Environmental drivers of sea stars feeding ecology in the Southern Ocean

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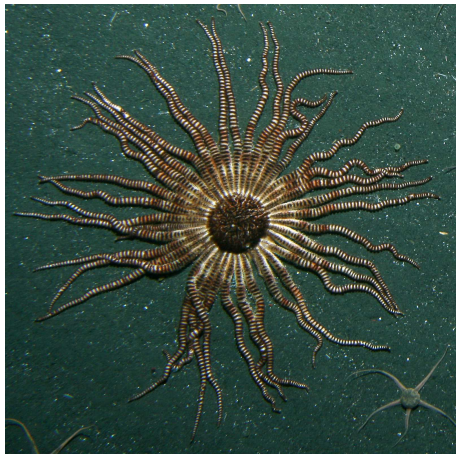
?

- 12% of known sea star species living in the Southern Ocean
- Important group of Antarctic benthos with possible trophic diversity (McClintock 1994)

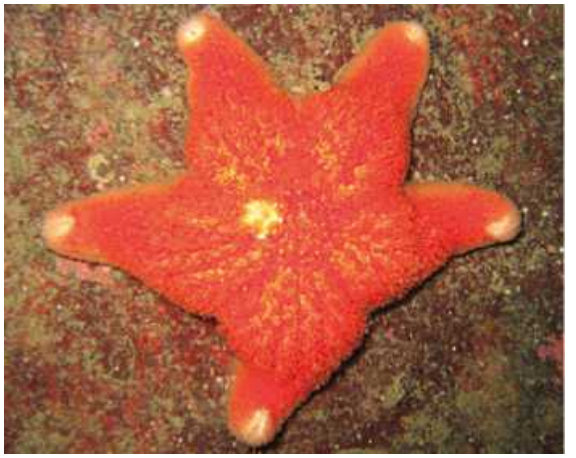
Detritus feeders
(*Bathybiaster* sp.)

Omnivores
(*Diplasterias* sp.)



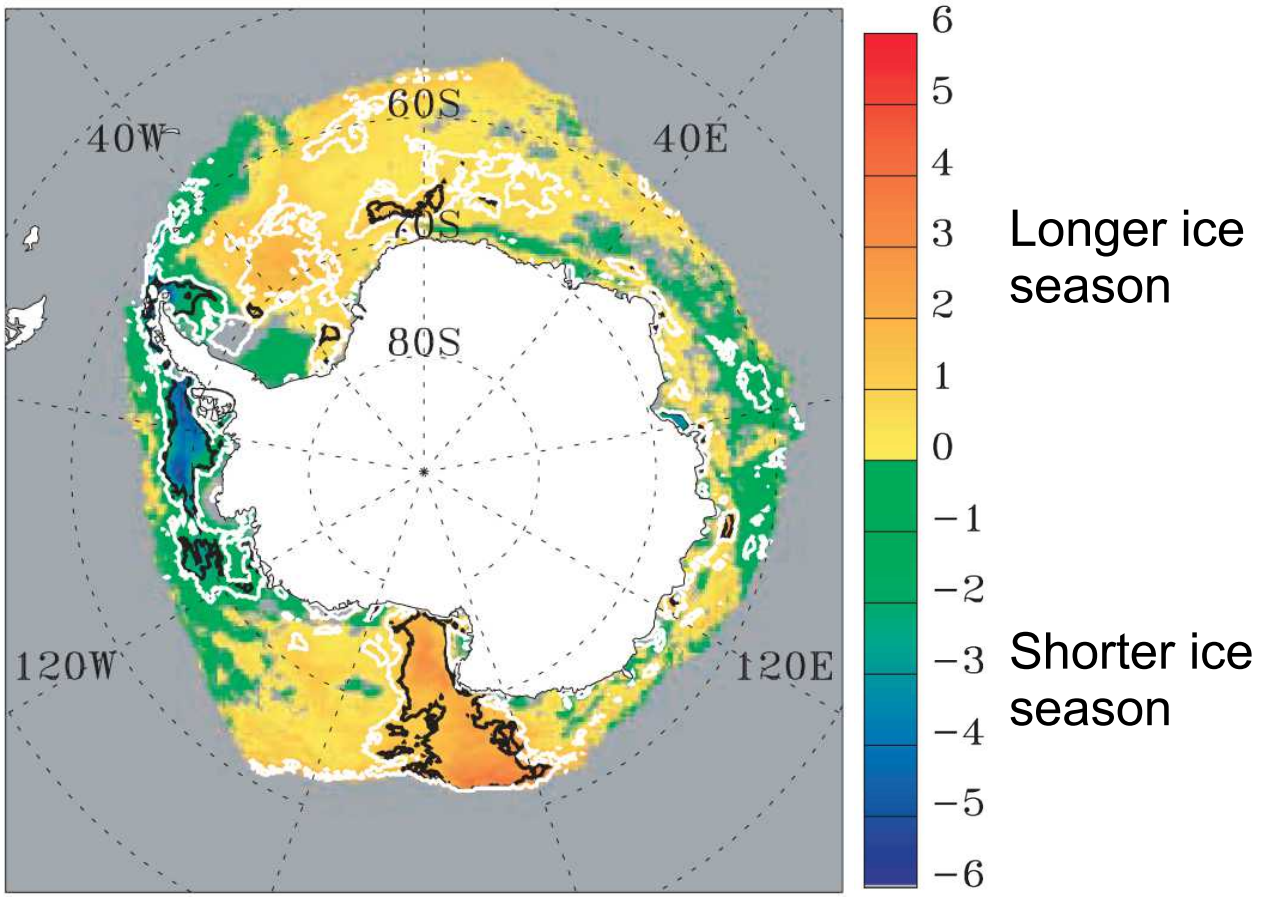
Predators on active prey
(*Labidiaster* sp.)

Predators on sessile prey
(*Notasterias* sp.)



Unknown
(*Peribolaster* sp.)

1979-2004 Ice season duration changes (days/year)



Stammerjohn et al., 2008

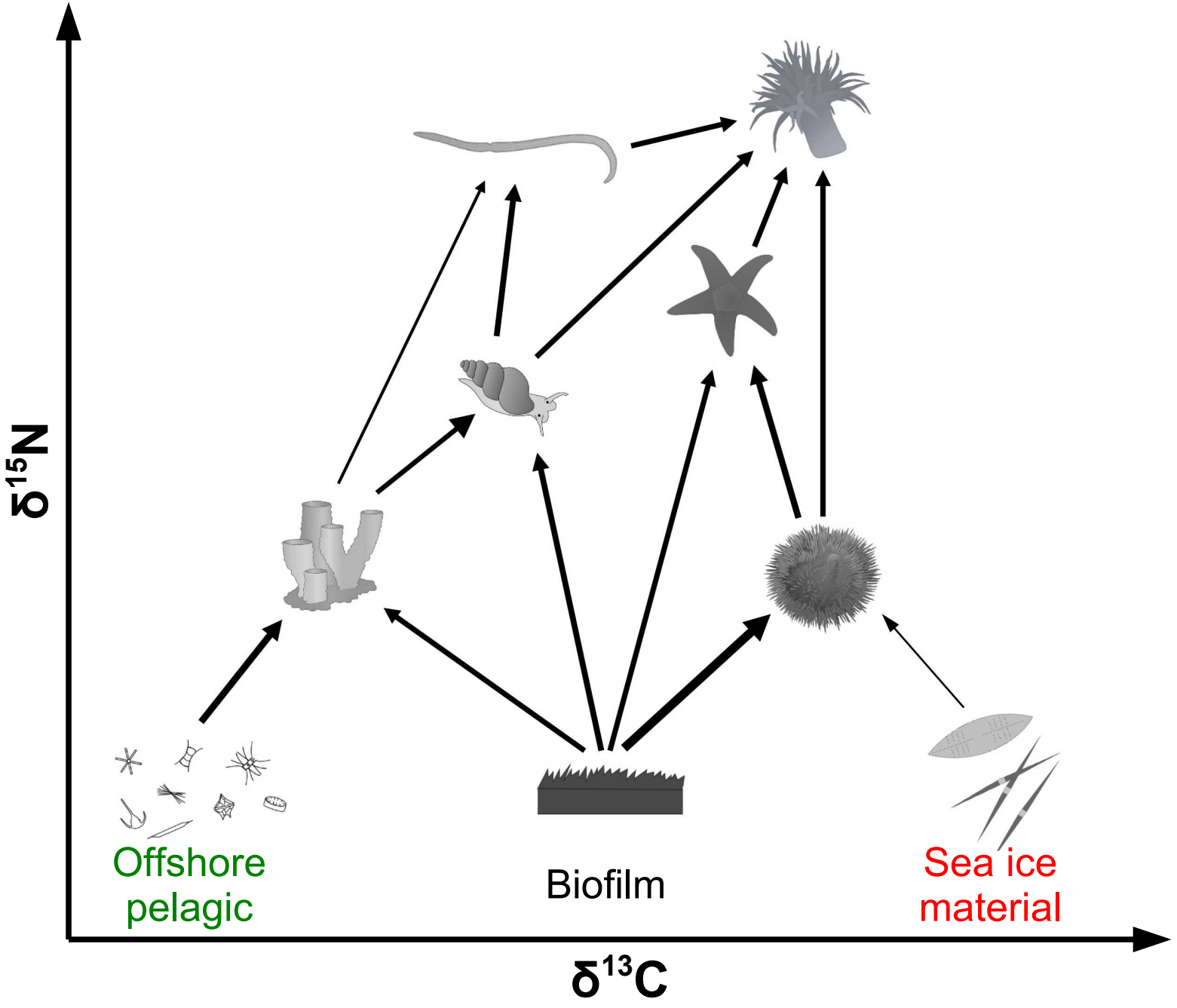
- Regional variations in changes of sea ice extent and ice season duration
- Impact on pelagic food webs and potential prey of sea stars

