Benthic Food Webs in Antarctica

~

Would you care for some more (micro)algae ?

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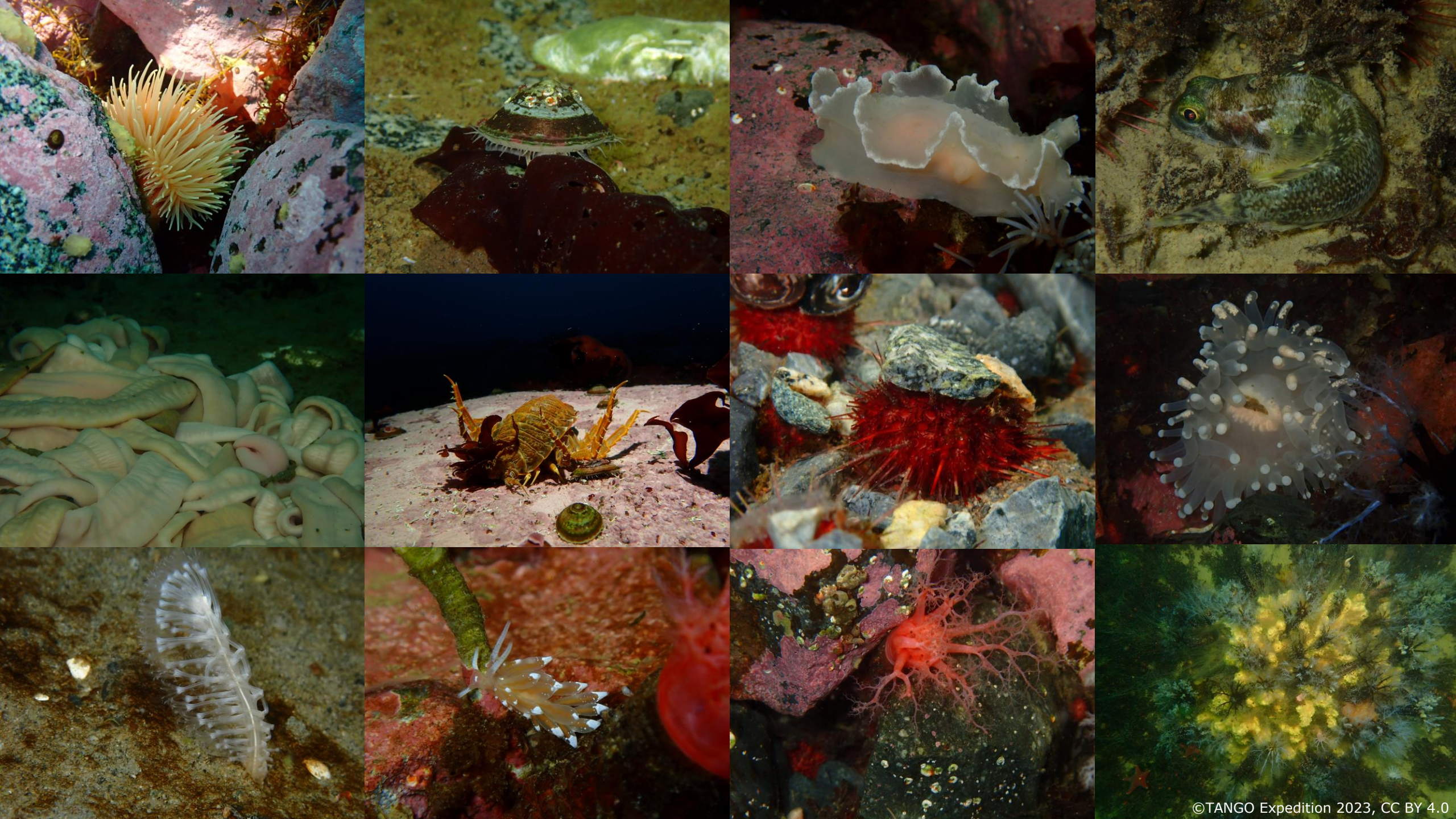

1) Introduction – Benthic communities of Antarctica

- Two main underwater habitats in the shallows

Soft sedimentary bottoms

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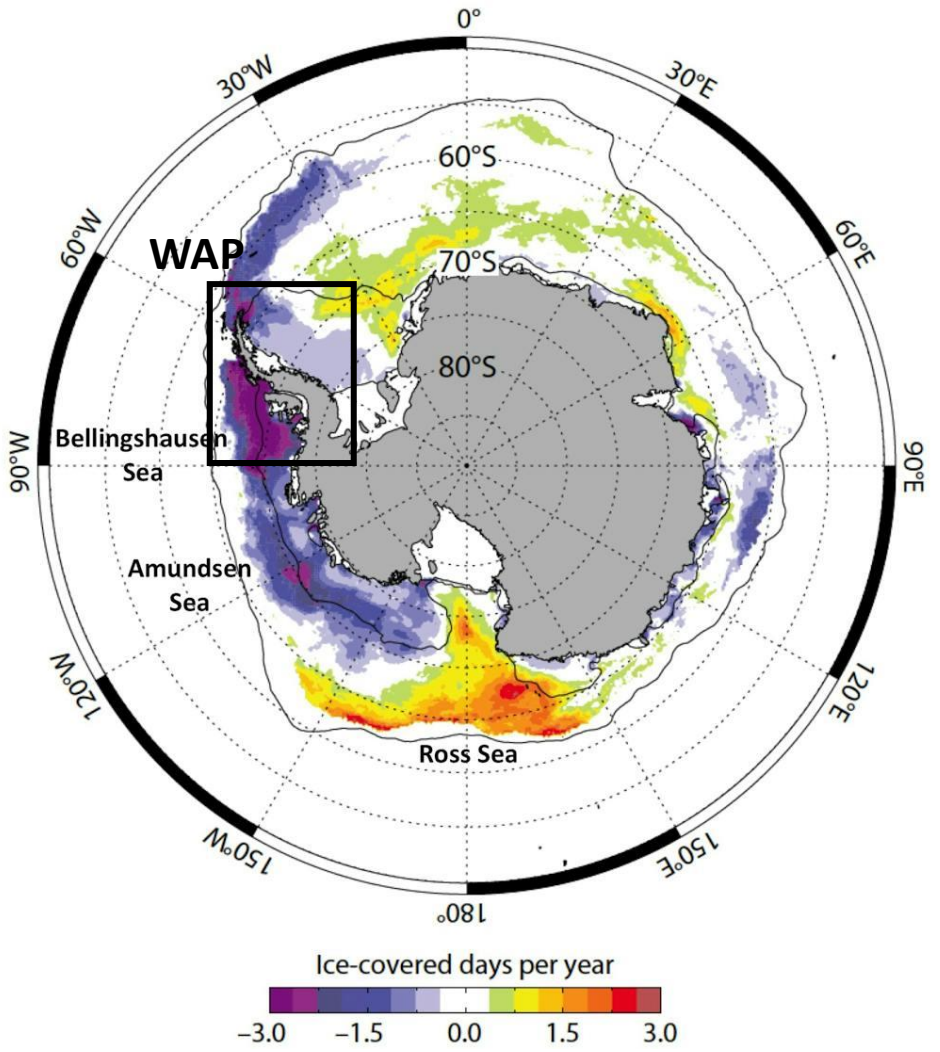
Soft sedimentary bottoms

Macroalgae forests

1) Introduction – Climate change in Antarctica

- Complex sea ice dynamics around Antarctica

⇒**1979 - 2014** : Net **increase of sea ice cover**... but not along the West Antarctic Peninsula (WAP)



Trends in sea ice duration (days of coverage) during the 1979-2010 period, taken from Maksym et al. (2012).

1) Introduction – Climate change in Antarctica

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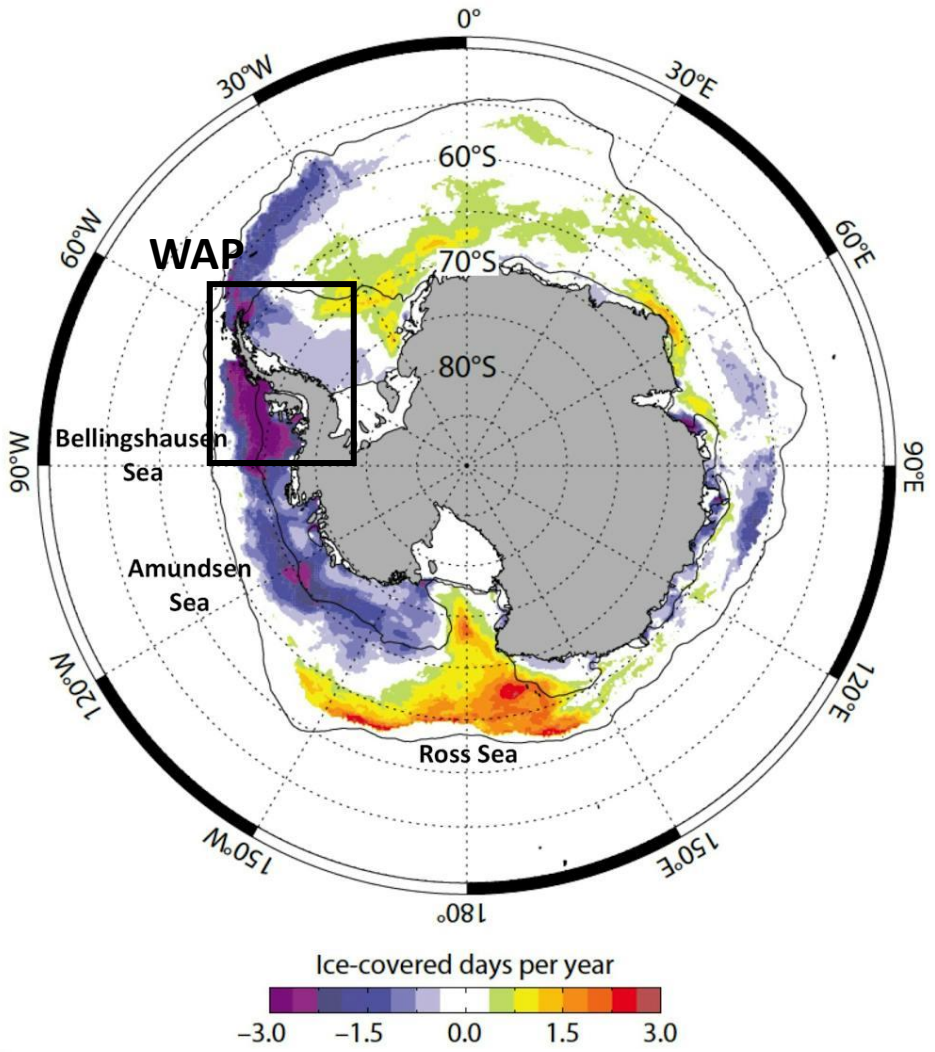
⇒**1979 - 2014** : Net **increase of sea ice cover**... but not along the West Antarctic Peninsula (WAP)

⇒**2014 - present** : **Dramatic decrease** of sea ice



Trends in sea ice duration (days of coverage) during the 1979-2010 period, taken from Maksym et al. (2012).

