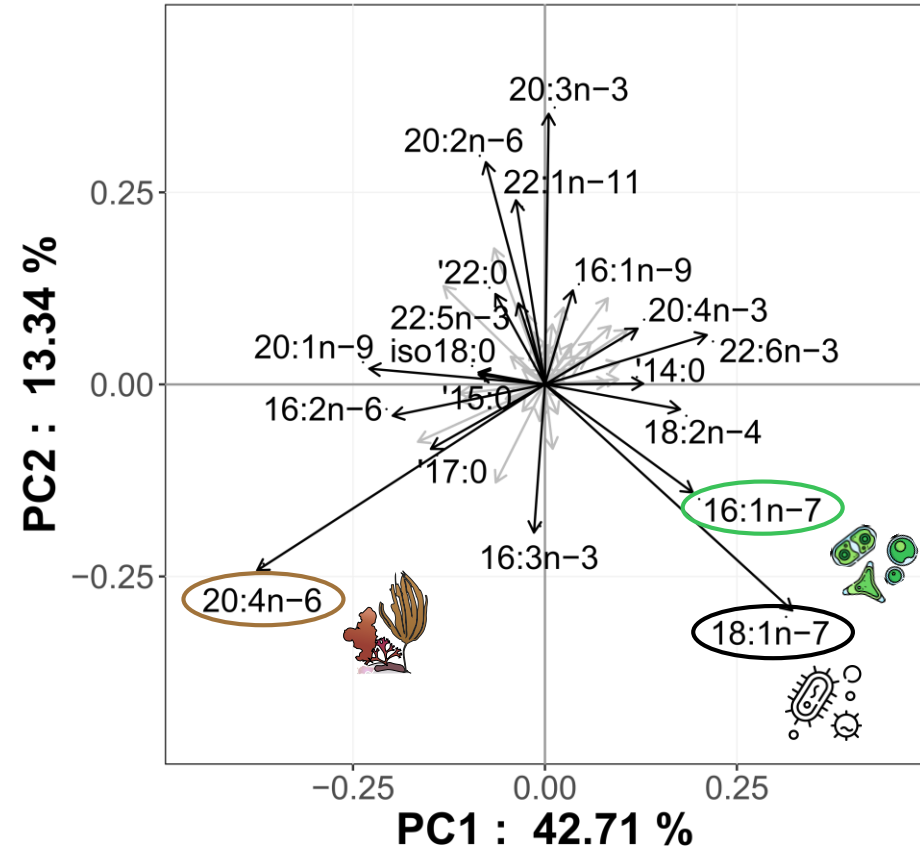
Fatty acid of consumers



Nacella concinna



rocky substrate
 soft sediment
 ○ DI1
□ DI2
◇ DI3
△ BL1
▽ BL2



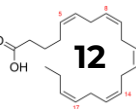
Scaling 1

(Smith et al., 1986; Kelly and Scheibling, 2012; Santos et al., 2017; Paar et al., 2019)

Anthony Voisin – anthony.voisin@univ-brest.fr

Lipids in the Ocean 2024

June 10th, 2024



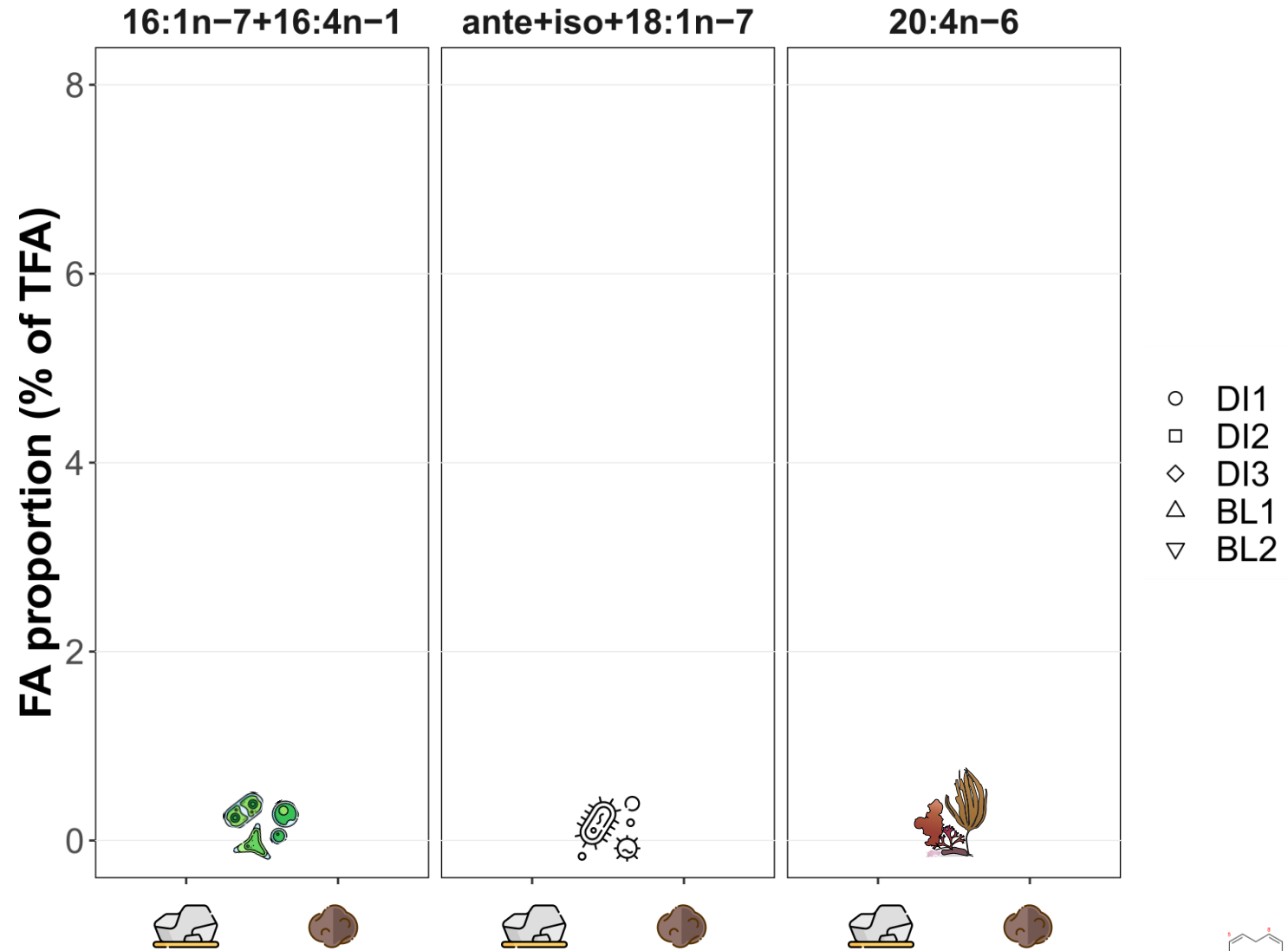
Results & Discussion

Fatty acid of consumers

⇒ Wilcoxon Mann Whitney test
(for each FA category)



Nacella concinna



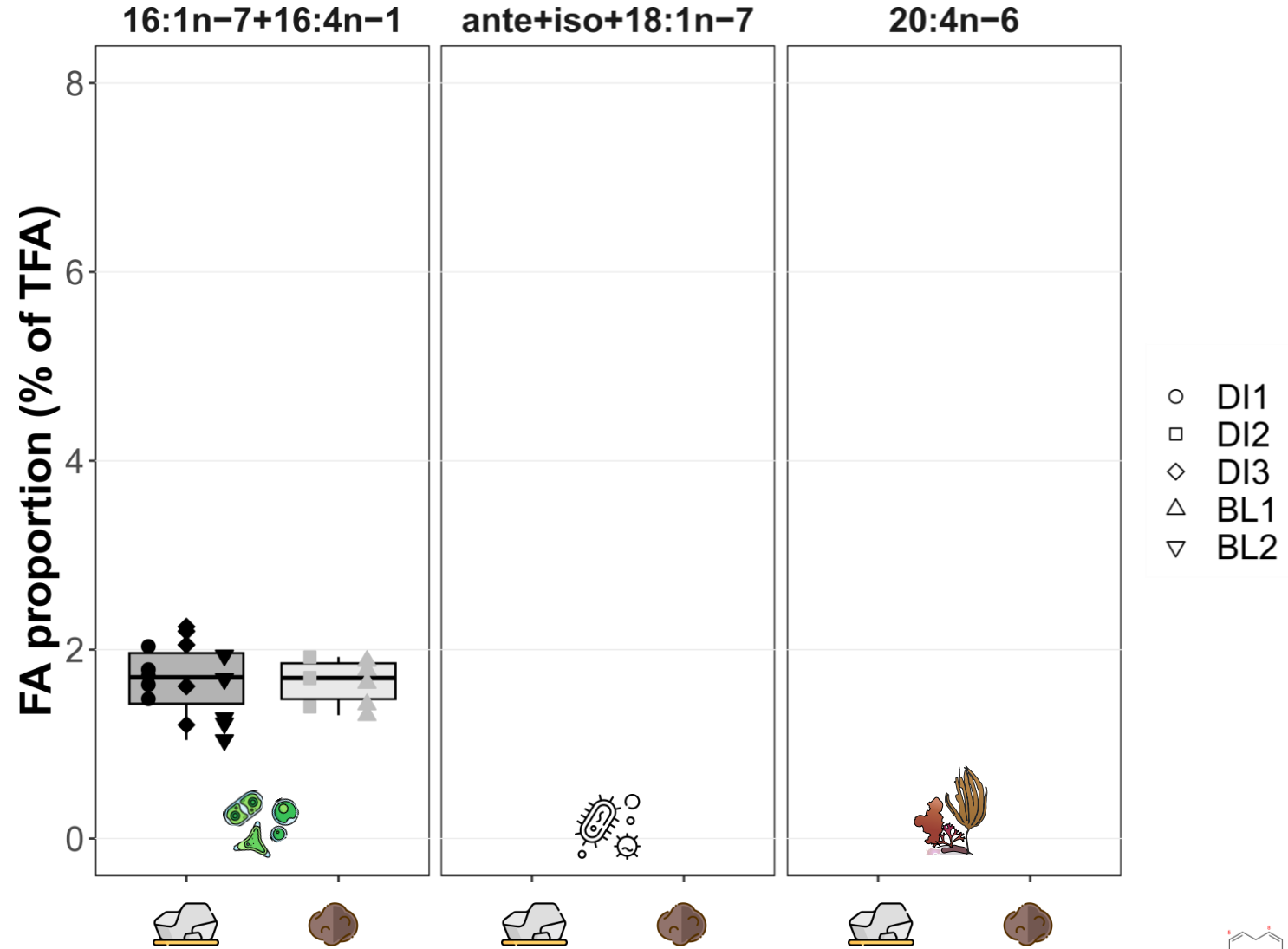
Results & Discussion

Fatty acid of consumers

⇒ Wilcoxon Mann Whitney test
(for each FA category)