Objectives

- To compare regional differences of trophic diversity and variability between and within Antarctic and Subantarctic regions

- Trophic diversity: differences in trophic ecology between species

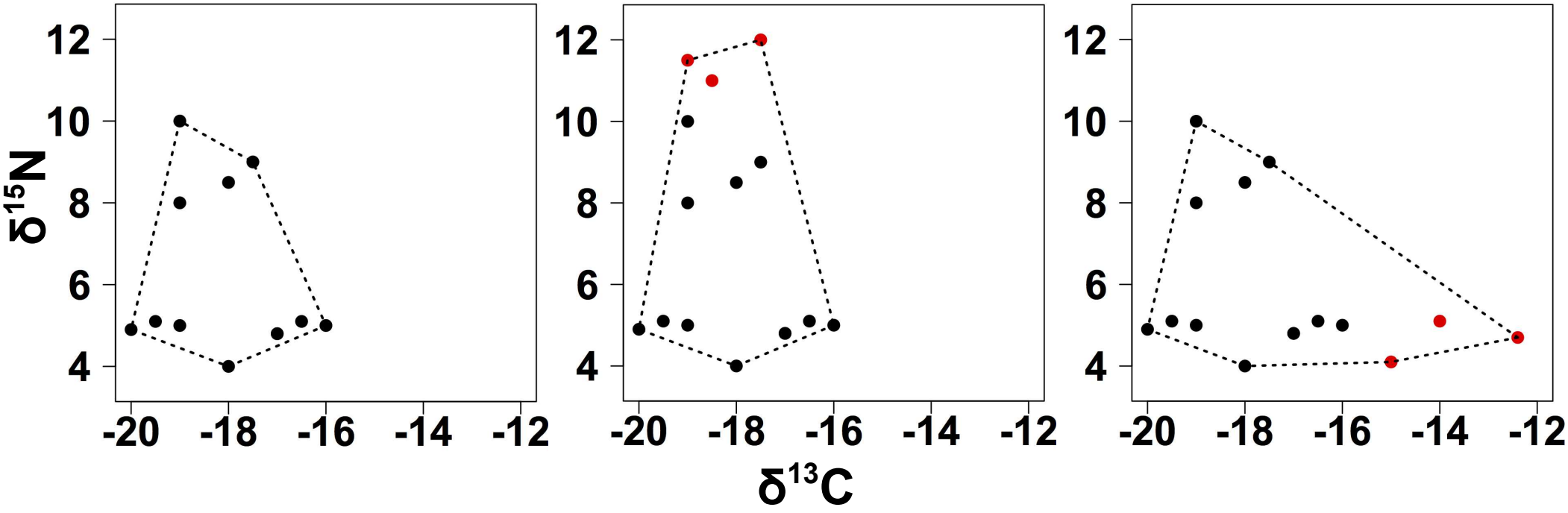
Stable isotopes in trophic ecology



Michel et al. 2017

Stable isotopes: Layman's metrics

- $\delta^{15}N$ range → estimation of trophic level diversity
- $\delta^{13}C$ range → estimation of source diversity
- Convex hull Total Area (TA) → overall trophic diversity and/or variability



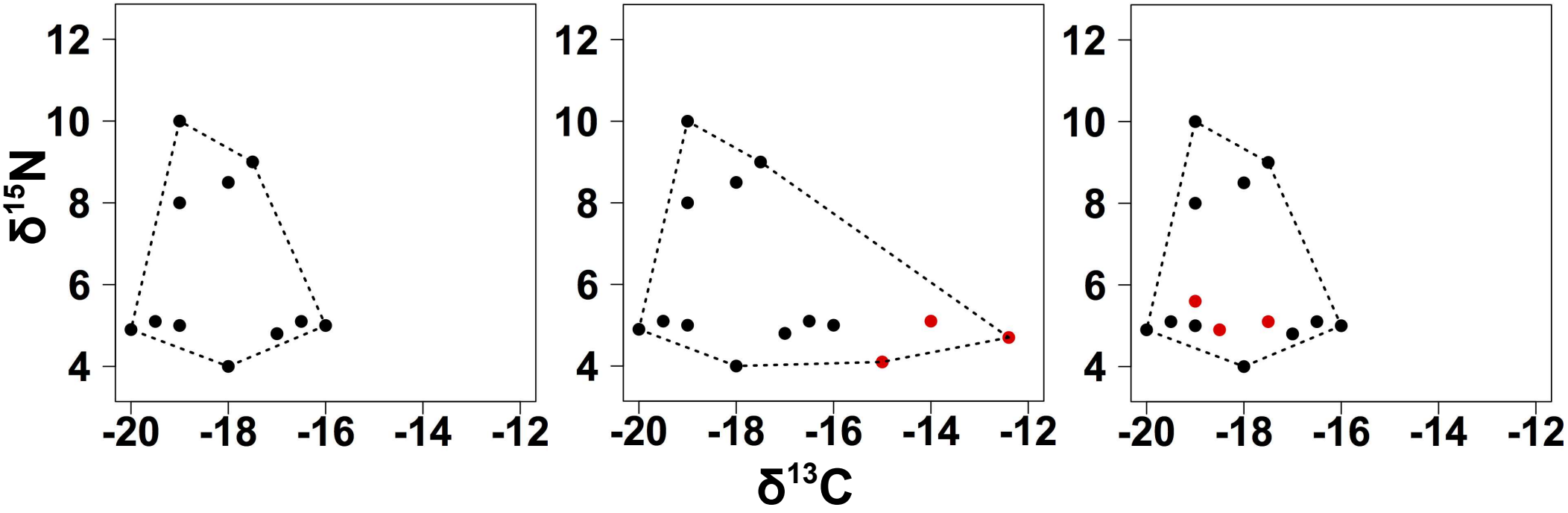
↑ $\delta^{15}N$ range
↑ TA

↑ $\delta^{13}C$ range
↑ TA

Layman et al. 2007

Stable isotopes: Layman's metrics

- Mean Centroid Distance (CD) → overall trophic diversity
- Nearest Neighbour Distance (NND) → density of species packing in isotopic space
- Standard Deviation of the Nearest Neighbour Distance (SDNND) → evenness of species packing in isotopic space



↑ CD
↑ NND
↑ SDNND

↓ CD
↓ NND
↓ SDNND

Layman et al. 2007

Sampling

- Combination of field samples and archived collections

- 1573 individuals

- 32 genus

Sampling

3 regions:

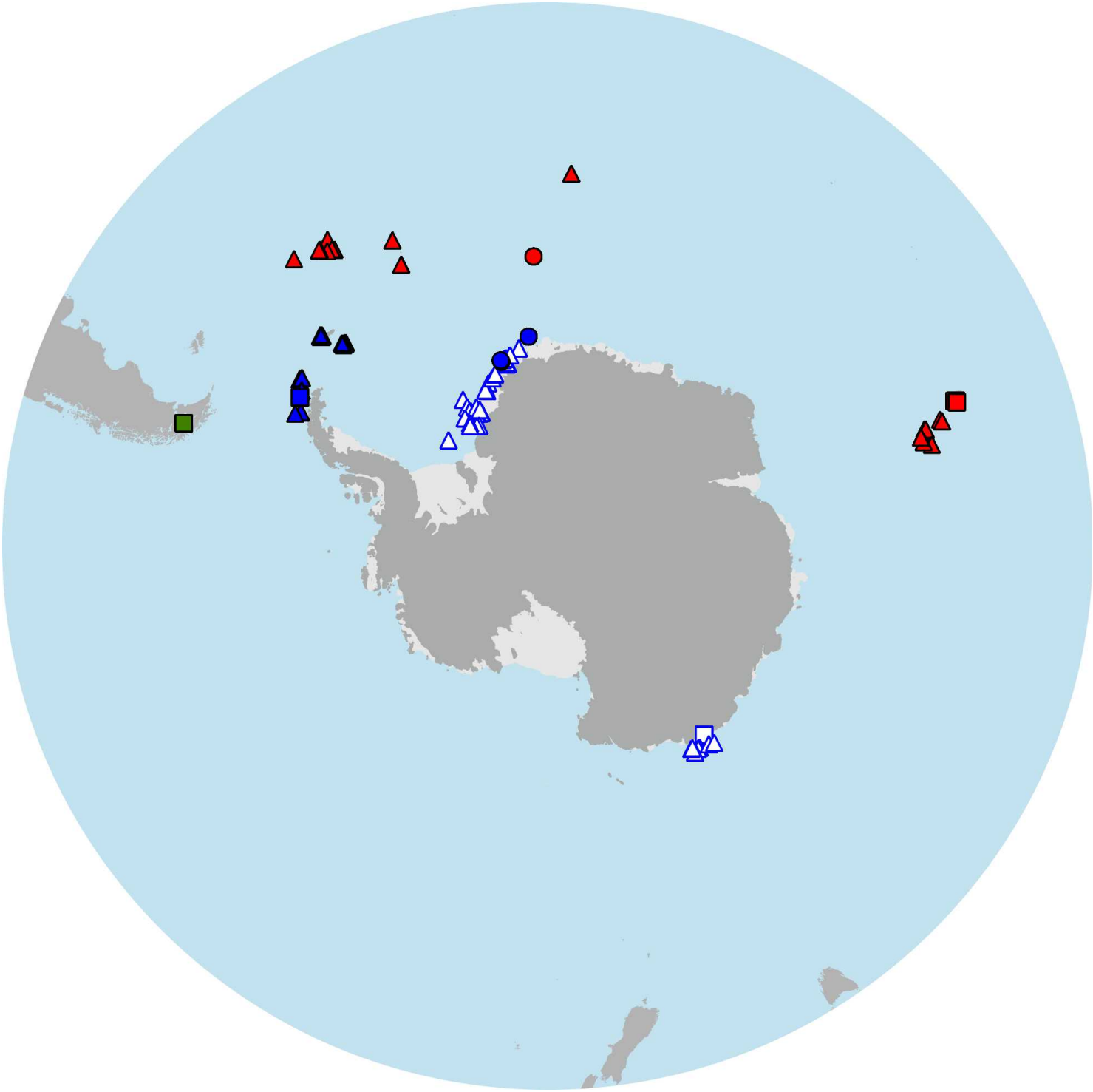
- Patagonia
- Subantarctic
- Antarctic

3 environment types:

- Coastal
- Continental shelf
- Abyssal

Sea ice:

- Absent
- Present



Analysis and data treatment

- $\delta^{13}C$ and $\delta^{15}N$ in tegument measured by EA-IRMS

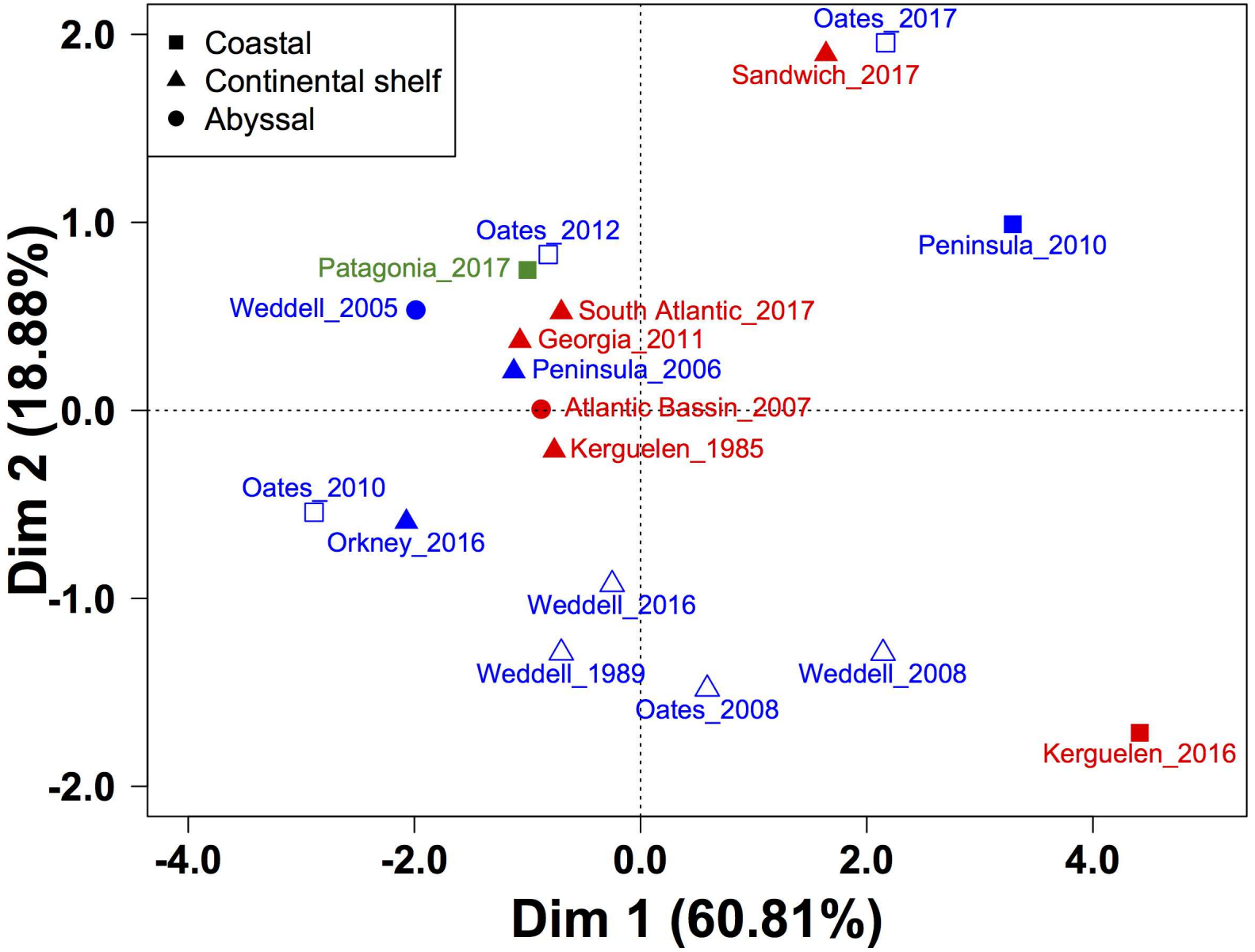
- Rescaling of $\delta^{13}C$ and $\delta^{15}N$ (Fry and Davis 2015) by groups of stations (same sampling campaign, same bathome, distance < 30km)