nature › communications earth & environment › articles › article

Article | Open access | Published: 13 September 2023

Record low Antarctic sea ice coverage indicates a new sea ice state

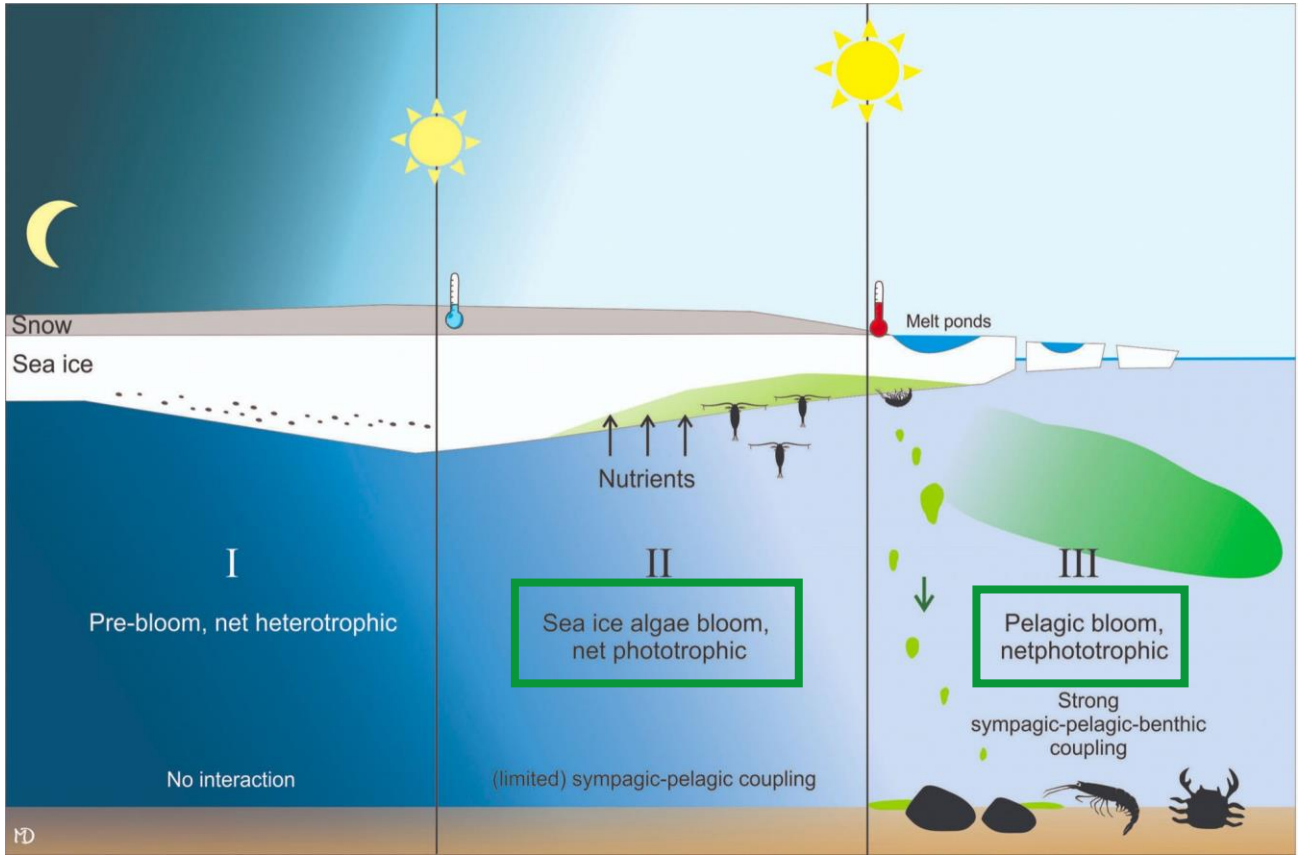
Ariaan Purich & Edward W. Doddridge

Communications Earth & Environment **4**, Article number: 314 (2023) | Cite this article

26k Accesses | **47** Citations | **1623** Altmetric | Metrics

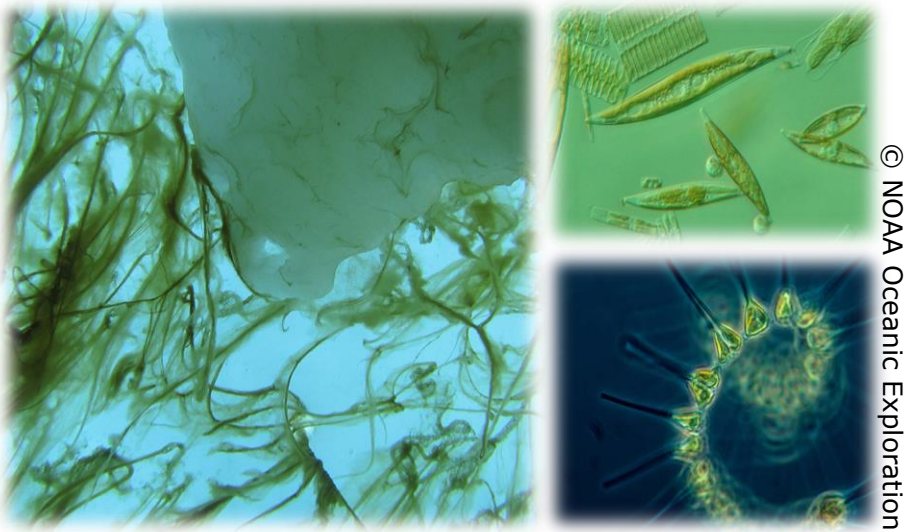
1) Introduction – Benthic communities under pressure

Changes in primary production dynamics



Major developmental phases of sympagic blooms during the winter–spring transition period and associated interactions with local primary consumers, diagram adapted from Leu et al. (2015)

- **Change** in **timing** and **magnitude** of **pelagic** & **sea ice algae blooms**



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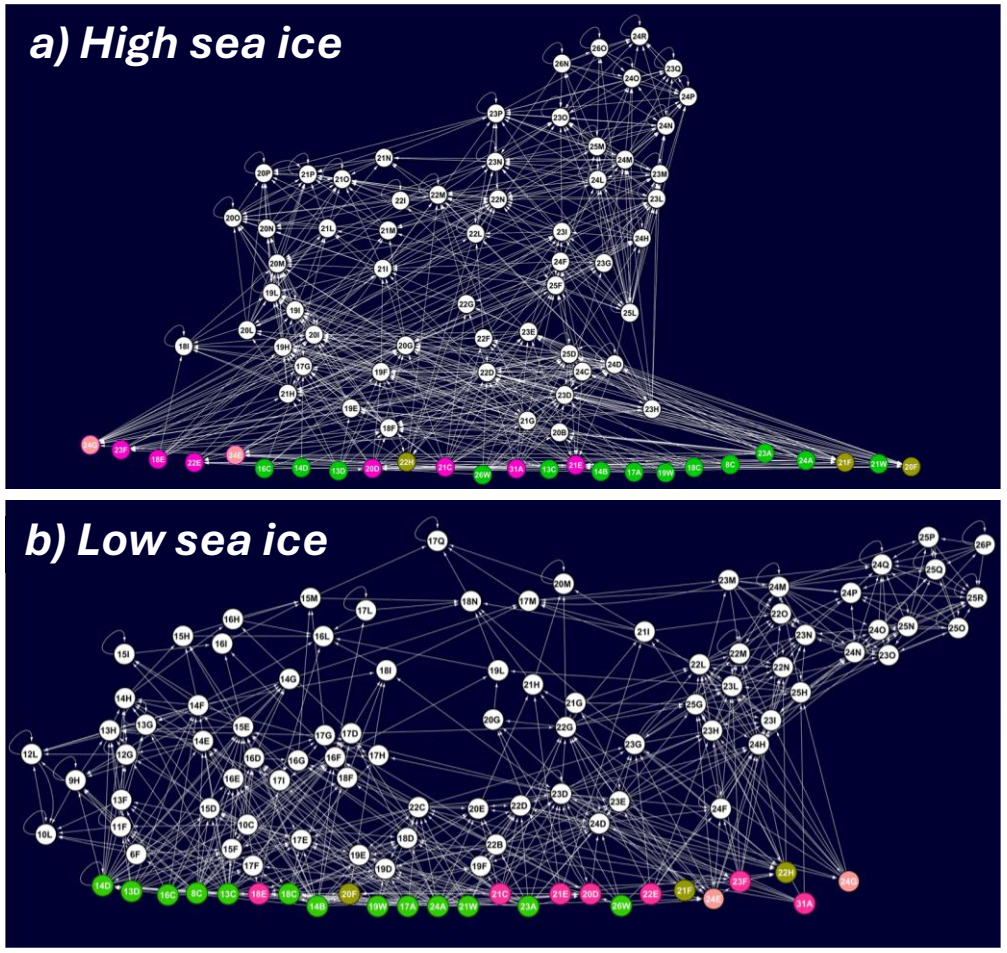
1) Introduction – Benthic communities under pressure

- Cascading effects in the communities through trophic interactions



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Article | Open access | Published: 28 August 2019

Antarctic food web architecture under varying dynamics of sea ice cover

Loreto Rossi, Simona Sporta Caputi, Edoardo Calizza, Giulio Careddu, Marco Oliverio, Stefano Schiaparelli & Maria Letizia Costantini

Scientific Reports **9**, Article number: 12454 (2019) | Cite this article

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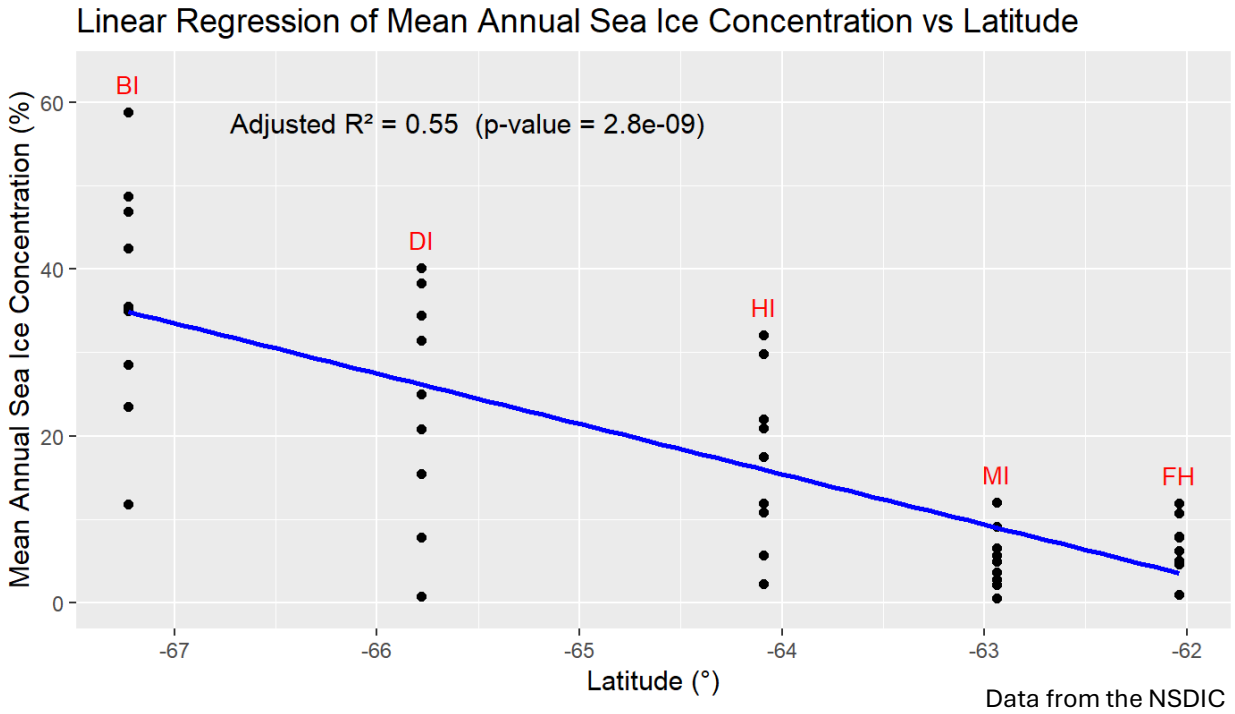
Benthic food web structure in Terra Nova Bay, Antarctica, before (**a**) and after (**b**) sea-ice break up. Each node represents one Isotopic Trophic Unit (ITU) in the community. Nodes containing basal food sources are highlighted in different colours: green = sympagic algae, brown = organic matter in sediments, pink = plankton, violet = macroalgae (Rossi et al. 2019).