Nacella concinna



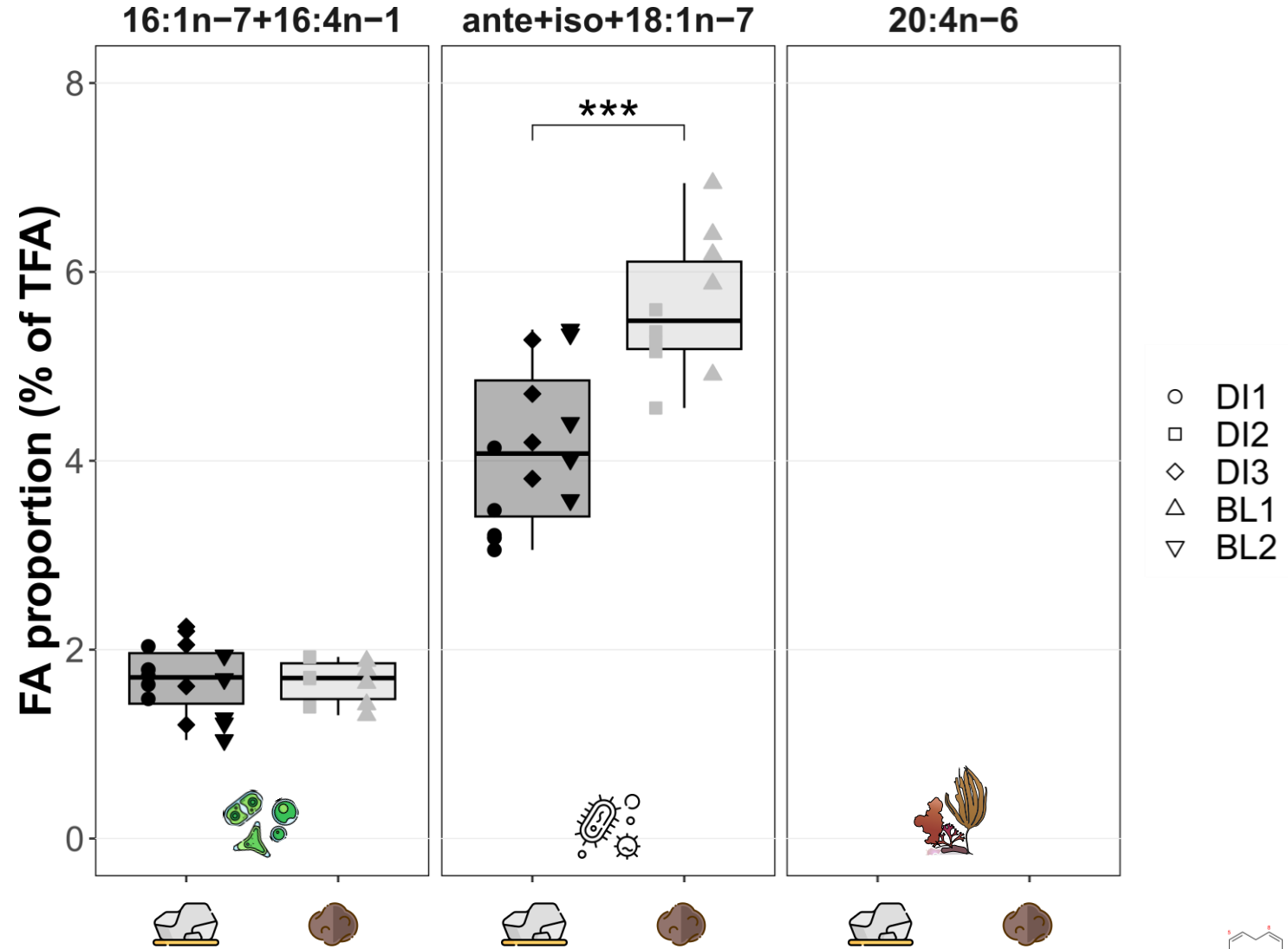
Results & Discussion

Fatty acid of consumers

⇒ Wilcoxon Mann Whitney test
(for each FA category)



Nacella concinna



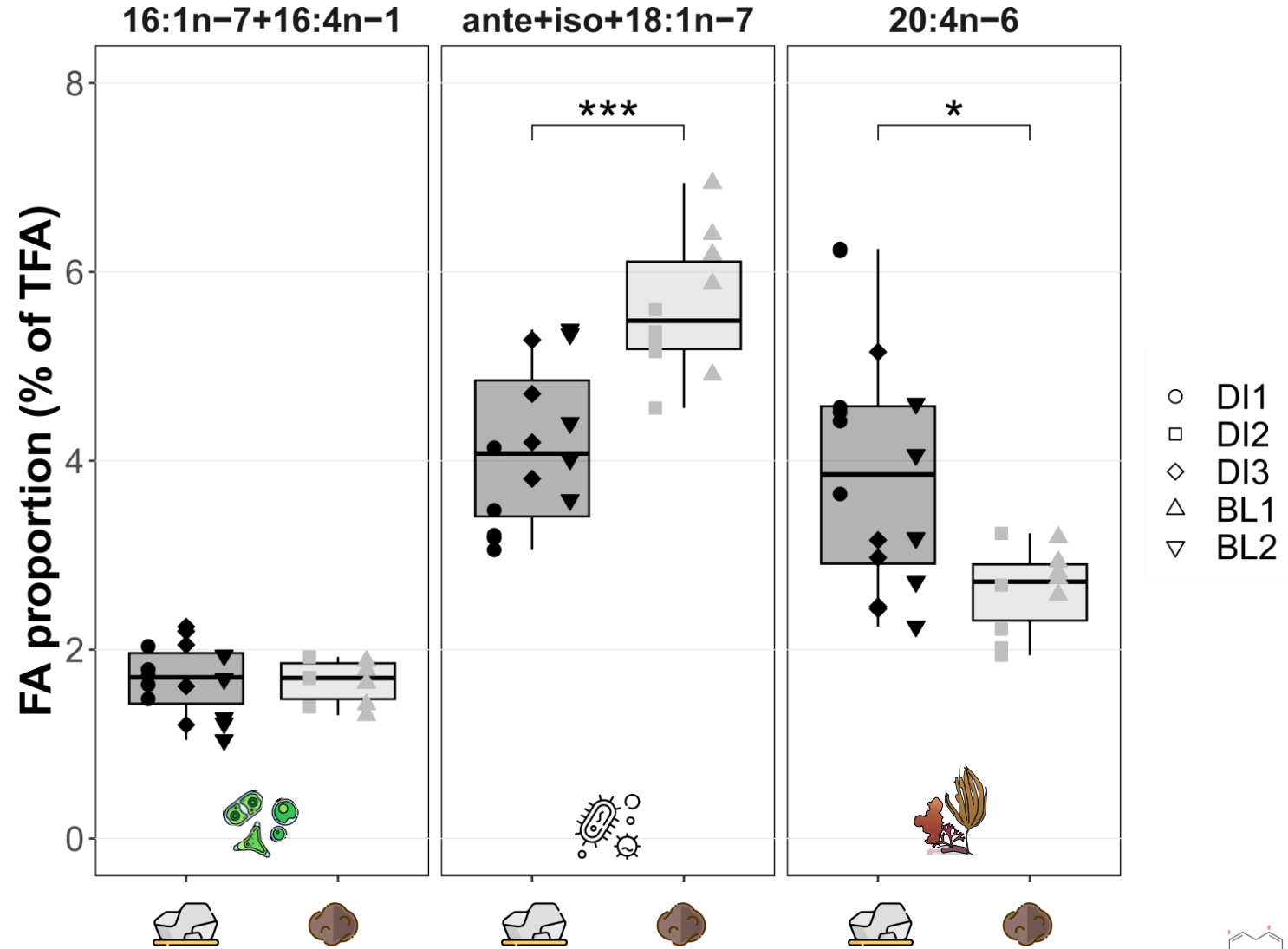
Results & Discussion

Fatty acid of consumers

⇒ Wilcoxon Mann Whitney test
(for each FA category)