  → grouping of stations by sampling campaigns

- Layman's metrics in each sampling campaign

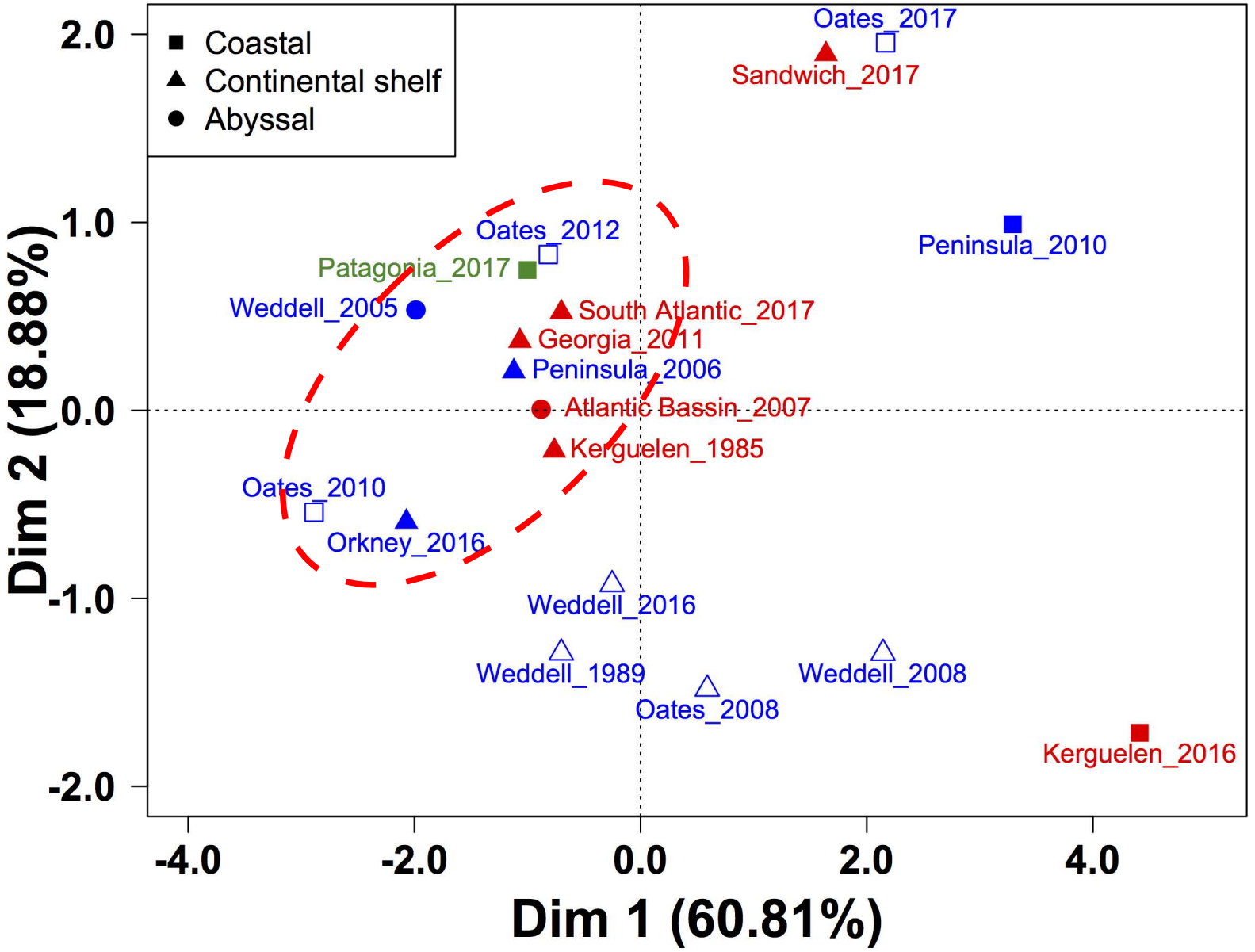
- Principal component analysis

Results



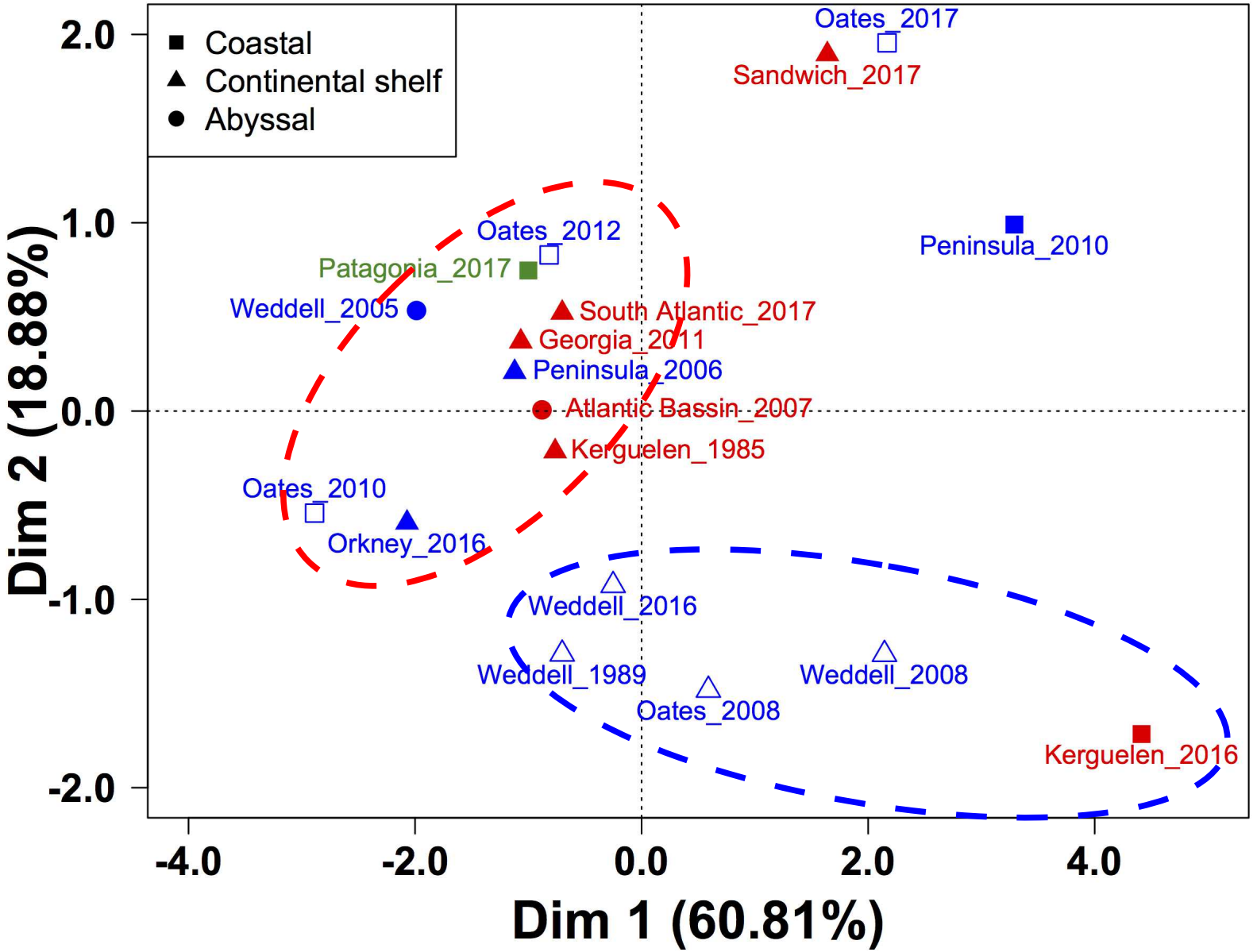
- Colour: region (Patagonia, Subantarctic, Antarctic)
- Sea ice: presence (open), absence (filled)

Results



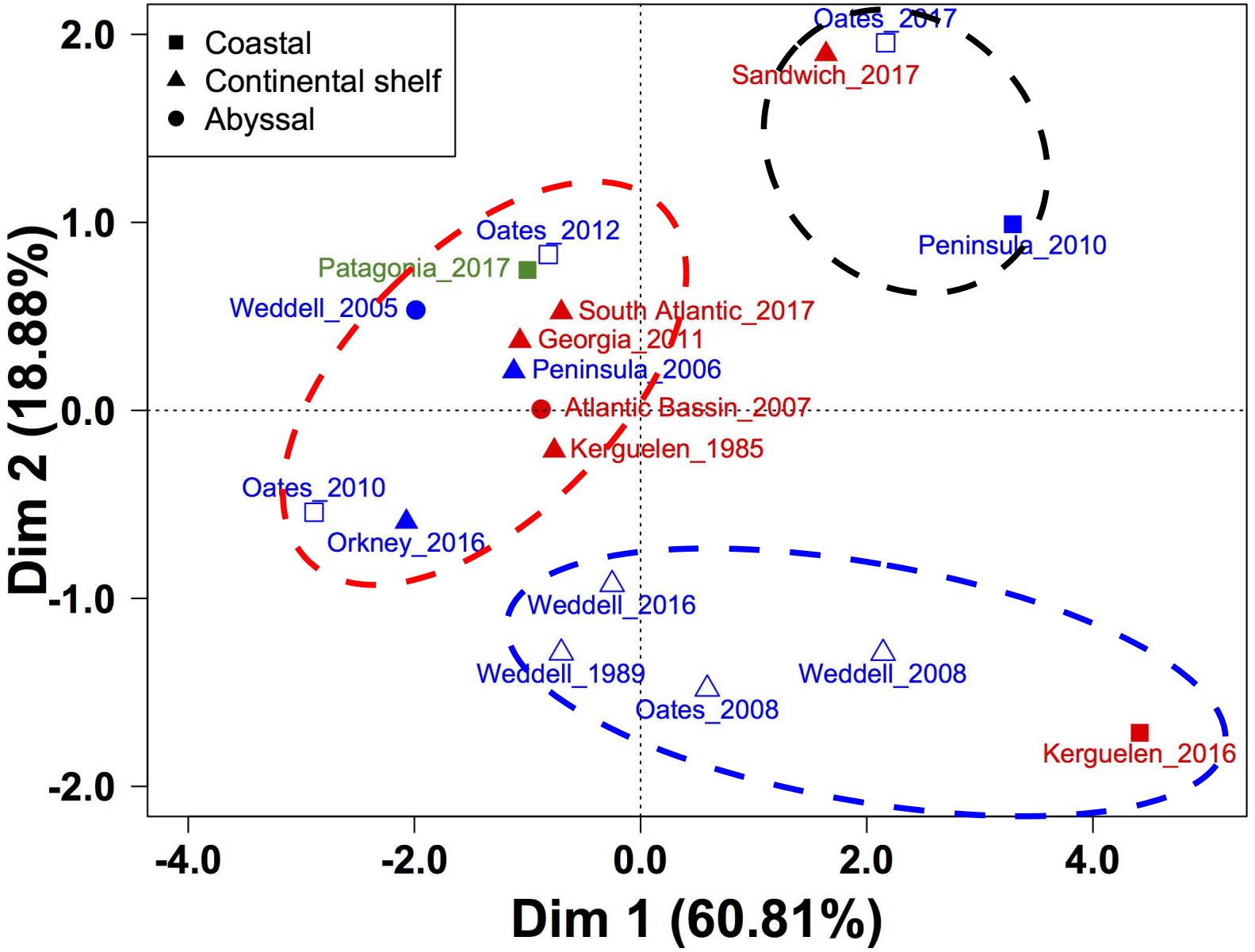
- Group 1: Low values for all Layman's metrics