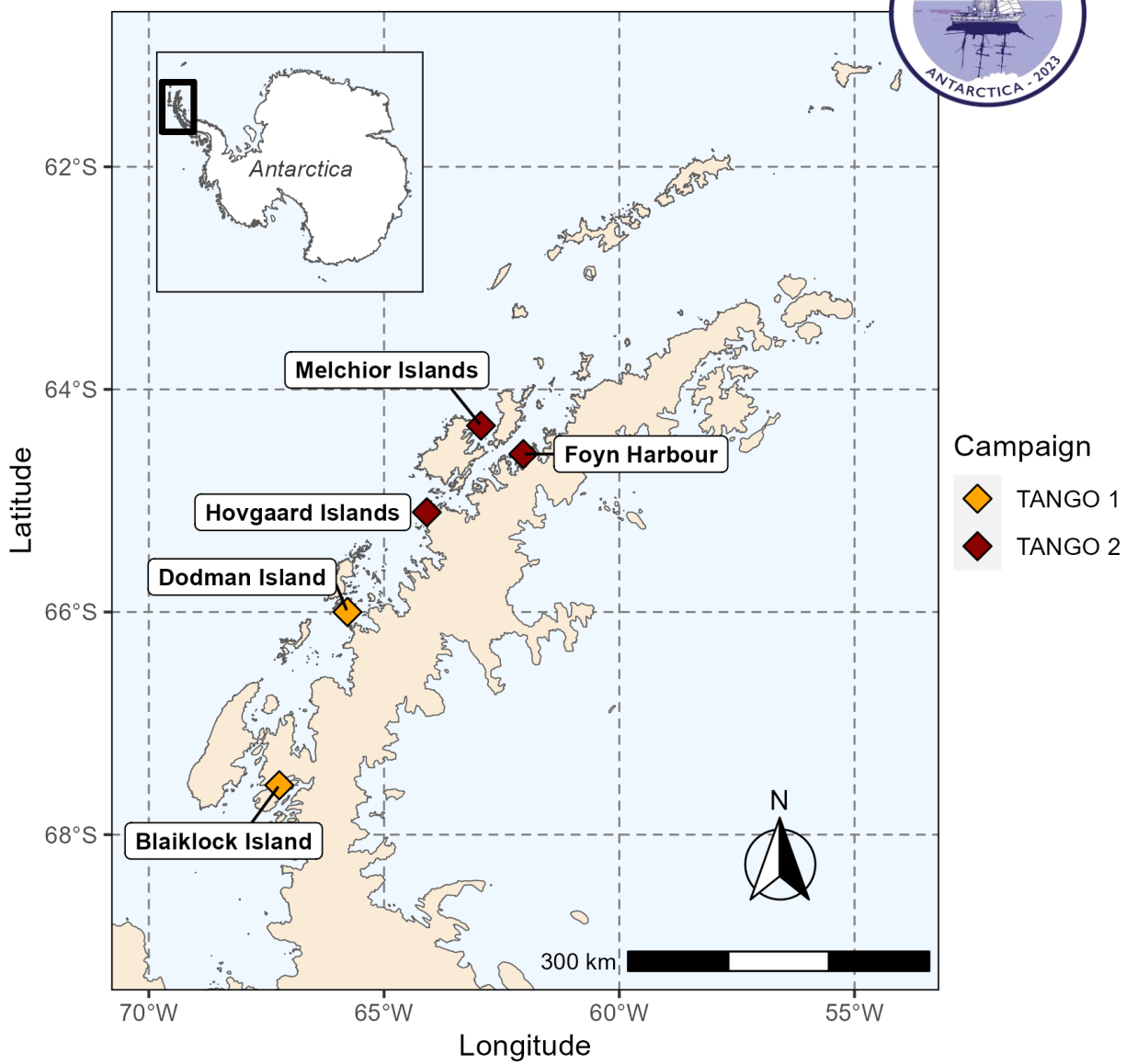
2) Methods – Sampling plan

Sampling areas

- 5 sampling locations
- Gradient of environmental conditions (e.g. sea ice cover)



TANGO 1 & 2 sampling locations



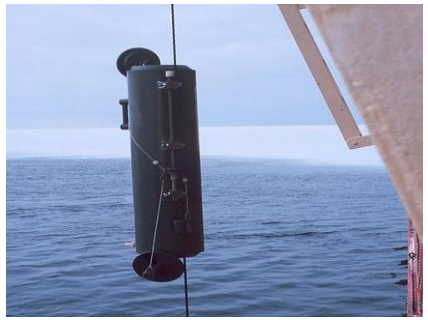
2) Methods – Sampling plan

- Two locations – **Dodman** & **Blaiklock Island**
- Five stations :

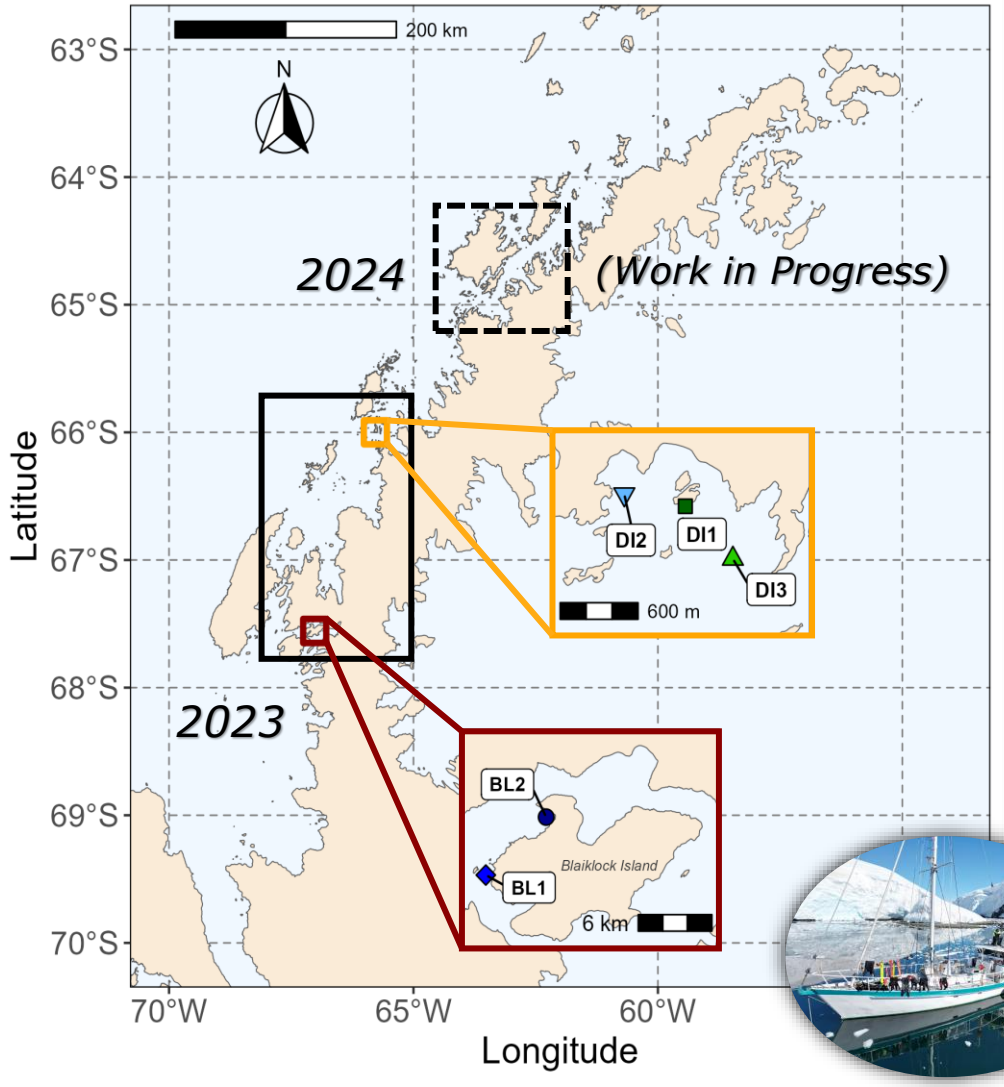
2 Macroalgae Forests (**DI1** & **DI3**)

3 Soft Sedimentary Bottoms (**DI2**, **BL1** & **BL2**)

- Underwater collects & Niskin bottles



TANGO 1 sampling stations



2) Methods – Research questions

1. Are sea ice algae more crucial as basal resources in one of the two habitats ?

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2. Is there a difference in consumers' trophic diversity between macroalgae forests and soft sedimentary bottoms?

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1. Are sea ice algae more crucial as basal resources in one of the two habitats ?

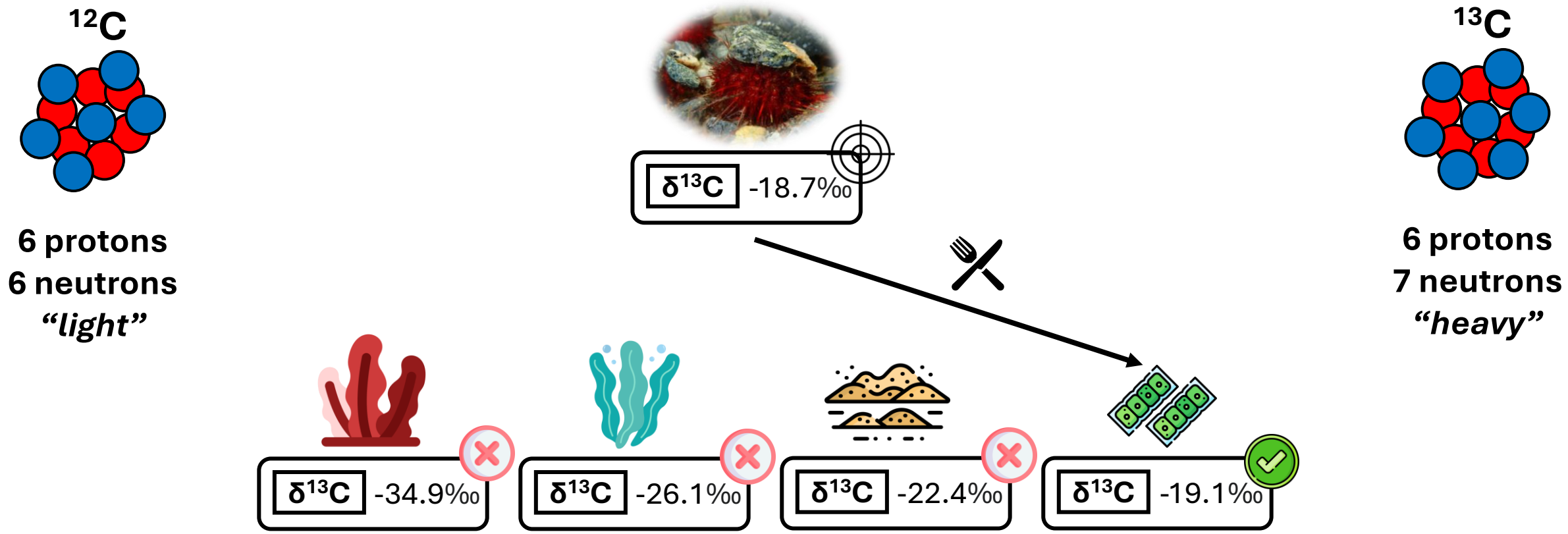
2. Is there a difference in consumers' trophic diversity between macroalgae forests and soft sedimentary bottoms?