Nacella concinna



Results & Discussion

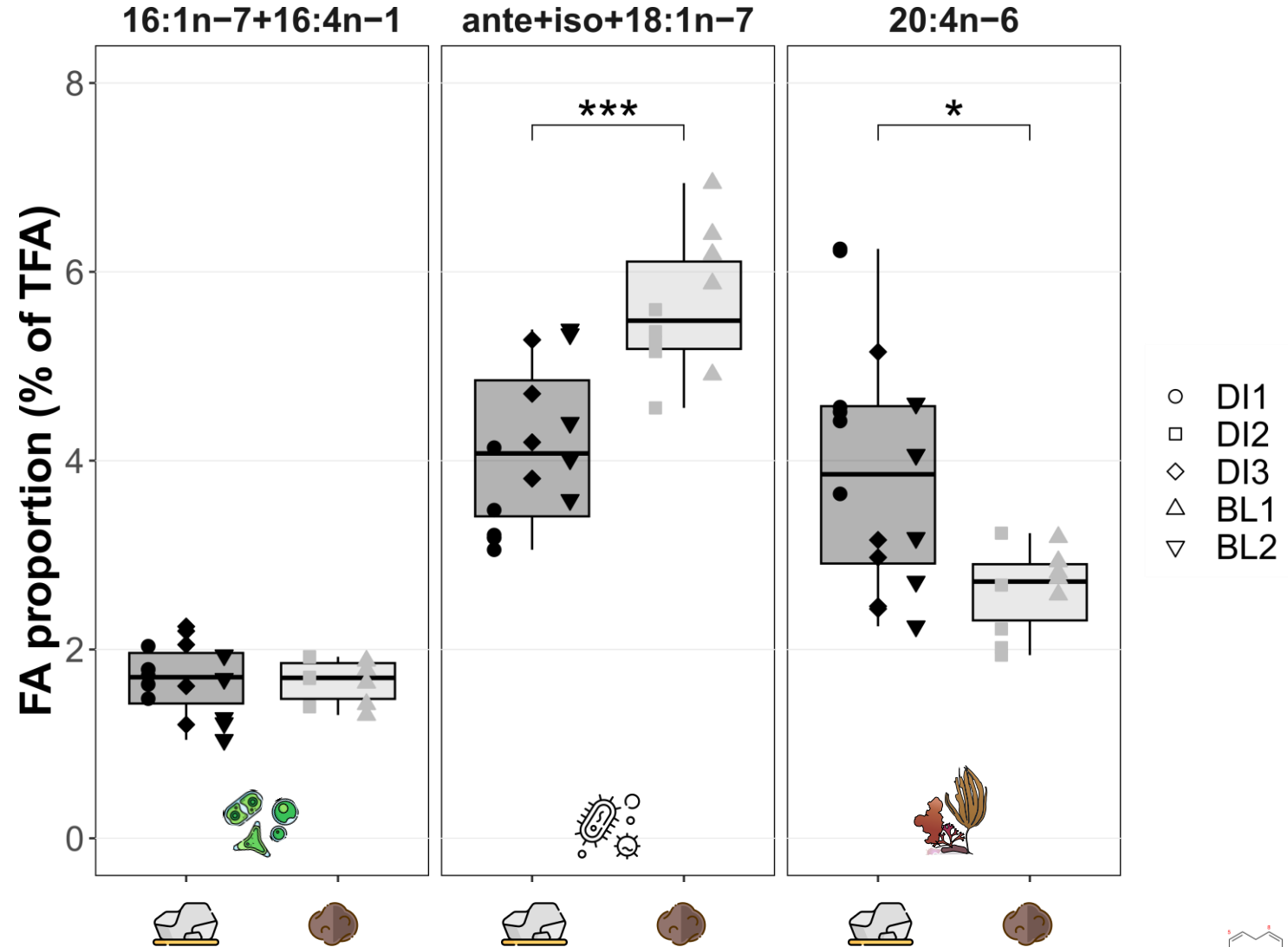
Fatty acid of consumers

⇒ Wilcoxon Mann Whitney test
(for each FA category)



Potential diet
plasticity

Food web
supported by
macroalgae vs
biofilm production

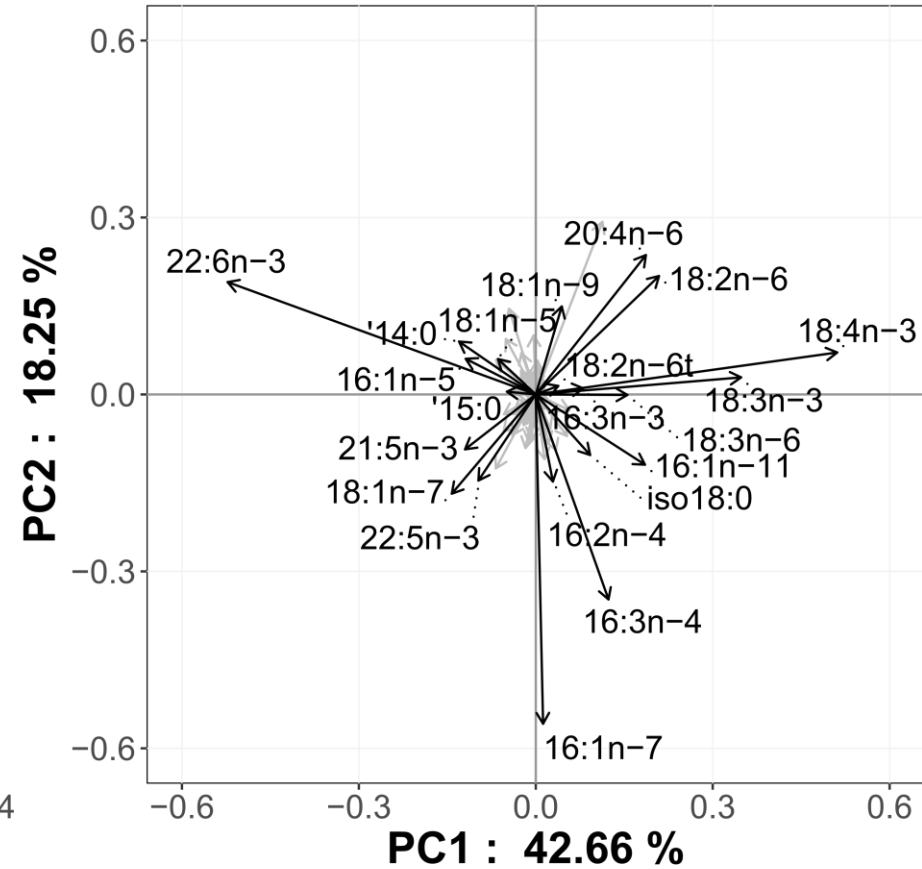
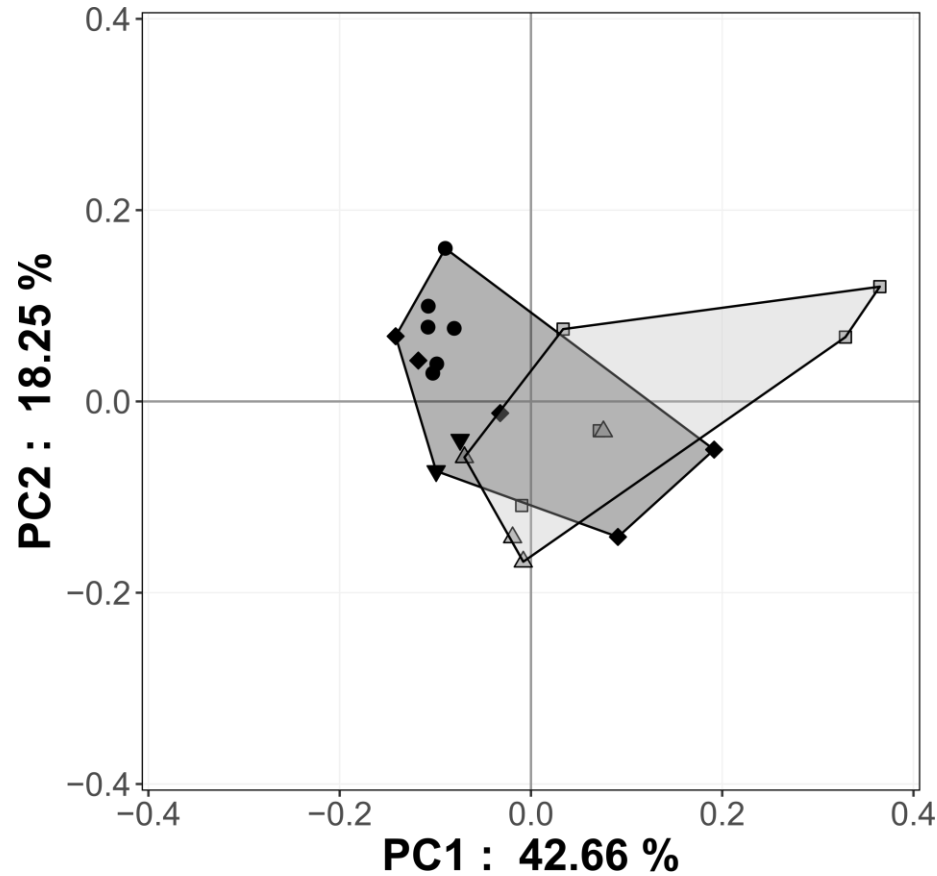