Results



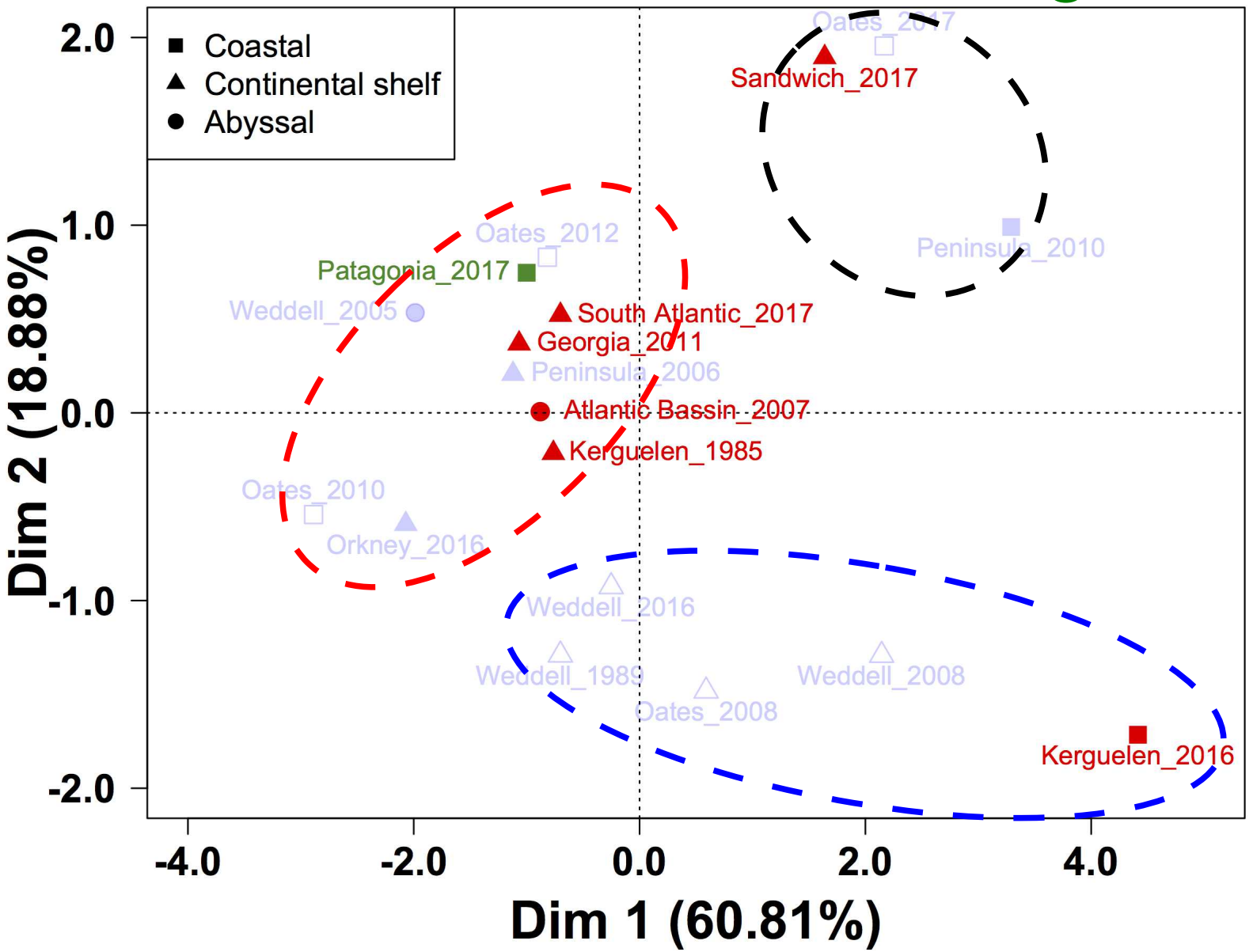
- Group 2: High TA linked to high $\delta^{13}C$ and $\delta^{15}N$ ranges

Results



- Group 3: High NND, SDNND

Results: Subantarctic and Patagonia

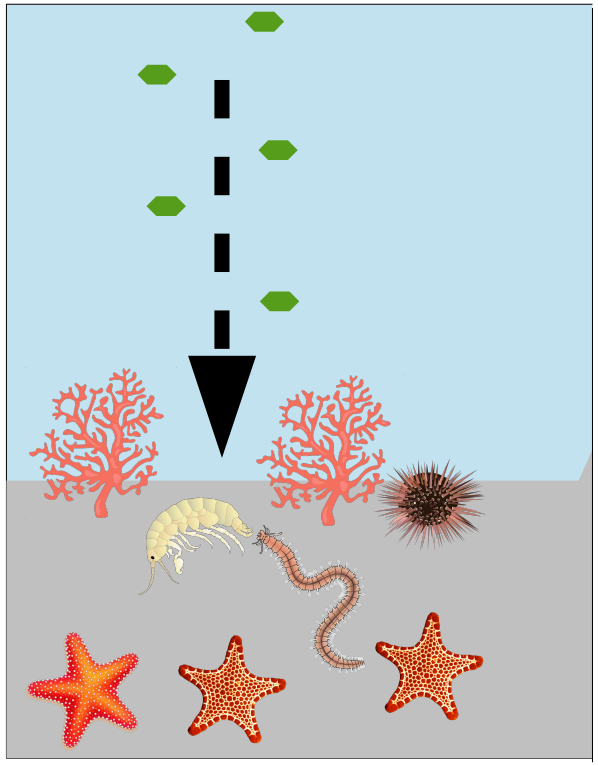


- Most Subantarctic stations and coastal Patagonia with low isotopic diversity but high isotopic diversity for the coastal Subantarctic station of Kerguelen

Trophic status of Subantarctic benthos

- Subantarctic continental shelf and abyssal plain: oligotrophic waters → low trophic diversity and variability?

Phytoplankton

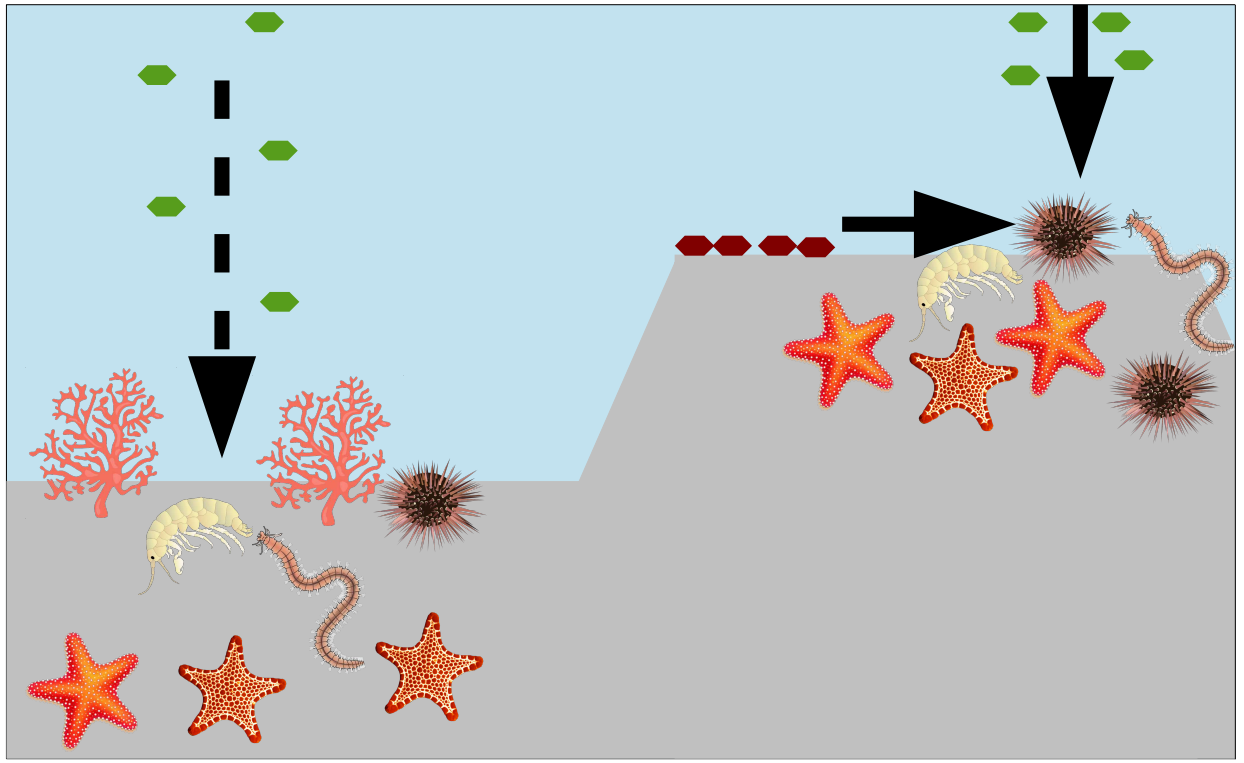


Sea stars in Subantarctic food webs

- Subantarctic continental shelf and abyssal plain: oligotrophic waters → low trophic diversity and variability?
- Coastal Subantarctic: reliance on varied food sources (seaweed and phytoplankton)?