3. How does the vertical food web structure differ between the two habitats ?

2) Methods – Stable isotopes

- Carbon stable isotopes ratios ($\delta^{13}C$)
  - Direct tracing of organic matter origin through the food webs

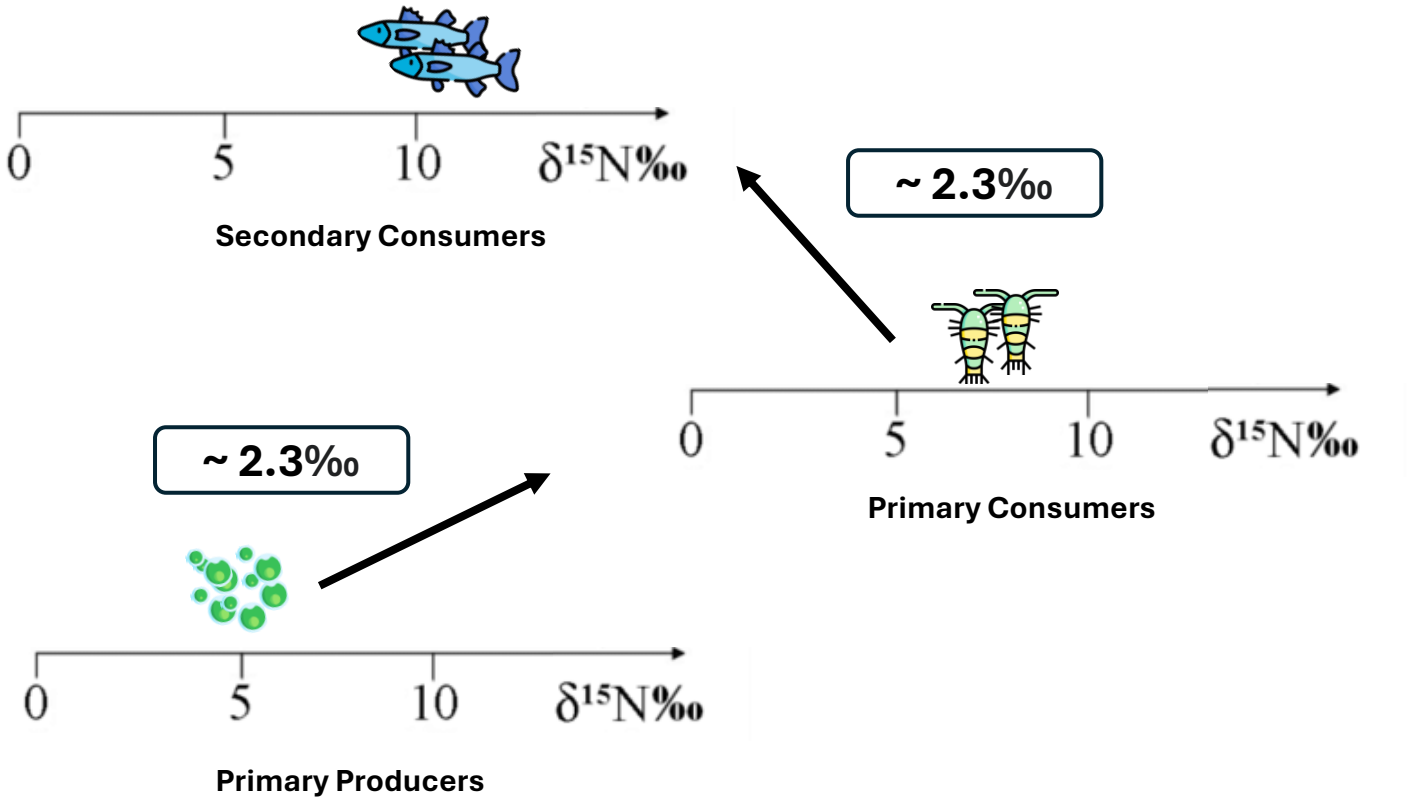
    $\Rightarrow$ Little change of $\delta^{13}C$ during trophic transfer



2) Methods – Stable isotopes

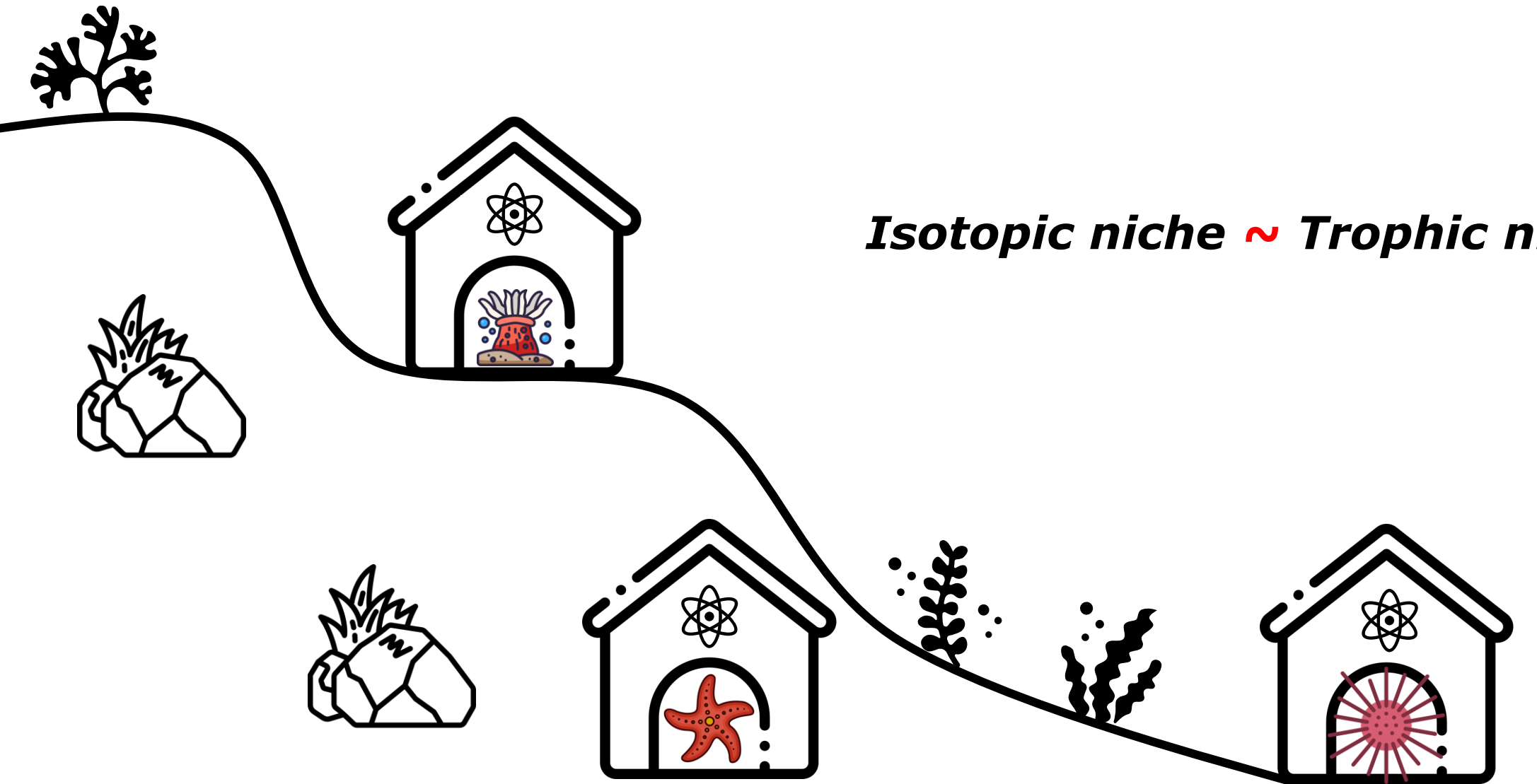
- Nitrogen stable isotopes ratios ($\delta^{15}N$)
  - Characterization of consumers' Trophic Position

    $\Rightarrow$ Stepwise increase of $\delta^{15}N$ after each trophic transfer (TEF ~ 2.3‰)