Results & Discussion

Fatty acid of consumers



Cnemidocarpa verrucosa



rocky substrate
 soft sediment
 ○ DI1
□ DI2
◇ DI3
△ BL1
▽ BL2

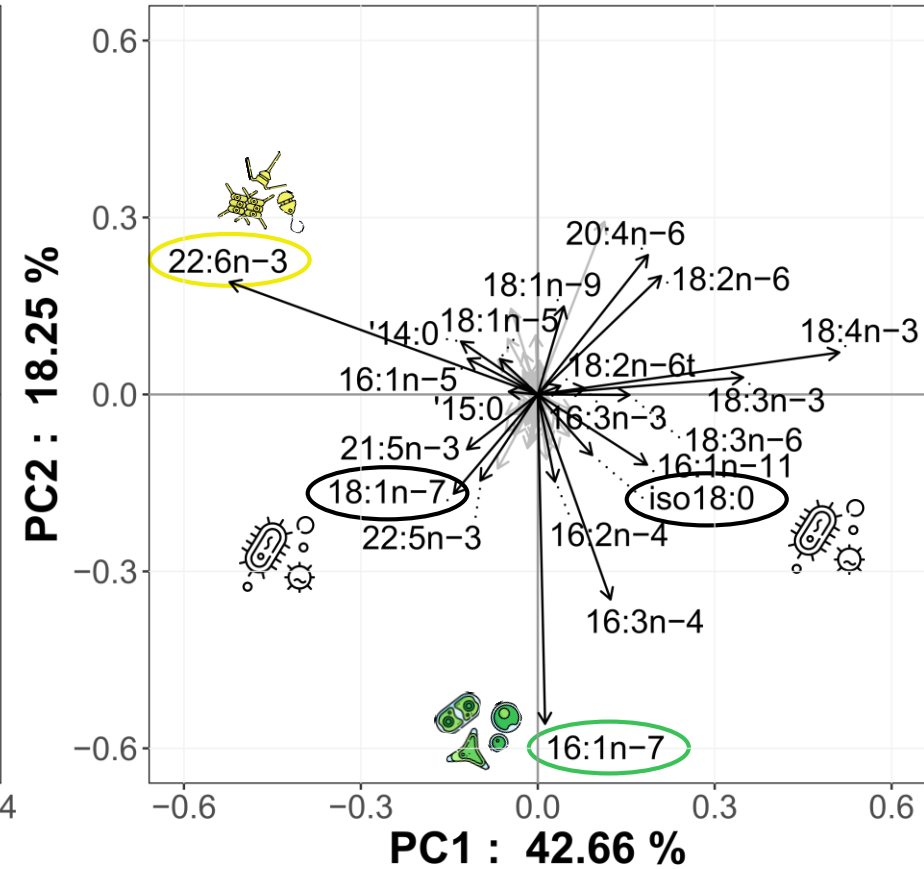
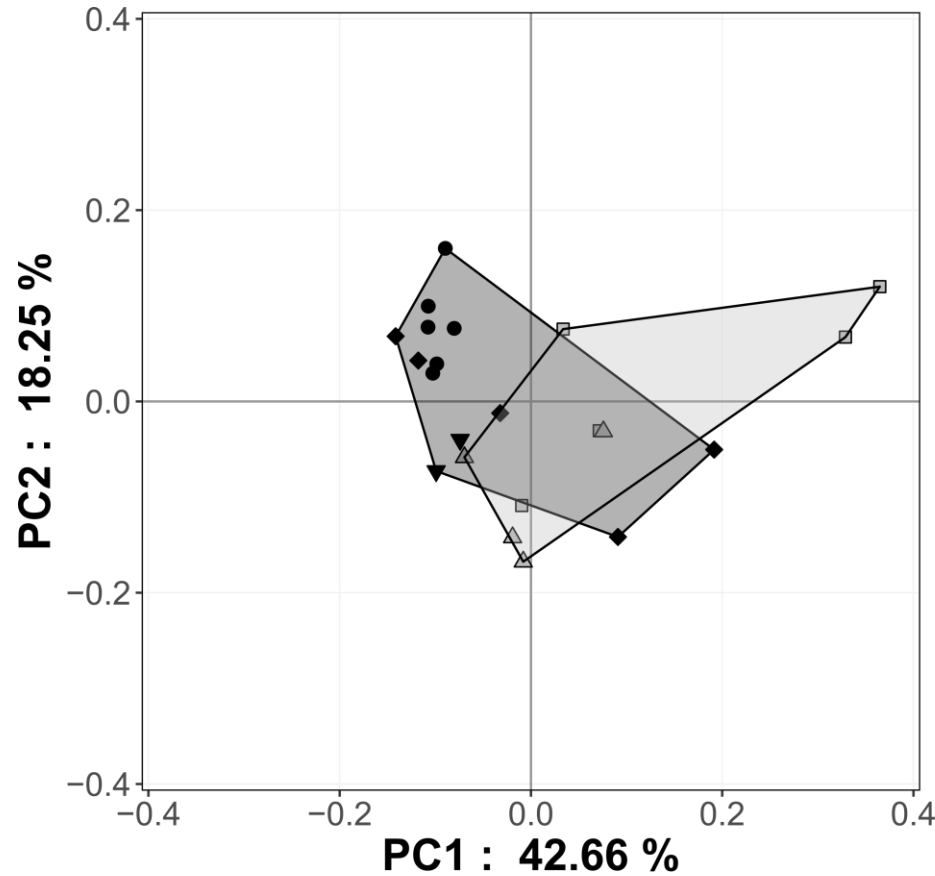
Scaling 1

Results & Discussion

Fatty acid of consumers



Cnemidocarpa verrucosa



rocky substrate
 soft sediment
 ○ DI1
□ DI2
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△ BL1
▽ BL2

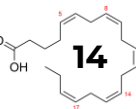
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(Smith et al., 1986; Kelly and Scheibling, 2012; Santos et al., 2017; Paar et al., 2019)

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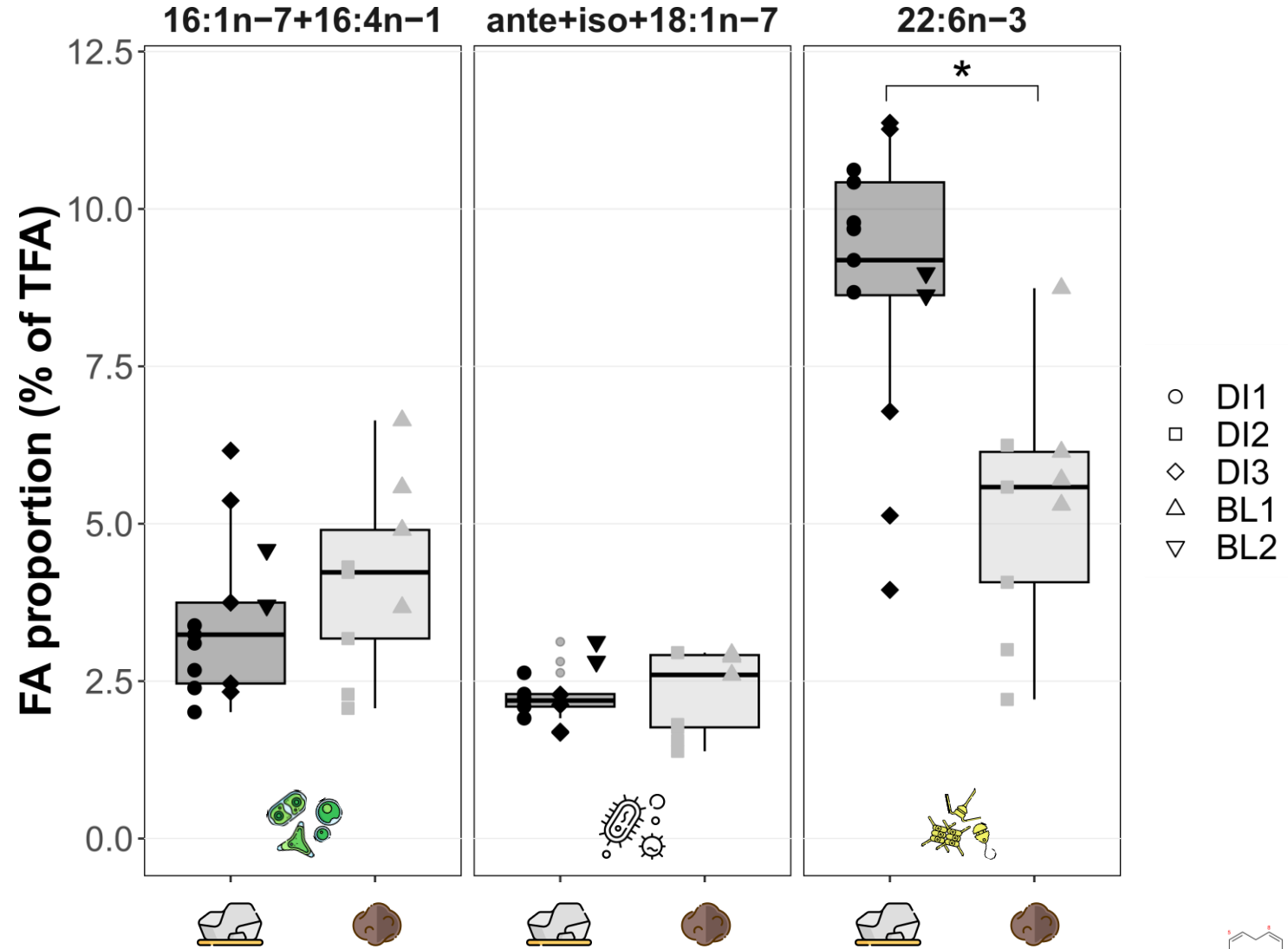
Results & Discussion

Fatty acid of consumers

⇒ Wilcoxon Mann Whitney test
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*Cnemidocarpa
verrucosa*



Results & Discussion

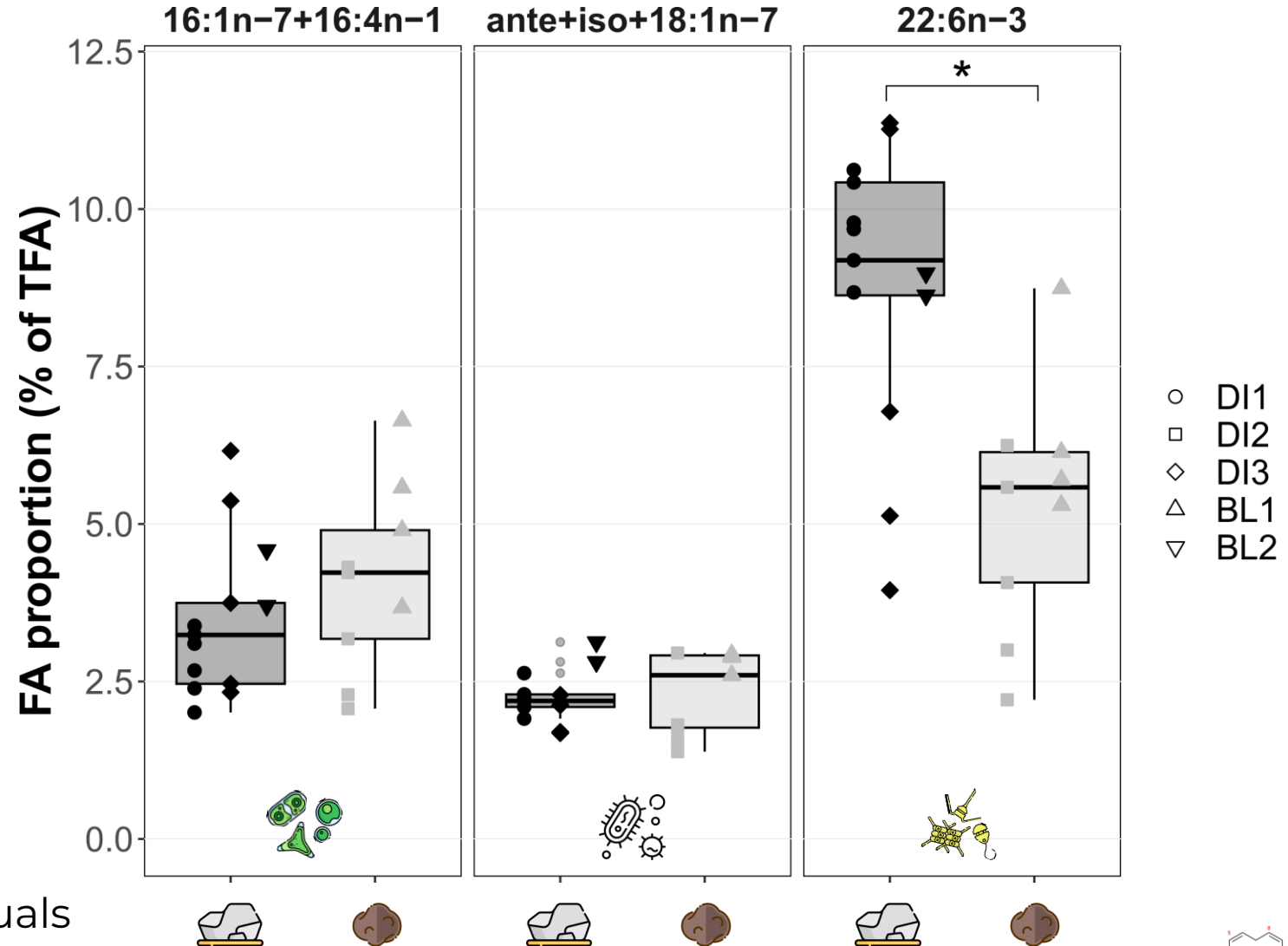
Fatty acid of consumers

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(for each FA category)