Phytoplankton

Seaweed or microphytobenthos

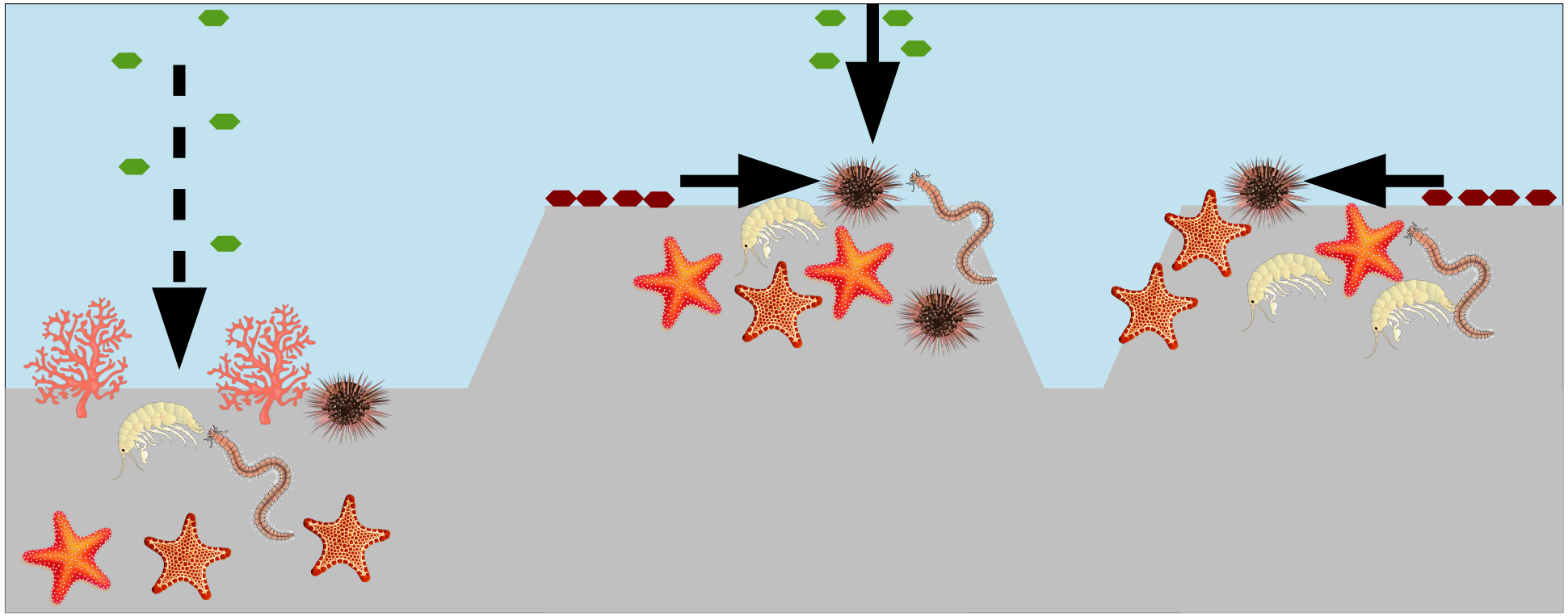


Sea stars in Subantarctic food webs

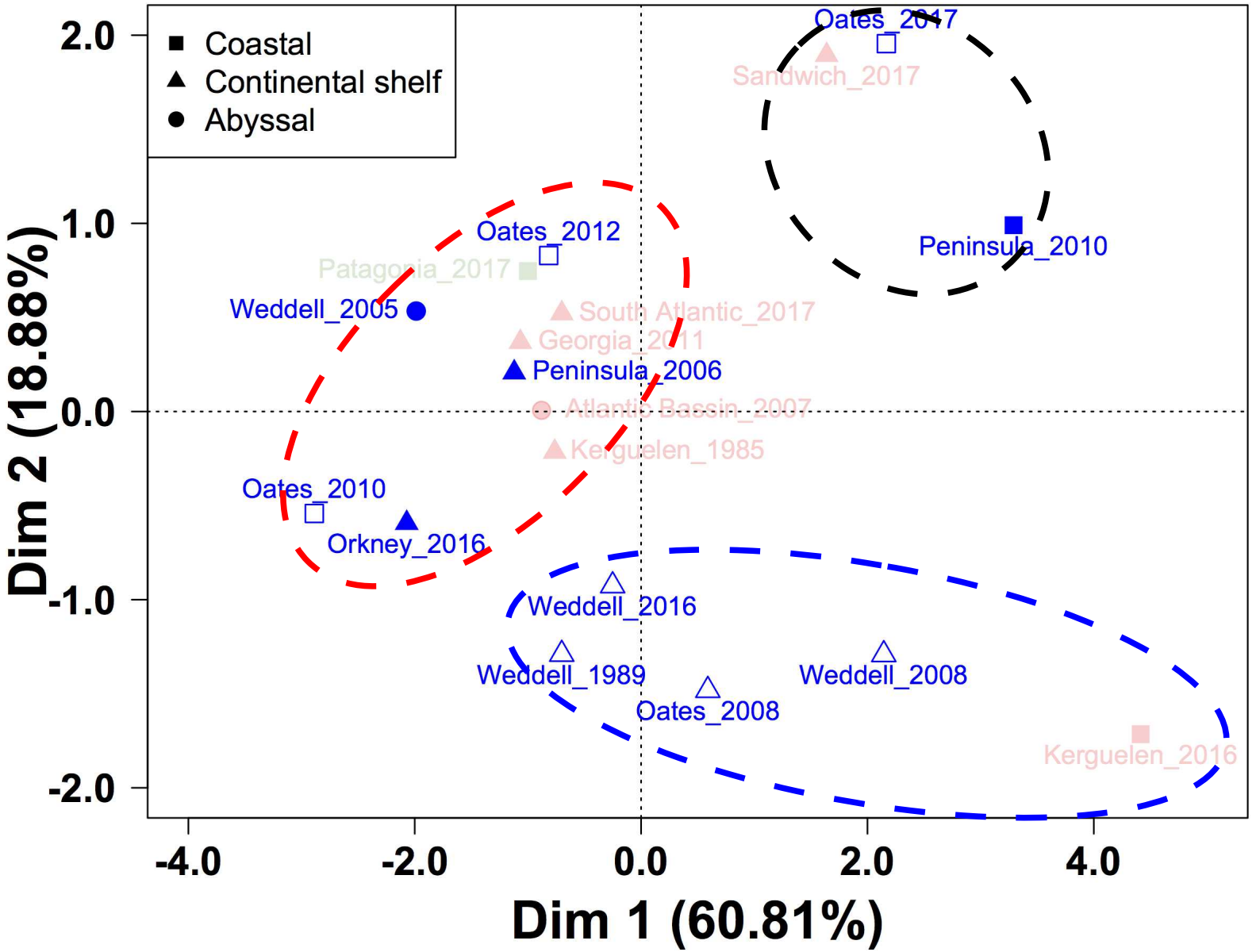
- Subantarctic continental shelf and abyssal plain: oligotrophic waters → low trophic diversity and variability?
- Coastal Subantarctic: reliance on varied food sources (seaweed and phytoplankton)?
- Coastal Patagonia: reliance on seaweed as the main food source?