"You are what you eat…plus a few permille"
DeNiro & Epstein, 1978

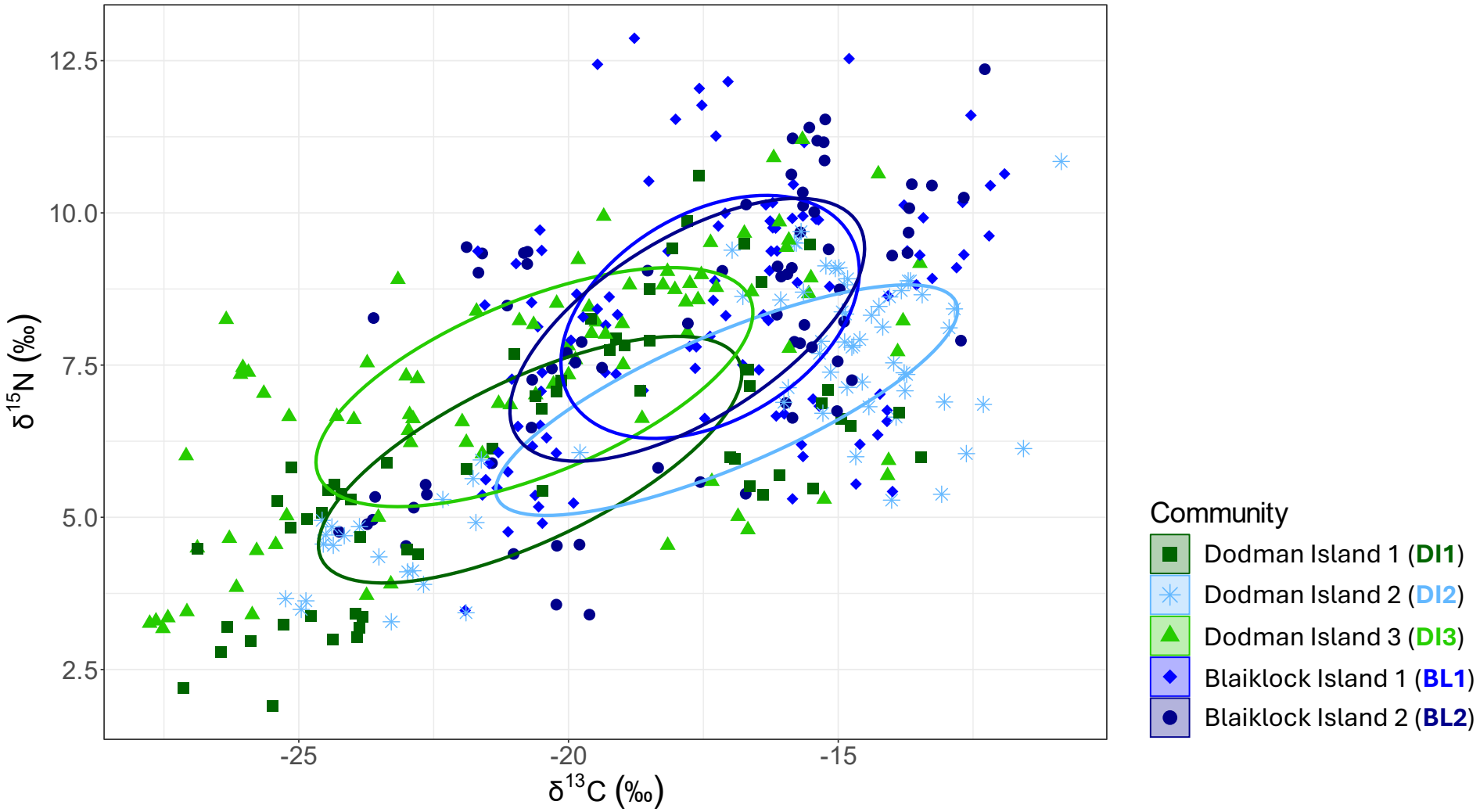
3) Results – Isotopic community niches



Isotopic niche ~ Trophic niche

3) Results – Isotopic community niches

- Isotopic niches - Standard Ellipses (~ central tendency)



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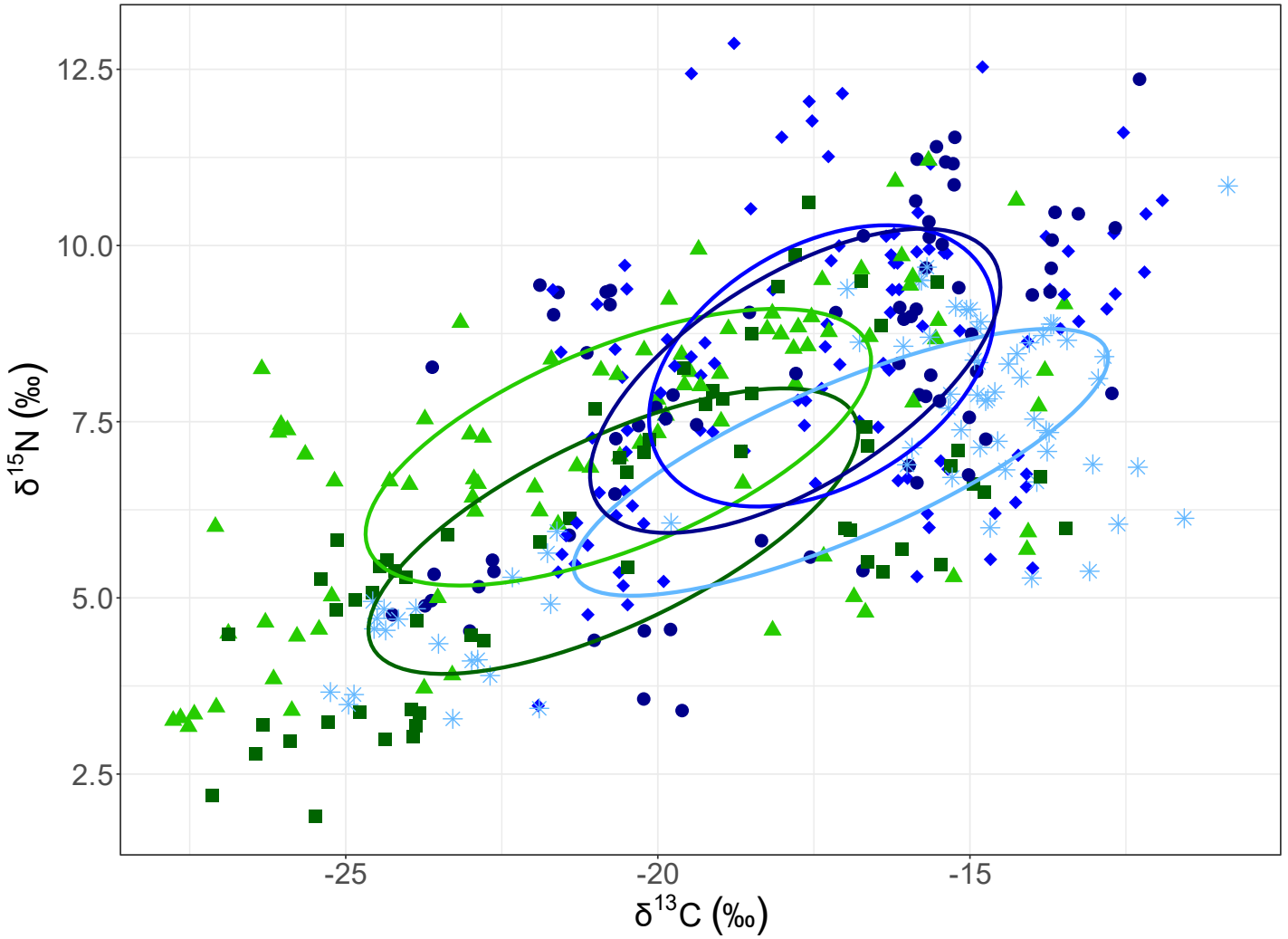

✓ Switch of **soft bottom communities** towards **higher $\delta^{13}C$ values**

Community
- Dodman Island 1 (**DI1**)
- Dodman Island 2 (**DI2**)
- Dodman Island 3 (**DI3**)
- Blaiklock Island 1 (**BL1**)
- Blaiklock Island 2 (**BL2**)

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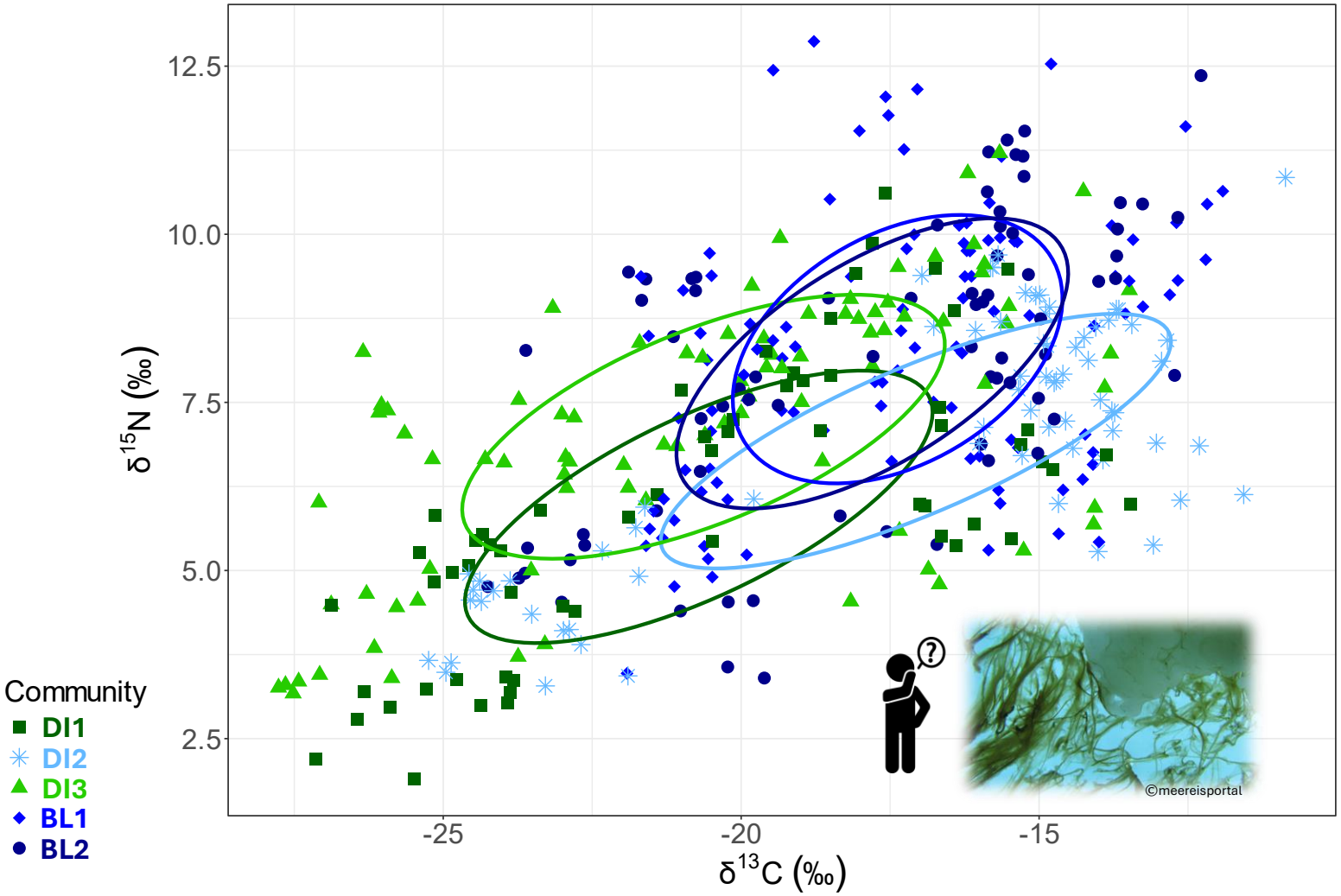