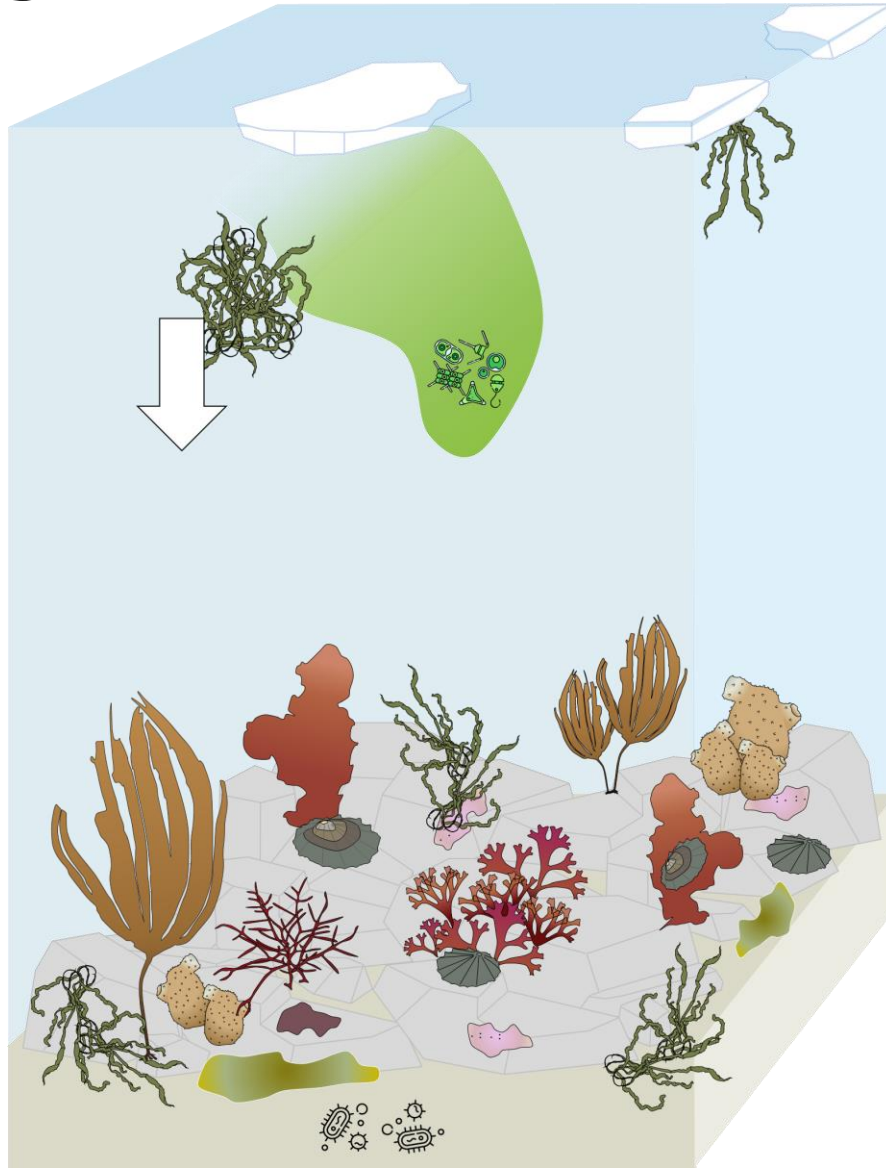


**Change of diet
potentially
linked
phytoplankton
dynamics**

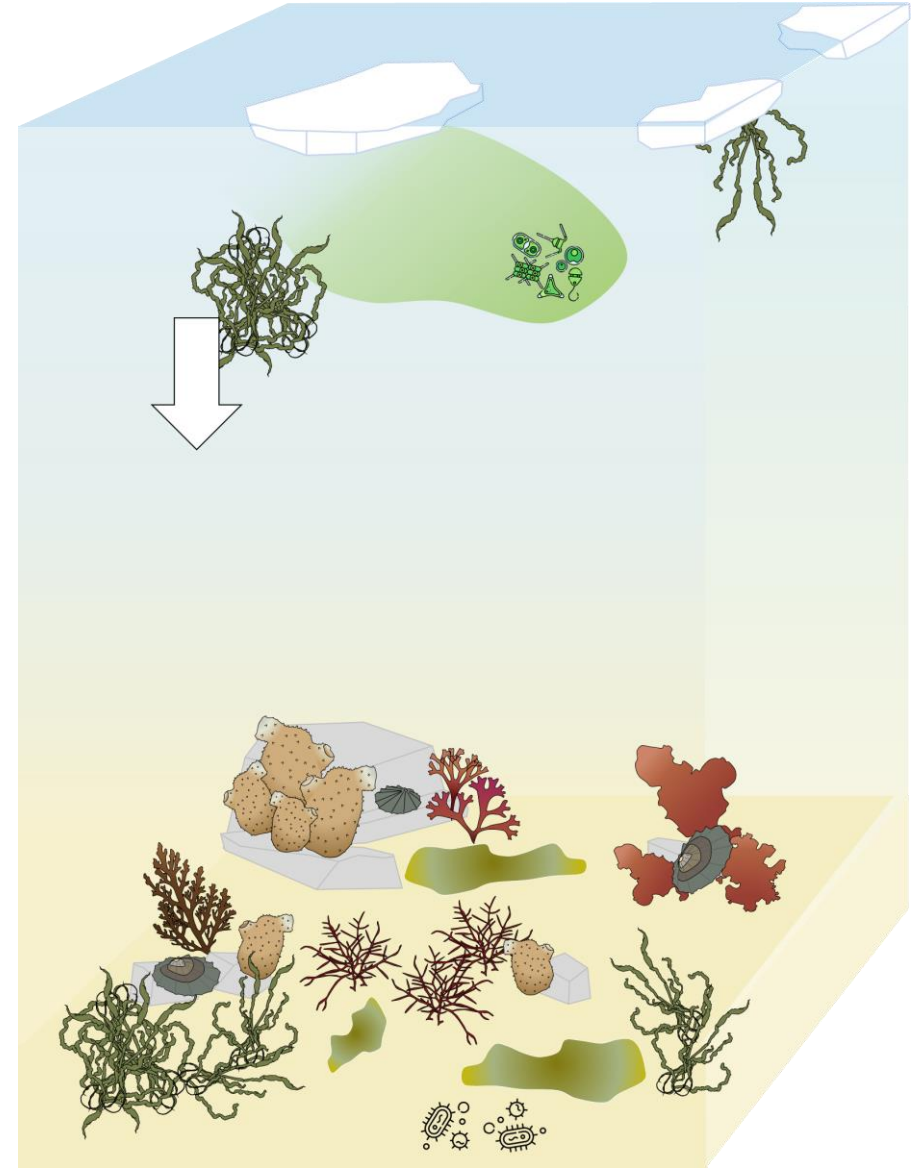
 High variability among individuals



Key points



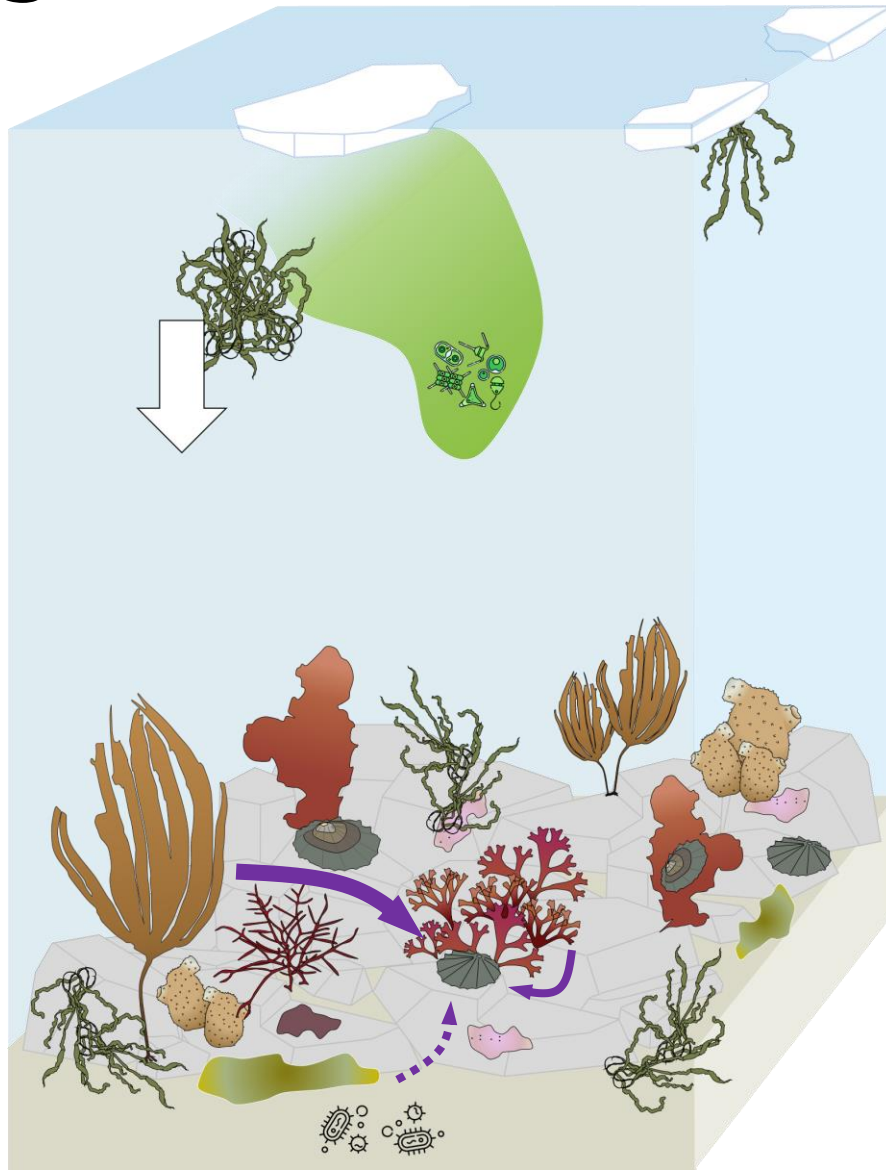