Phytoplankton

Seaweed or microphytobenthos

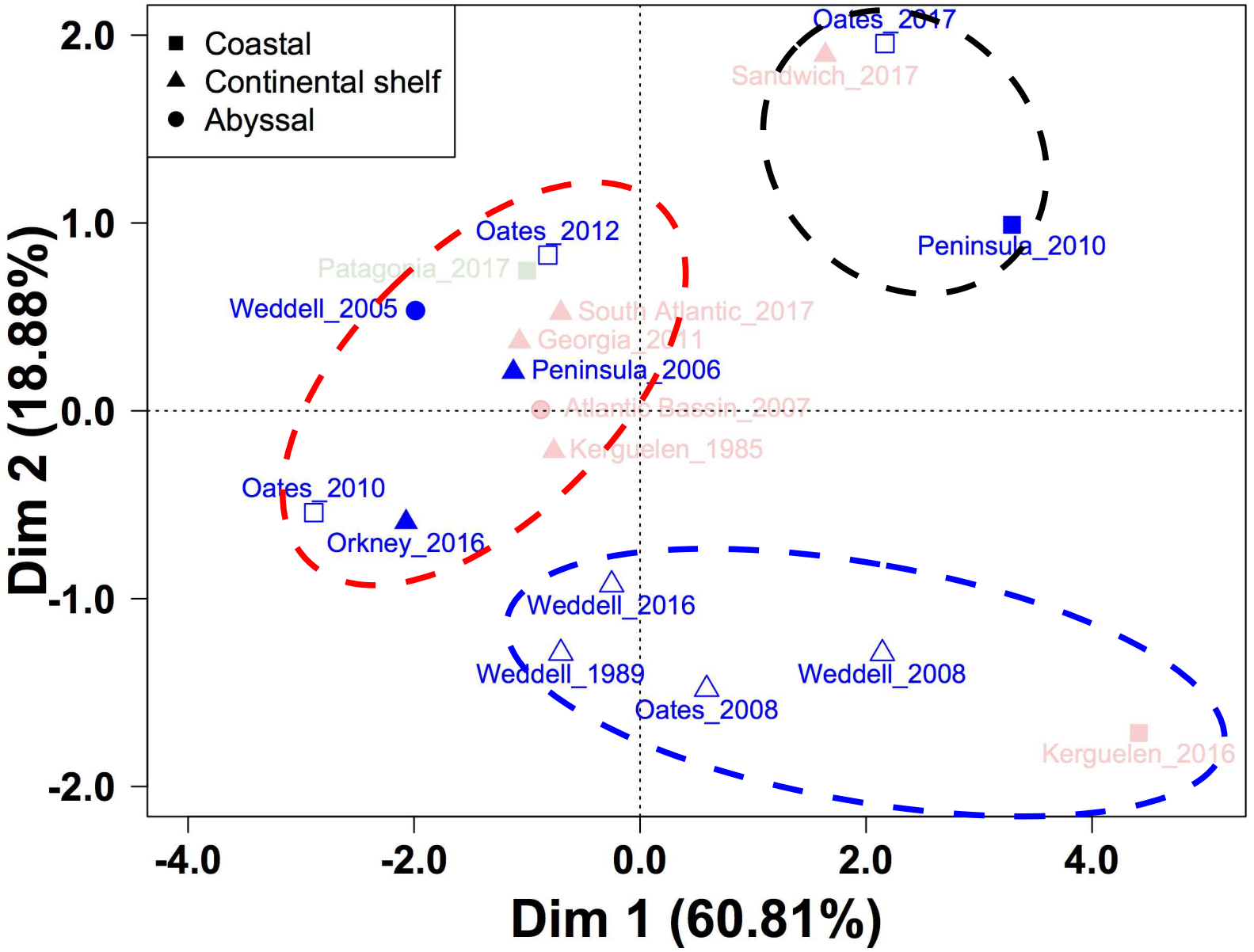


Results: Antarctic



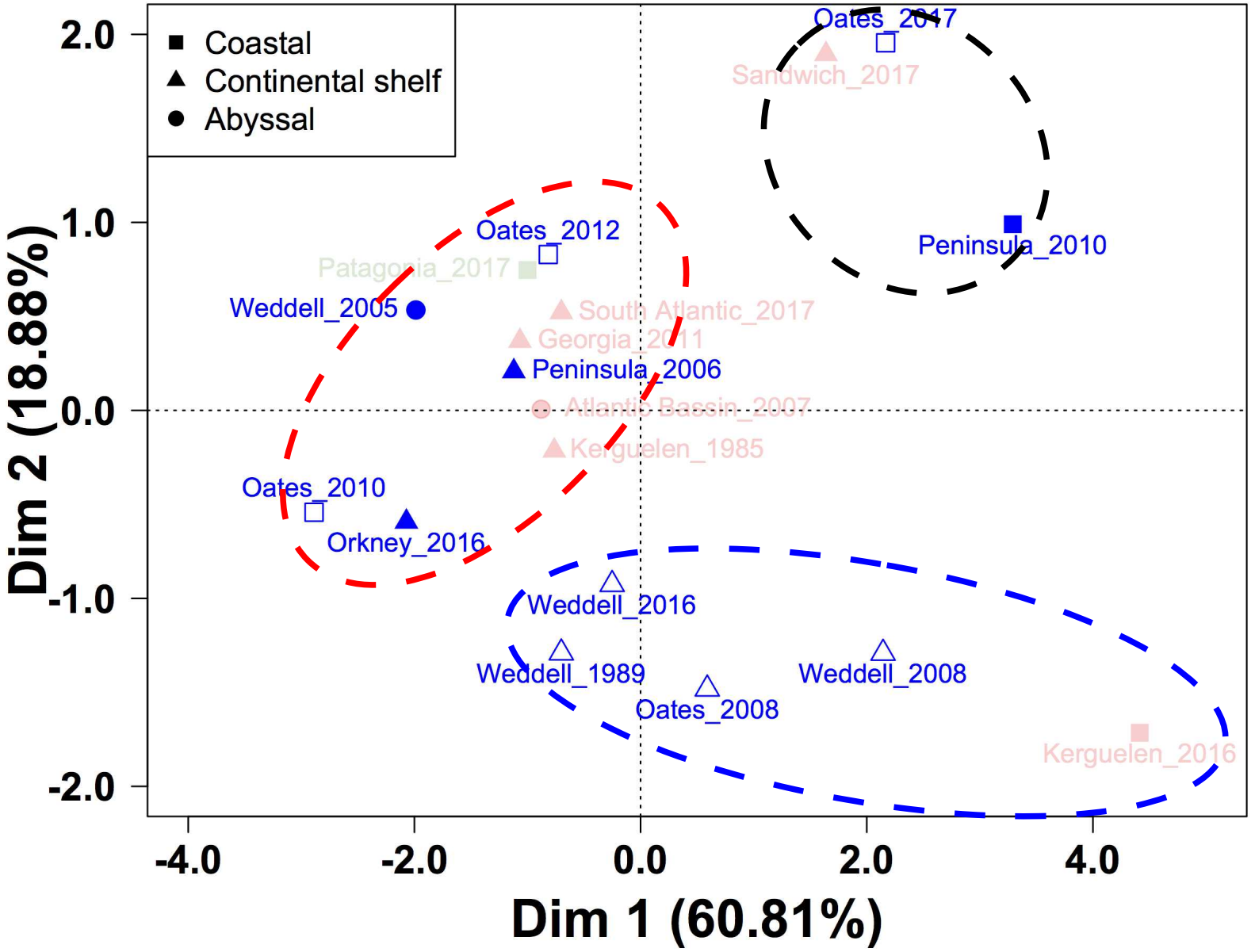
- Low values for all Layman's metrics for the continental shelf stations not covered by sea ice and the coastal stations covered by sea ice (except Oates_2017)

Results: Antarctic



- Higher TA linked to high $\delta^{13}C$ and $\delta^{15}N$ ranges for sea stars from the Antarctic continental shelf covered by sea ice

Results: Antarctic

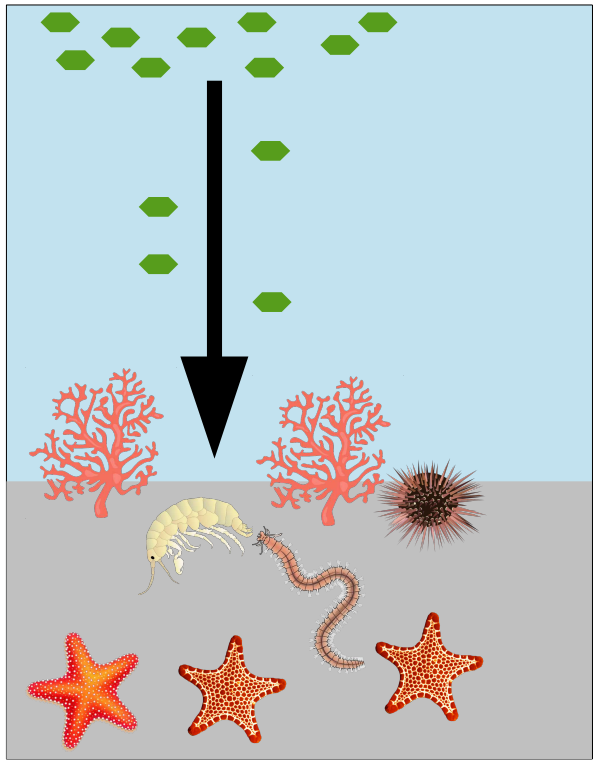


- Similarly to the coastal Subantarctic station of Kerguelen, high values for all Layman's metrics for the Antarctic coastal station of Peninsula not covered by sea ice (Peninsula_2010)