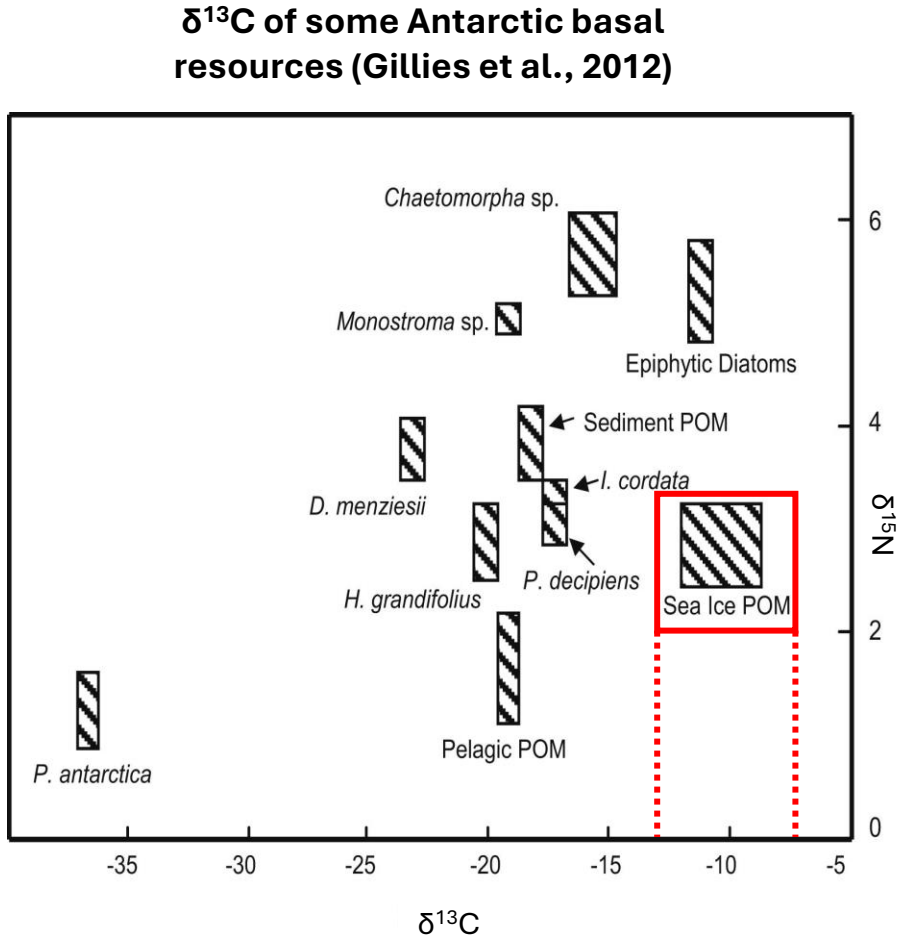

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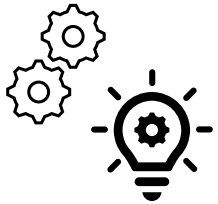
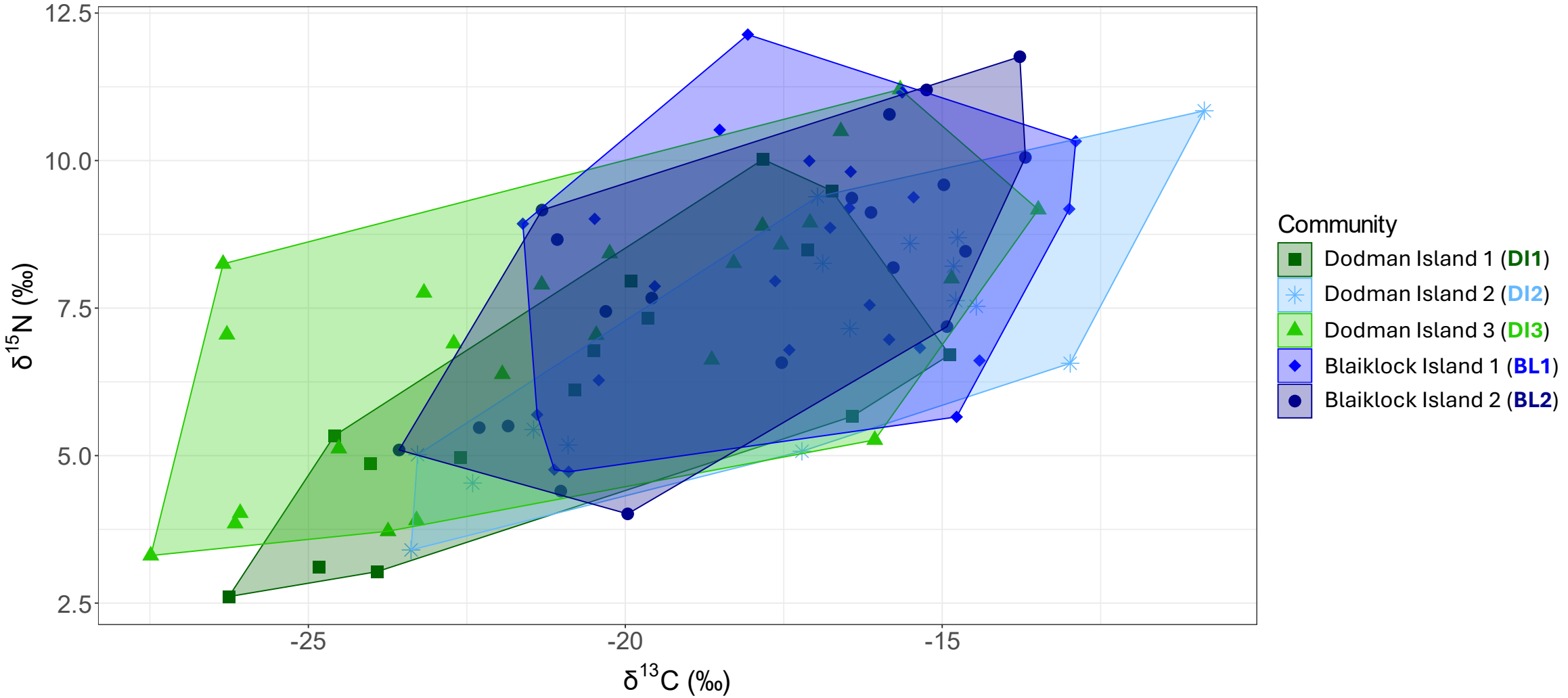


In **soft bottoms**, consumers' SI ratios switched toward **higher $\delta^{13}C$ values** ~ **sea ice algae**, suggesting their **higher importance** in this habitat

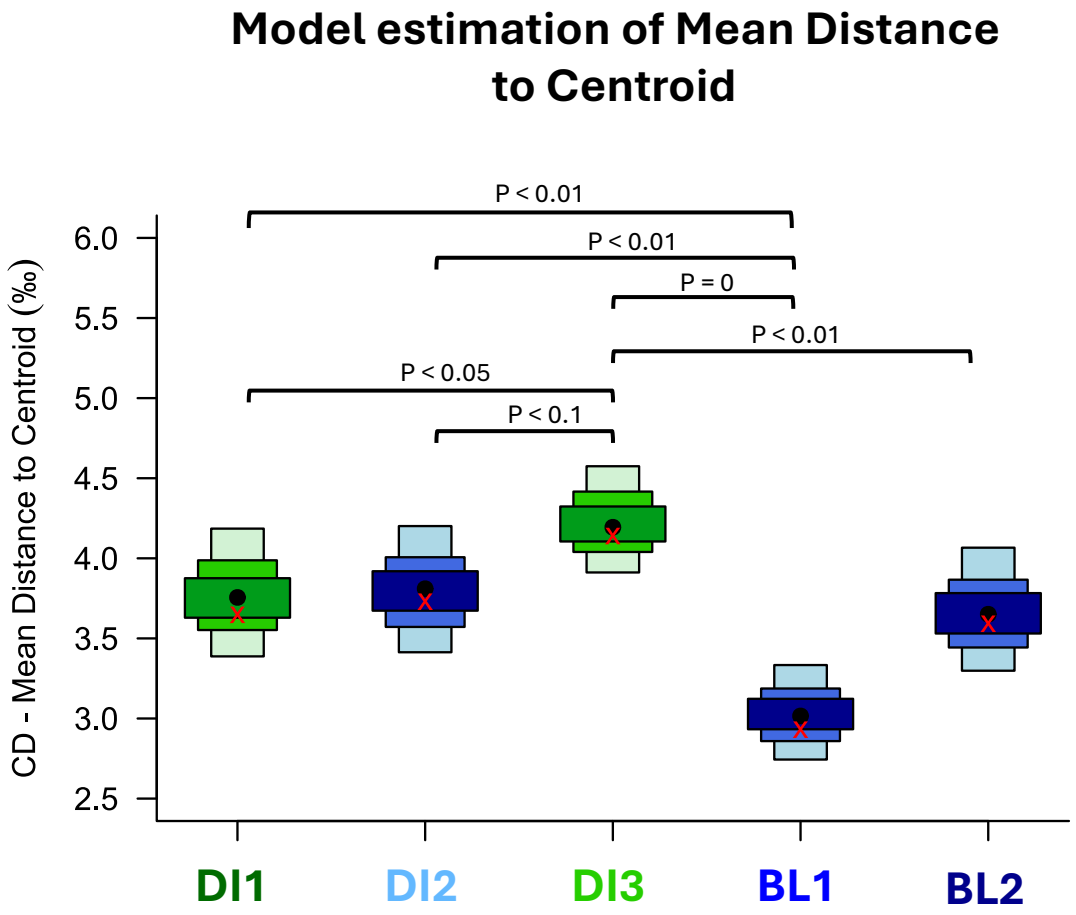
3) Results – Isotopic community niches

- Isotopic niches – Convex Hulls (integrate also extreme diets)



3) Results – Isotopic community niches

🔍 Layman metrics – Mean Distance to Centroid (~ trophic diversity)

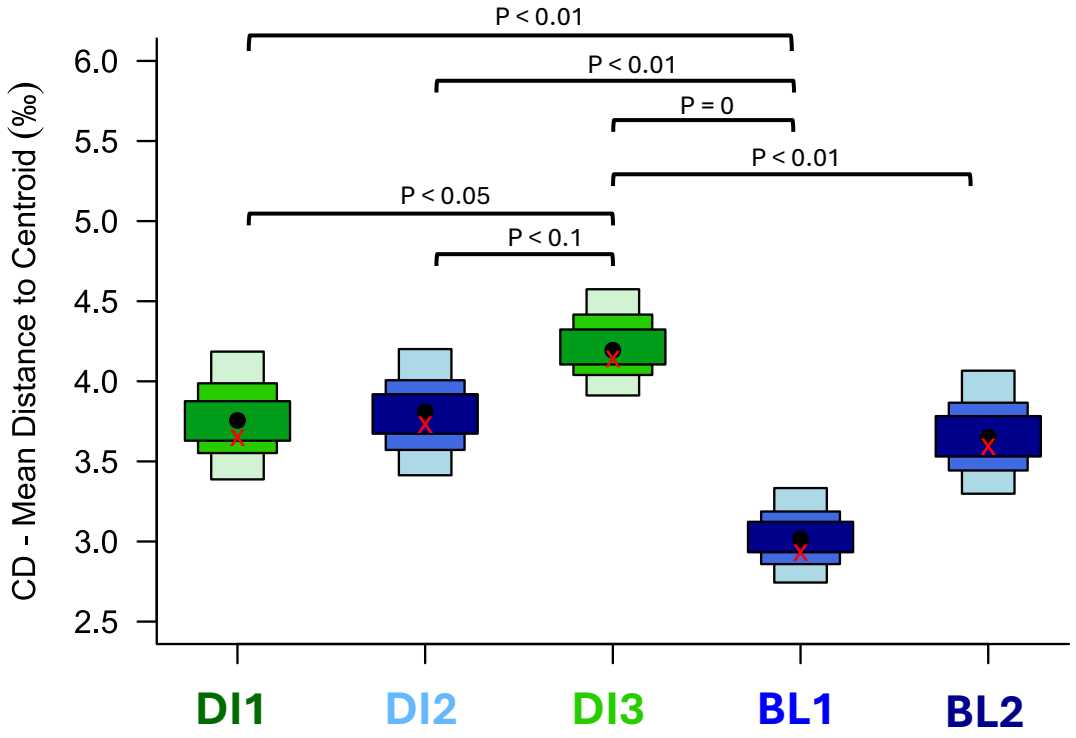


- ✓ **Larger** trophic **diversity** in **DI3 macroalgae forest**
- ✓ **Smaller** trophic **diversity** in **BL1 soft bottom**

3) Results – Isotopic community niches

- Layman metrics - Carbon Range (~ diversity of exploited basal resources)