Rocky substrate



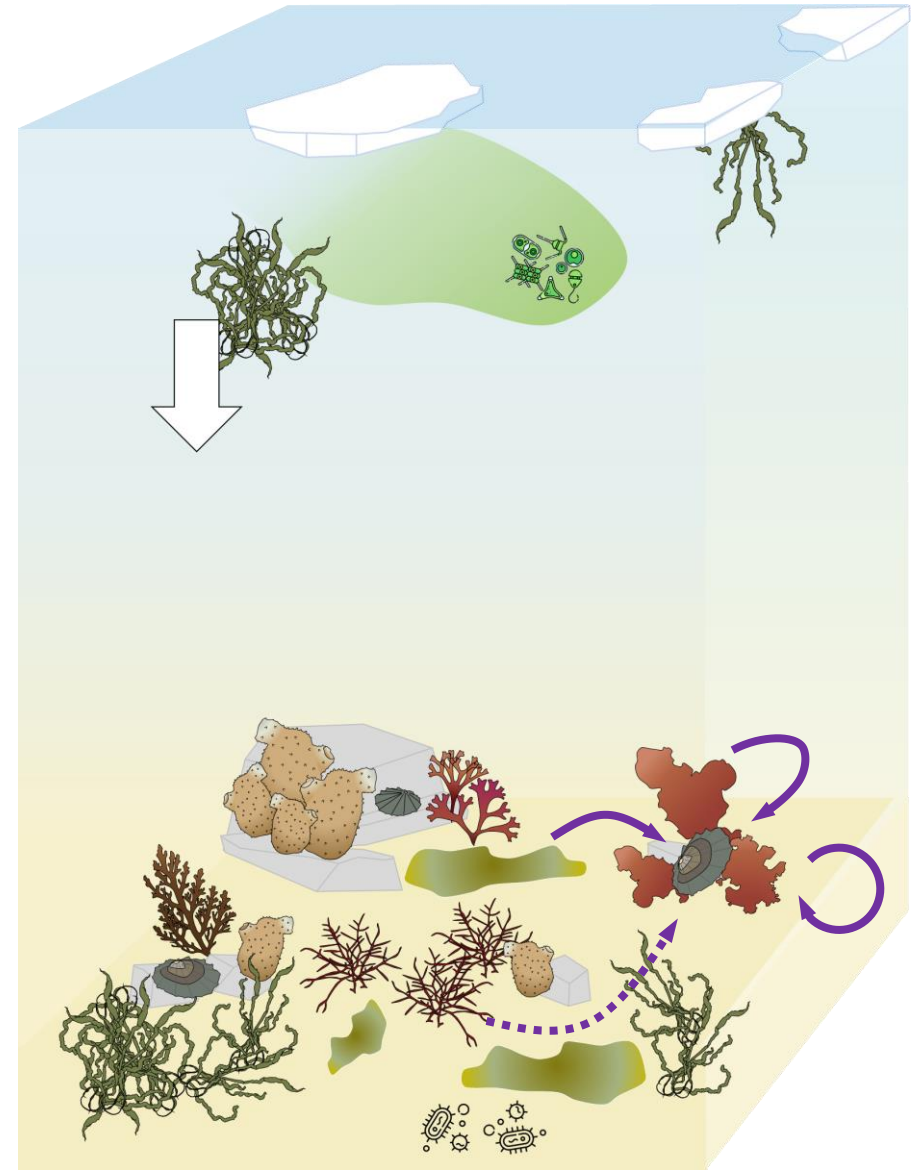
Soft sediments

Key points

→ "Eaten by"



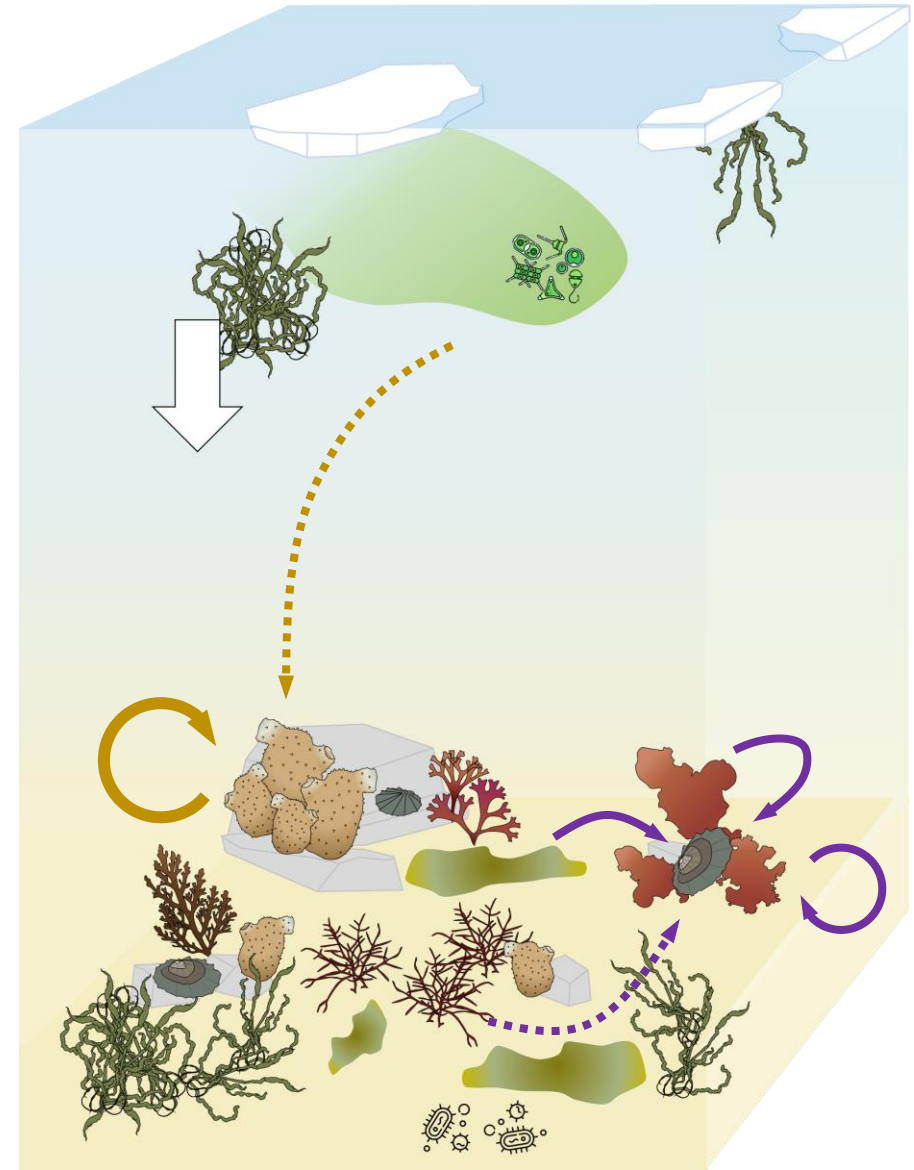
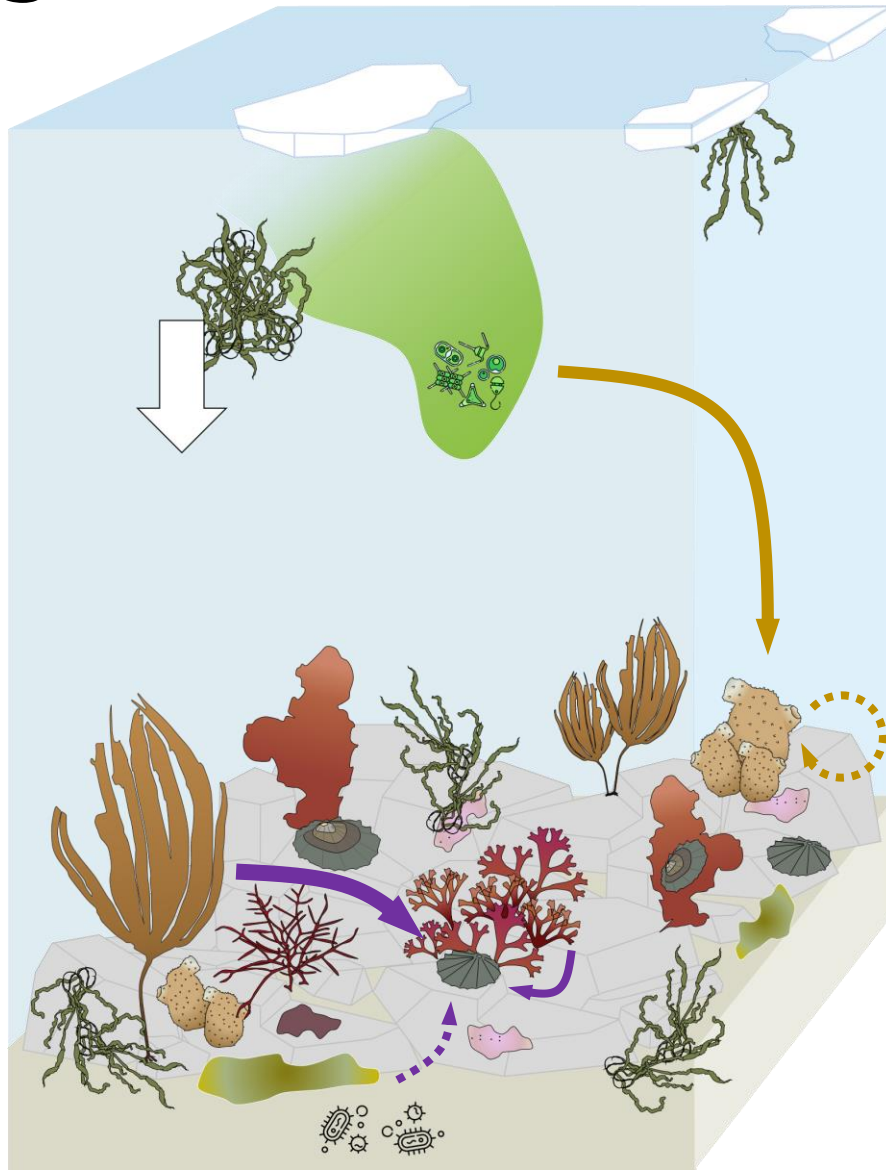
Rocky substrate