Model estimation of Mean Distance to Centroid



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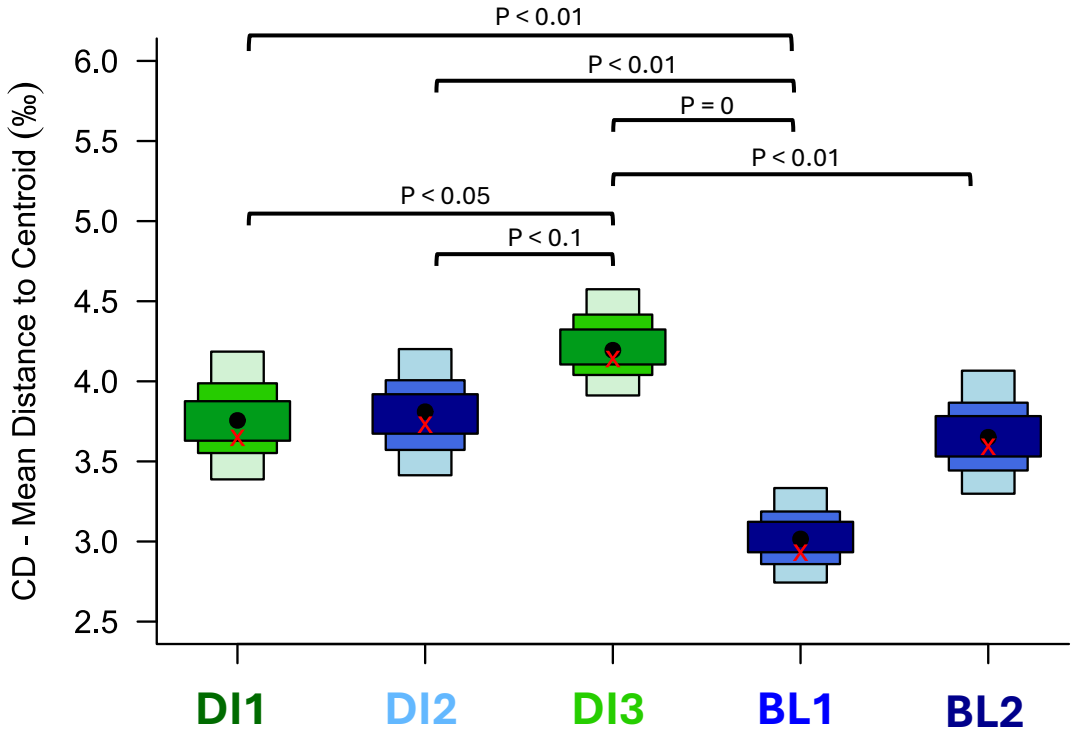
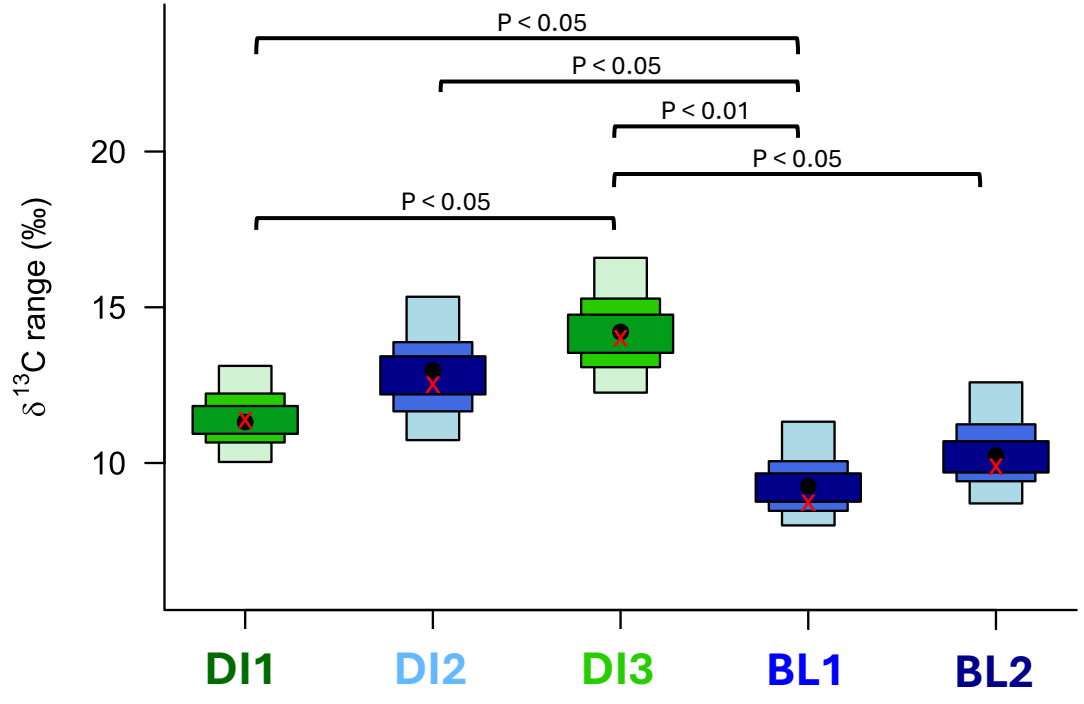


$R^2 = 0.836$

~

p = 0.029

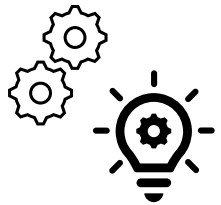
Model estimation of Carbon Range



3) Results – Isotopic community niches

② Is there a difference in consumers' trophic diversity between macroalgae forests and soft sedimentary bottoms?

⬇



Higher trophic diversity in communities with a **wider range of basal resources,** but **no apparent habitat-related differences**

3) Results – Vertical structure of food webs

- Trophic positions - SPOM baseline

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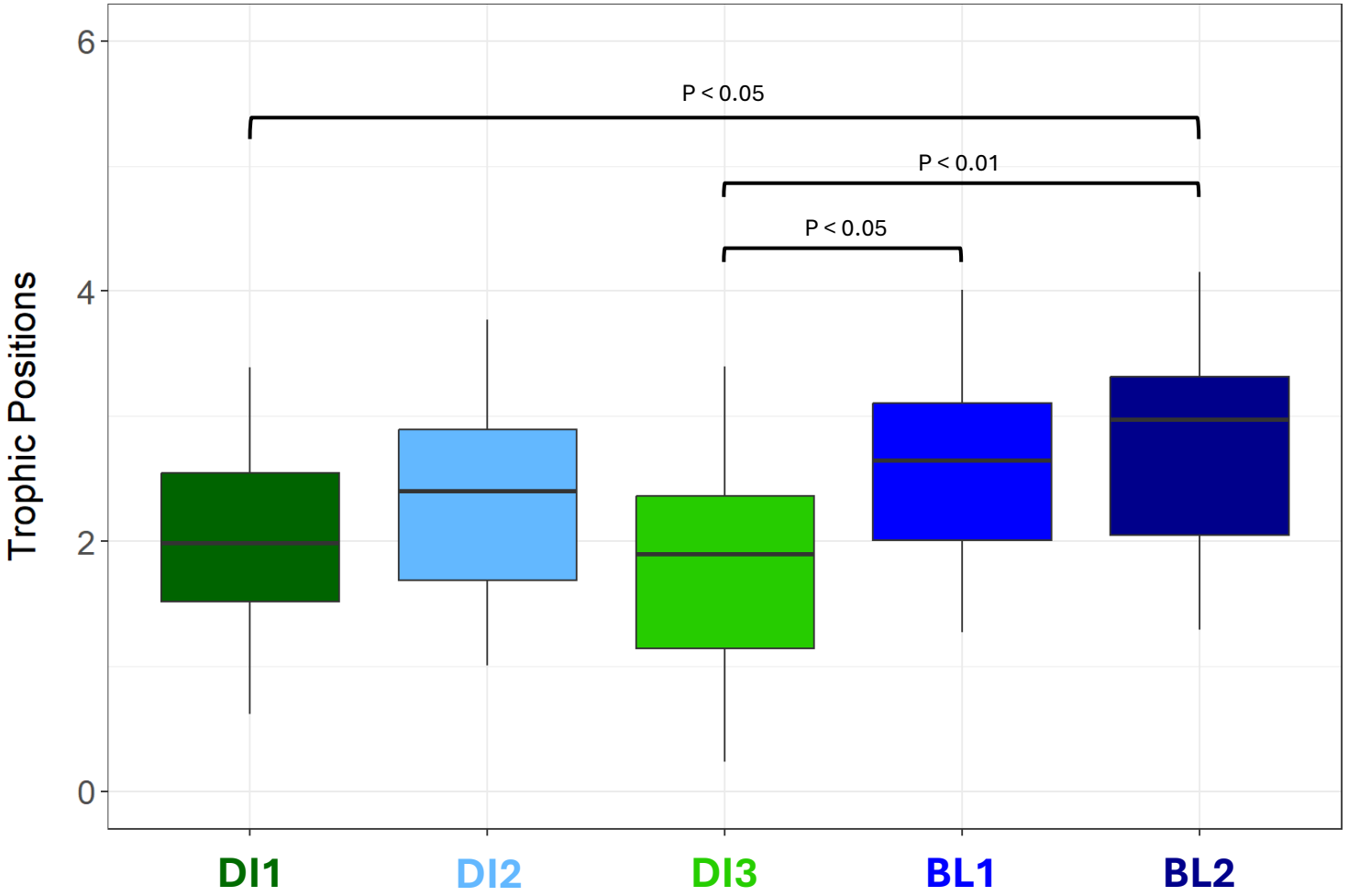

✓ **Higher** mean **trophic position** of consumers in **soft bottoms**

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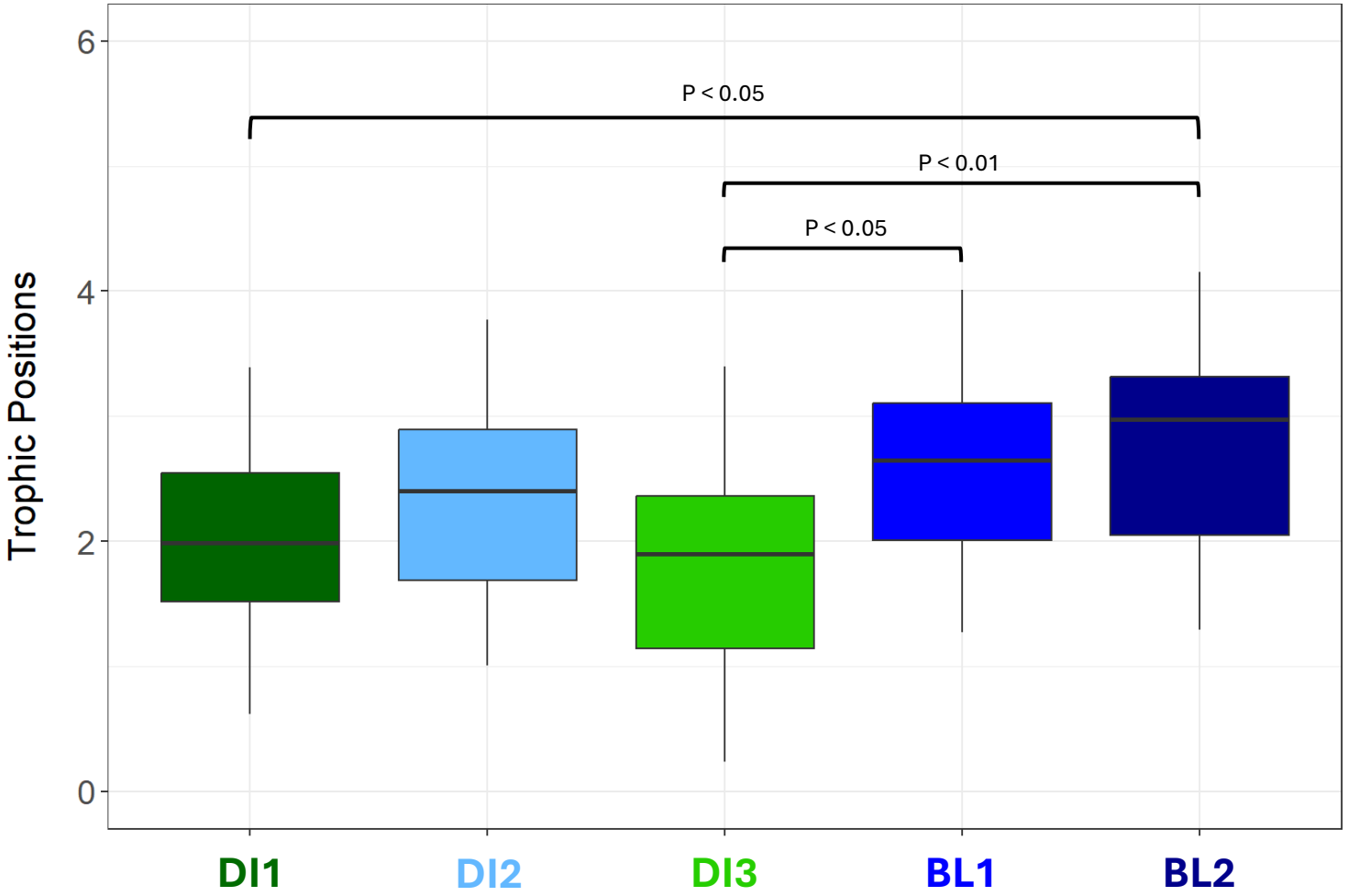

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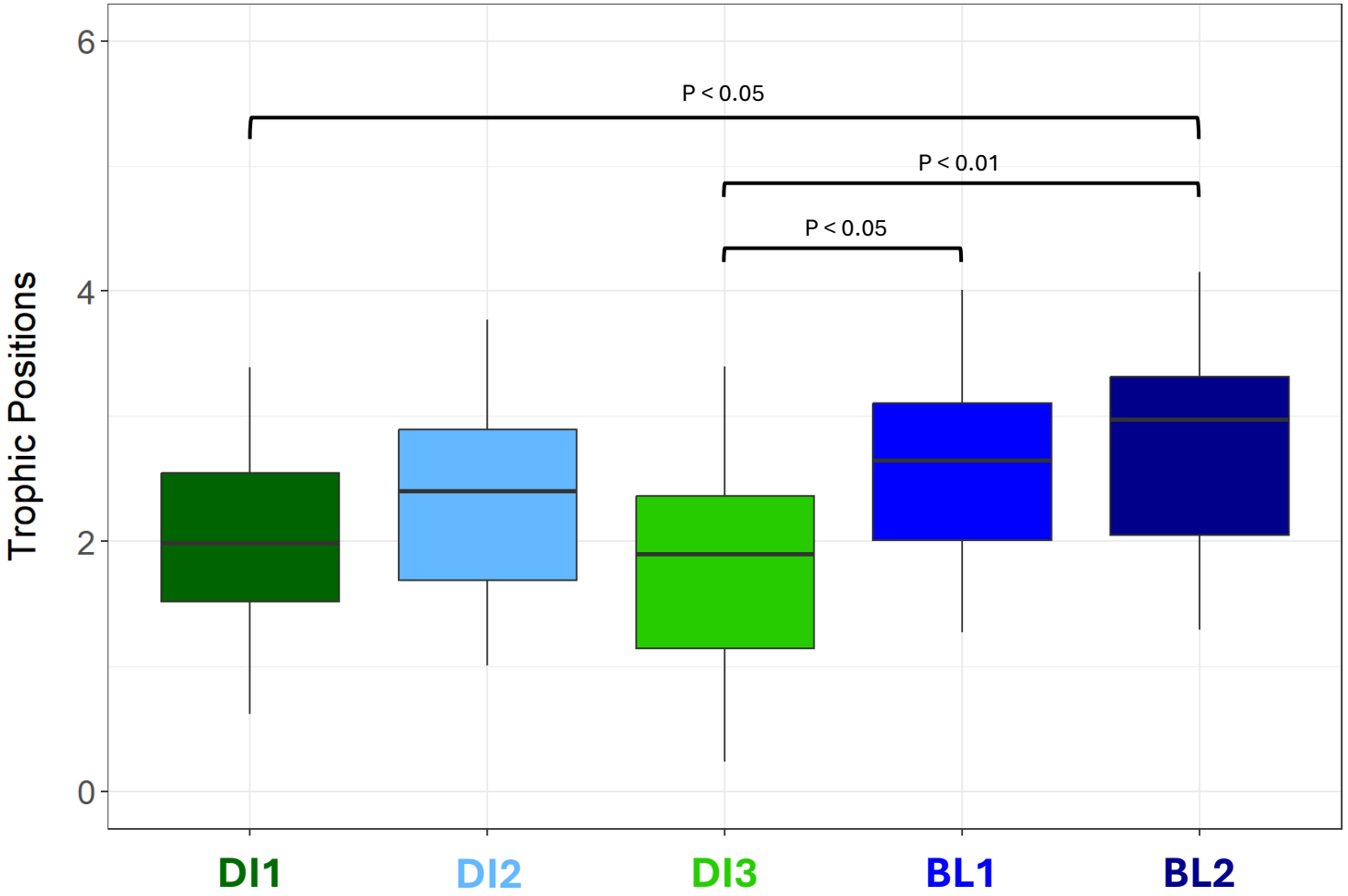

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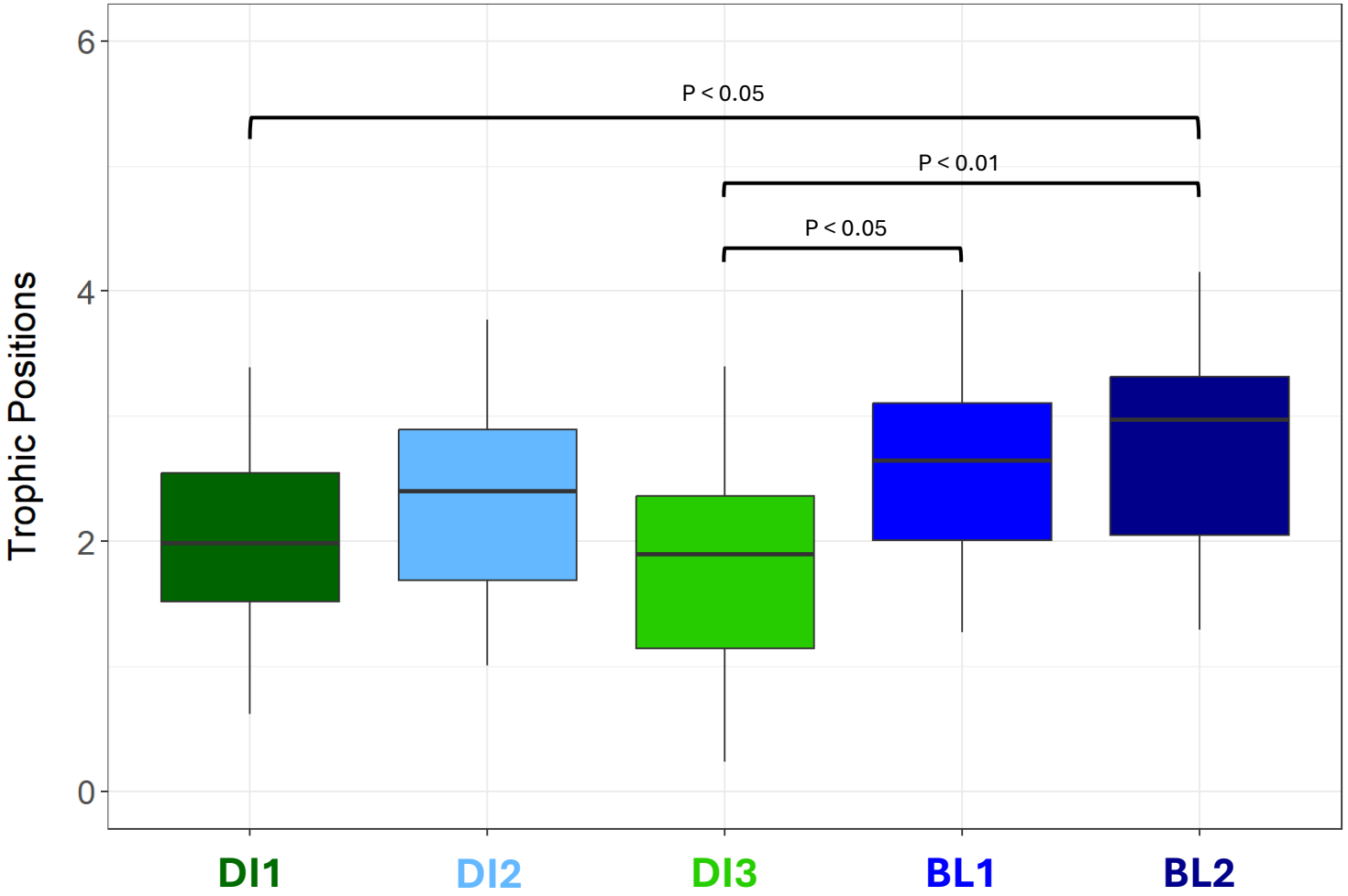

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✖ Switch of primary / secondary omnivores diet :

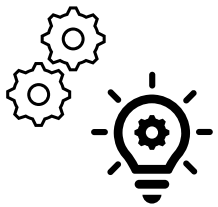
⇒ More animal OM ?

⇒ More detritial OM ?

3) Results – Vertical structure of food webs

3

How does the vertical food web structure differ between the two habitats ?



Higher trophic position of consumers in soft bottoms, resulting in a higher mean trophic position at the community scale.

4) What’s next?

- The ultimate question

How do changes in **environmental conditions influence trophic interactions** inside **each type of habitats** ?

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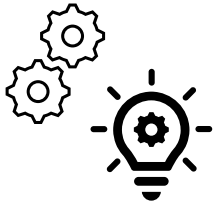
TANGO 2024 samples are on their way !

Thank you for listening !

Special thanks to the *RV Australis* crew for all their support during TANGO 2023 & 2024, to Davide Cadonici for the processing of the 2023 stable isotope samples and to Camille Moreau for the beautiful underwater images!

5) Take home message(s)



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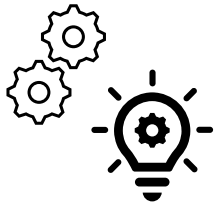

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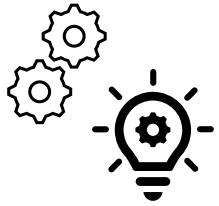

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