Soft sediments

Key points

→ "Eaten by"



Rocky substrate

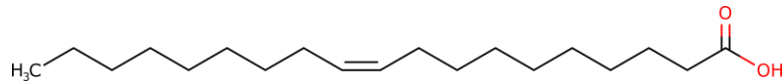
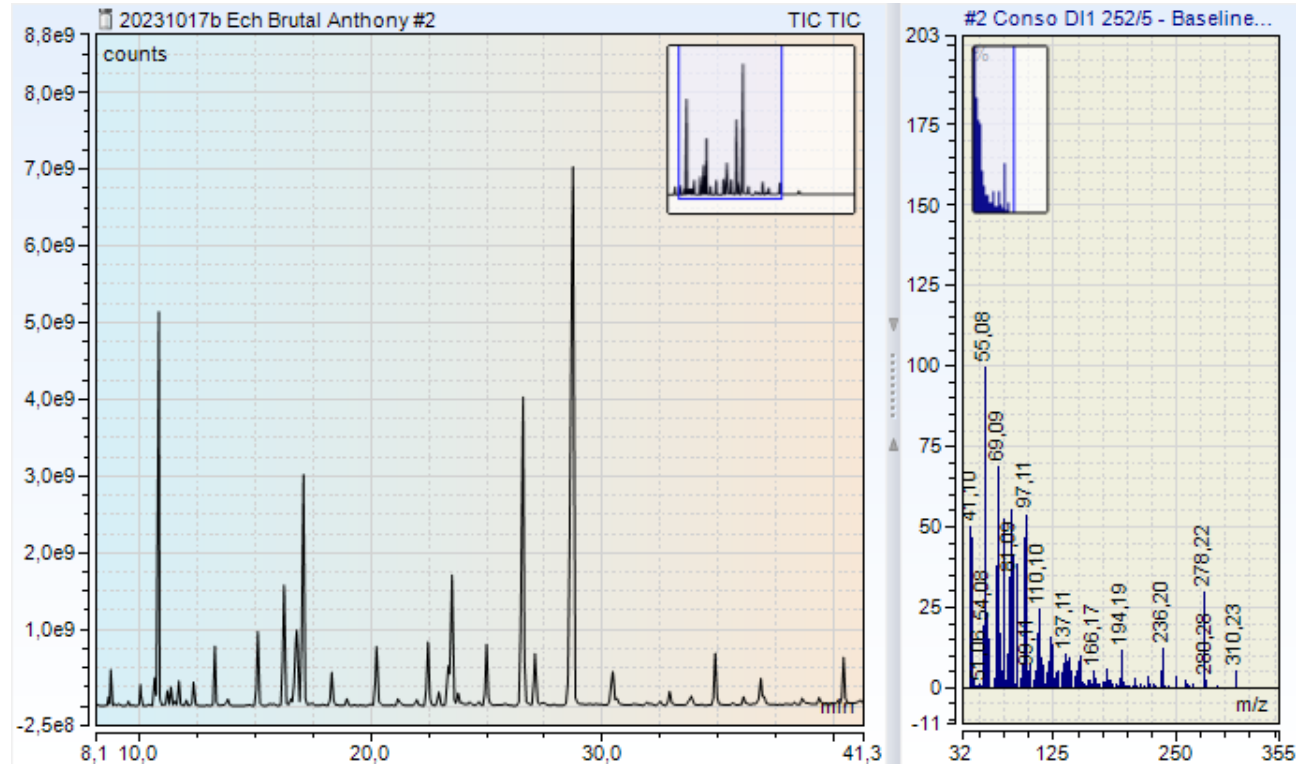


Soft sediments

What's next?

GC-FID + GC-MS

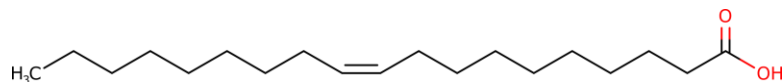
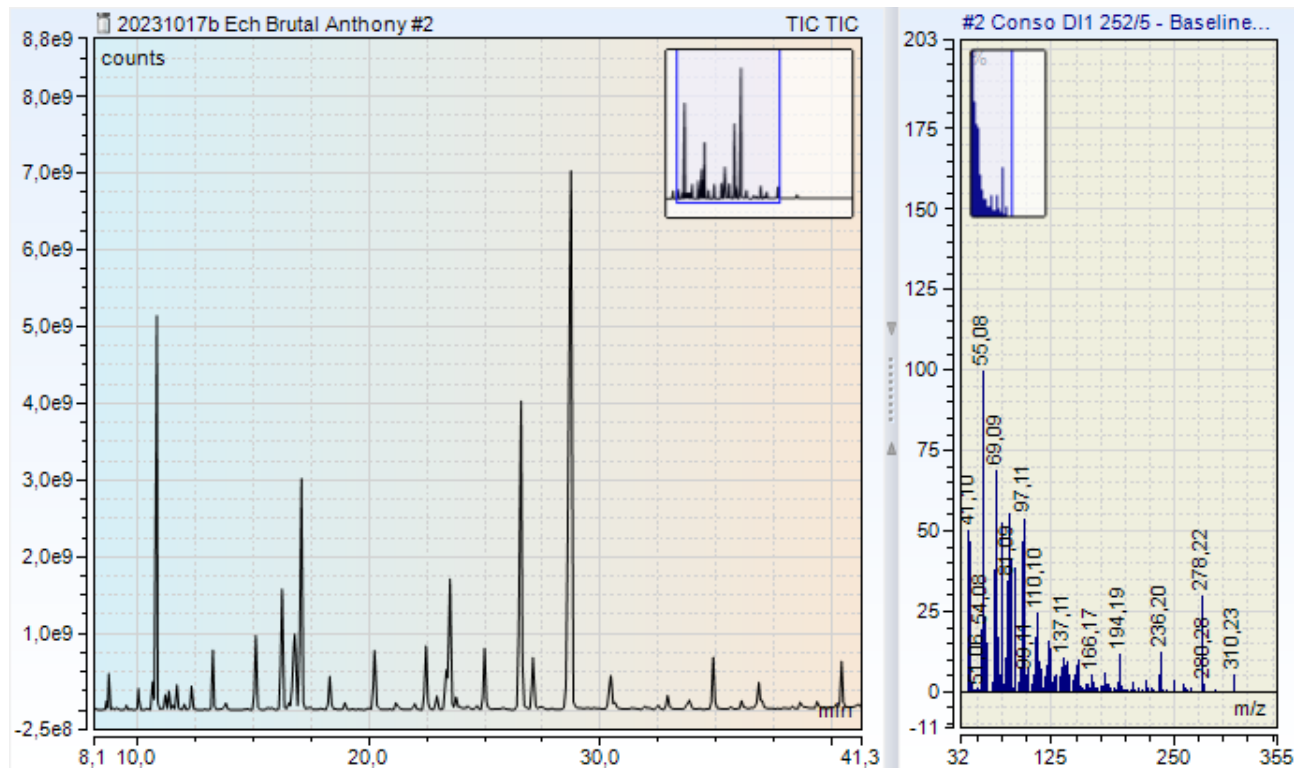
⇒ Combination with GC-Mass Spectrometry



What's next?

GC-FID + GC-MS

⇒ Combination with GC-Mass Spectrometry



DEADLINE FOR SUBMISSION

- Submission deadline for Oral communication: **Extended until 15th of June.**
- Submission deadline for Poster communication: **Extended until 15th of June.**



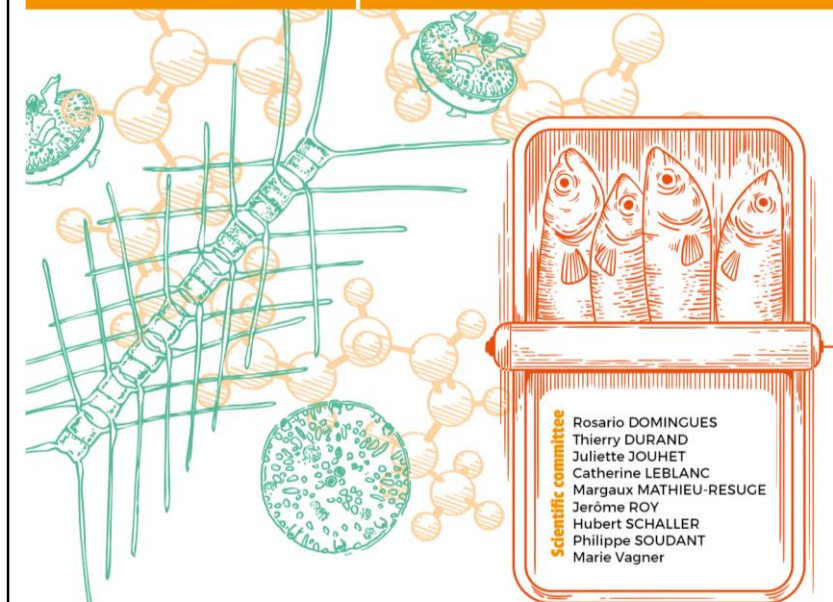
19th GERLI International Lipidomics meeting

From sea to fork

Lipidou: eus ar mor d'ar fourchetez

IUEM, Brest

23-26 september 2024

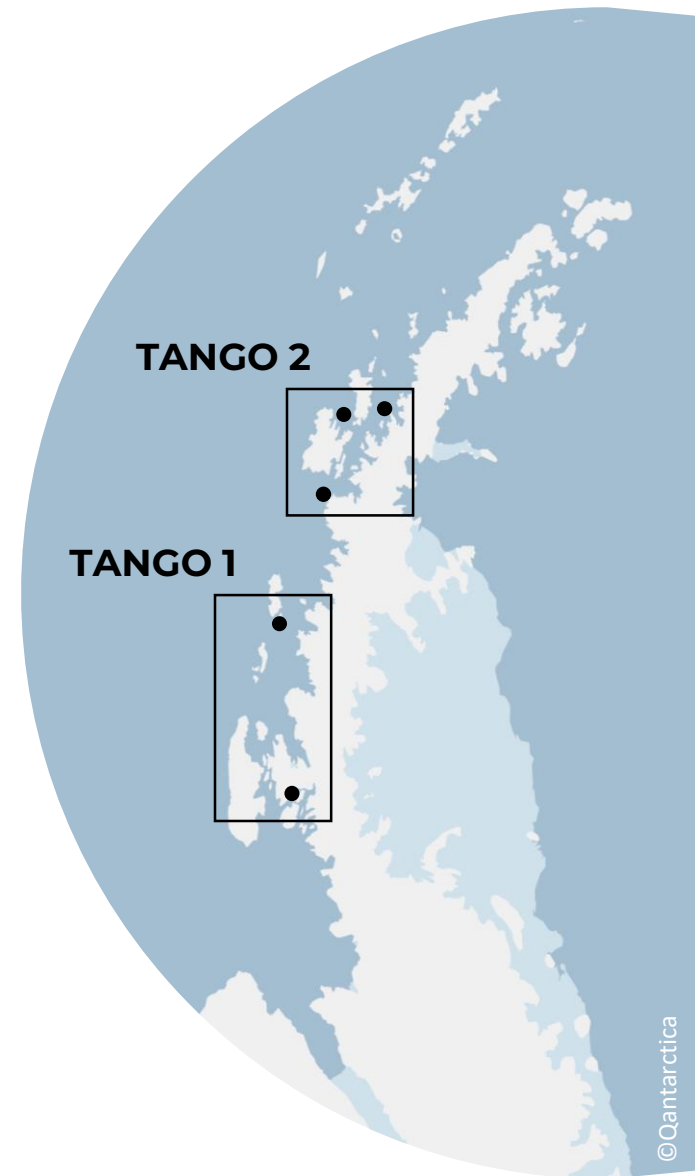
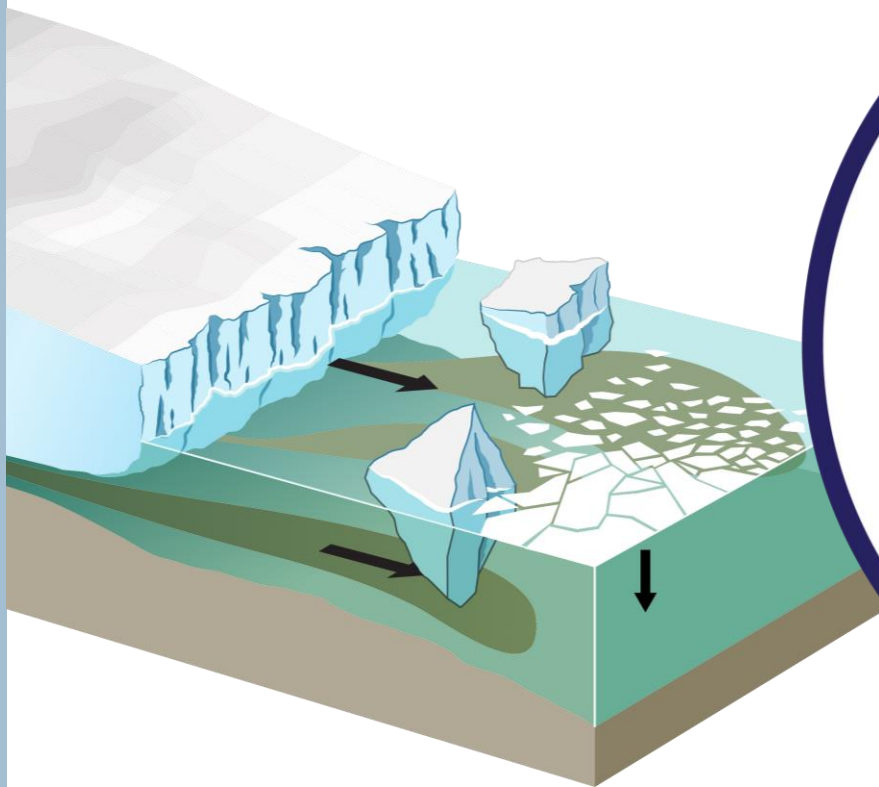


Scientific committee
Rosario DOMINGUES
Thierry DURAND
Juliette JOUHET
Catherine LEBLANC
Margaux MATHIEU-RESUGE
Jerôme ROY
Hubert SCHALLER
Philippe SOUDANT
Marie Vagner

What's next?

TANGO 2 expedition

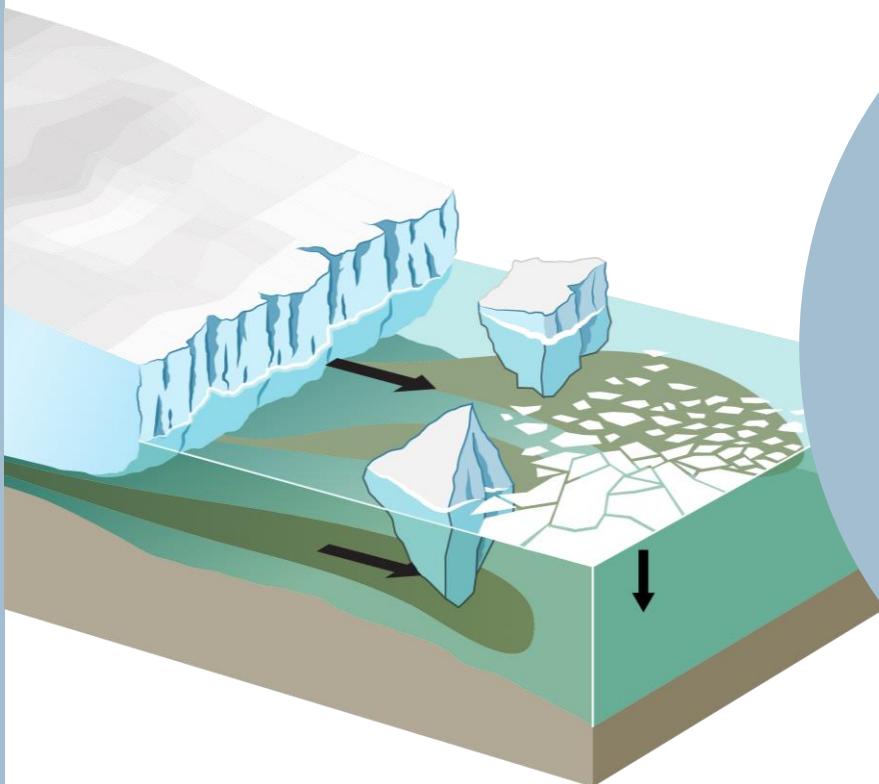
⇒ Northern West Antarctic Peninsula (February 2024)



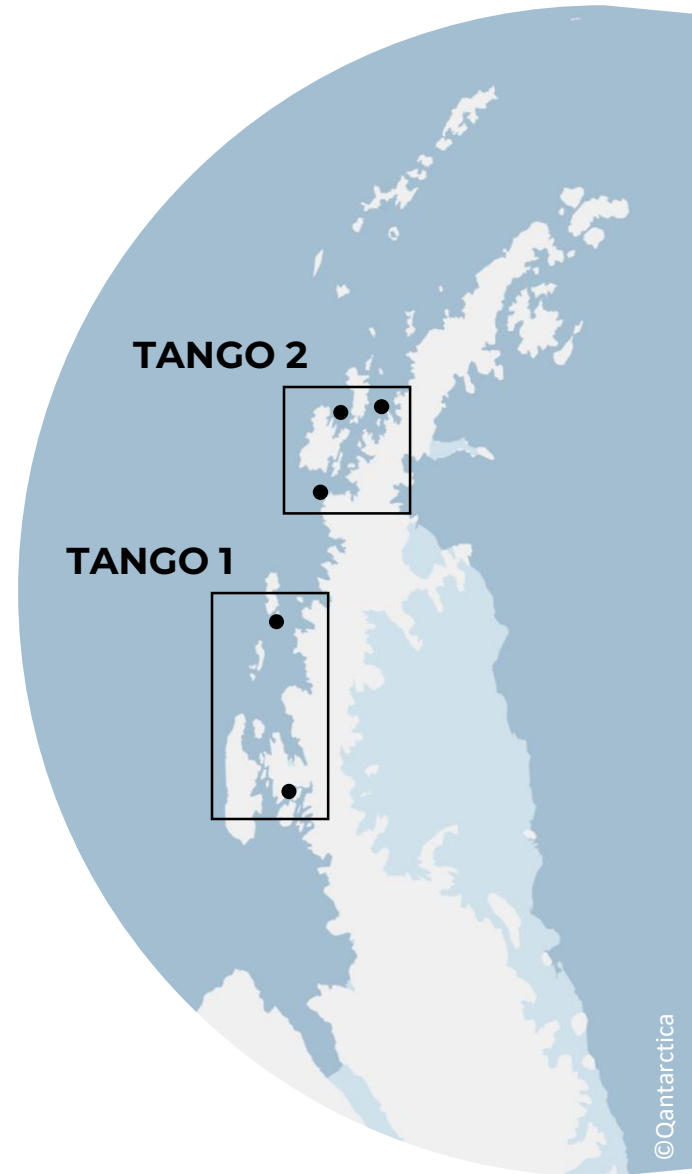
What's next?

TANGO 2 expedition

⇒ Northern West Antarctic Peninsula (February 2024)



Do environmental conditions, linked to ice disturbances, influence diet of Antarctic benthic species?



Thank you for your attention

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