Trophic status of Antarctic benthos

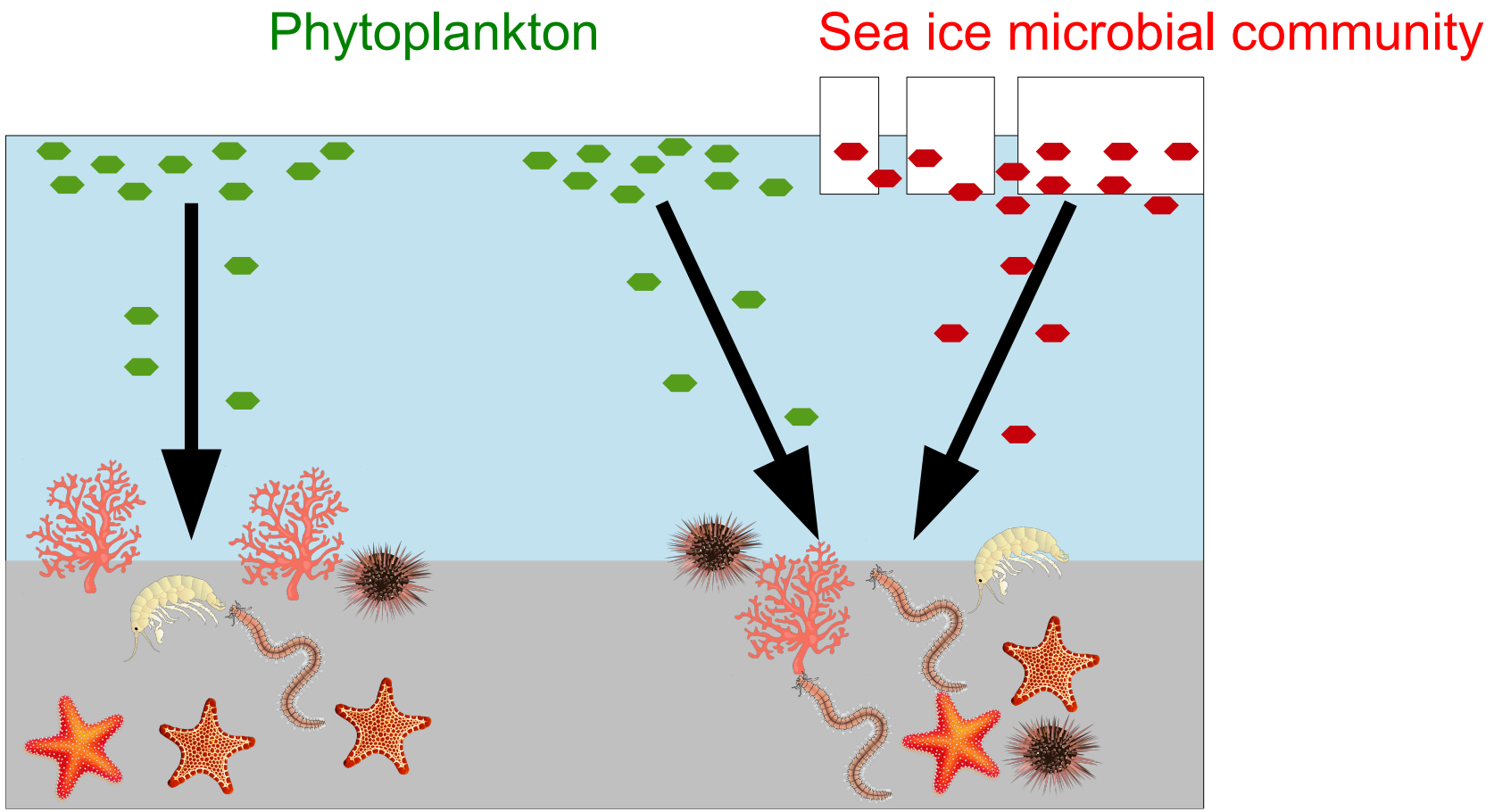
- Antarctic continental shelf and abyssal plain not covered by sea ice: summer phytoplankton bloom + bentho-pelagic coupling → heavy reliance on sinking phytoplankton for the whole sea star assemblage

Phytoplankton



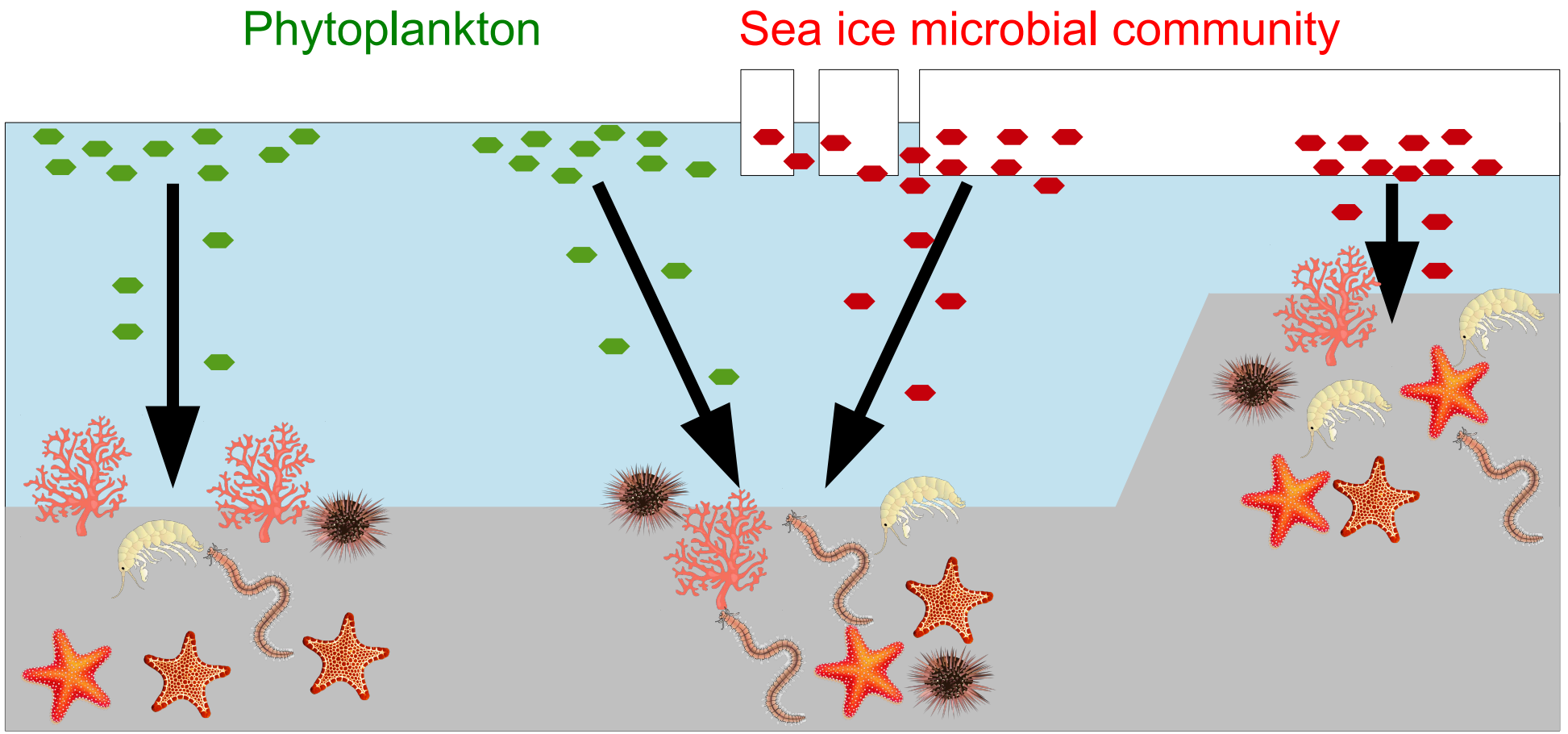
Trophic status of Antarctic benthos

- Antarctic continental shelf and abyssal plain not covered by sea ice: summer phytoplankton bloom + bentho-pelagic coupling → heavy reliance on sinking phytoplankton for the whole sea star assemblage
- Antarctic continental shelf covered by sea ice: summer phytoplankton bloom + melting sea ice + bentho-pelagic coupling in Antarctic → higher diversity of food sources for sea stars



Trophic status of Antarctic benthos

- Antarctic continental shelf and abyssal plain not covered by sea ice: summer phytoplankton bloom + bentho-pelagic coupling → heavy reliance on sinking phytoplankton for the whole sea star assemblage
- Antarctic continental shelf covered by sea ice: summer phytoplankton bloom + melting sea ice + bentho-pelagic coupling in Antarctic → higher diversity of food sources for sea stars
- Antarctic coast covered by sea ice: High reliance of the benthos on sea ice material only (Michel et al. 2017, but see Oates_2017)



Take home message

- Decreasing trophic diversity from the coast to the continental shelf in Subantarctic due to increasing oligotrophy

- Sea ice presence on the Southern Ocean continental shelf

  → increasing trophic diversity of sea stars?

- Sea ice presence on the Southern Ocean coast

  → decreasing of trophic diversity of sea stars?

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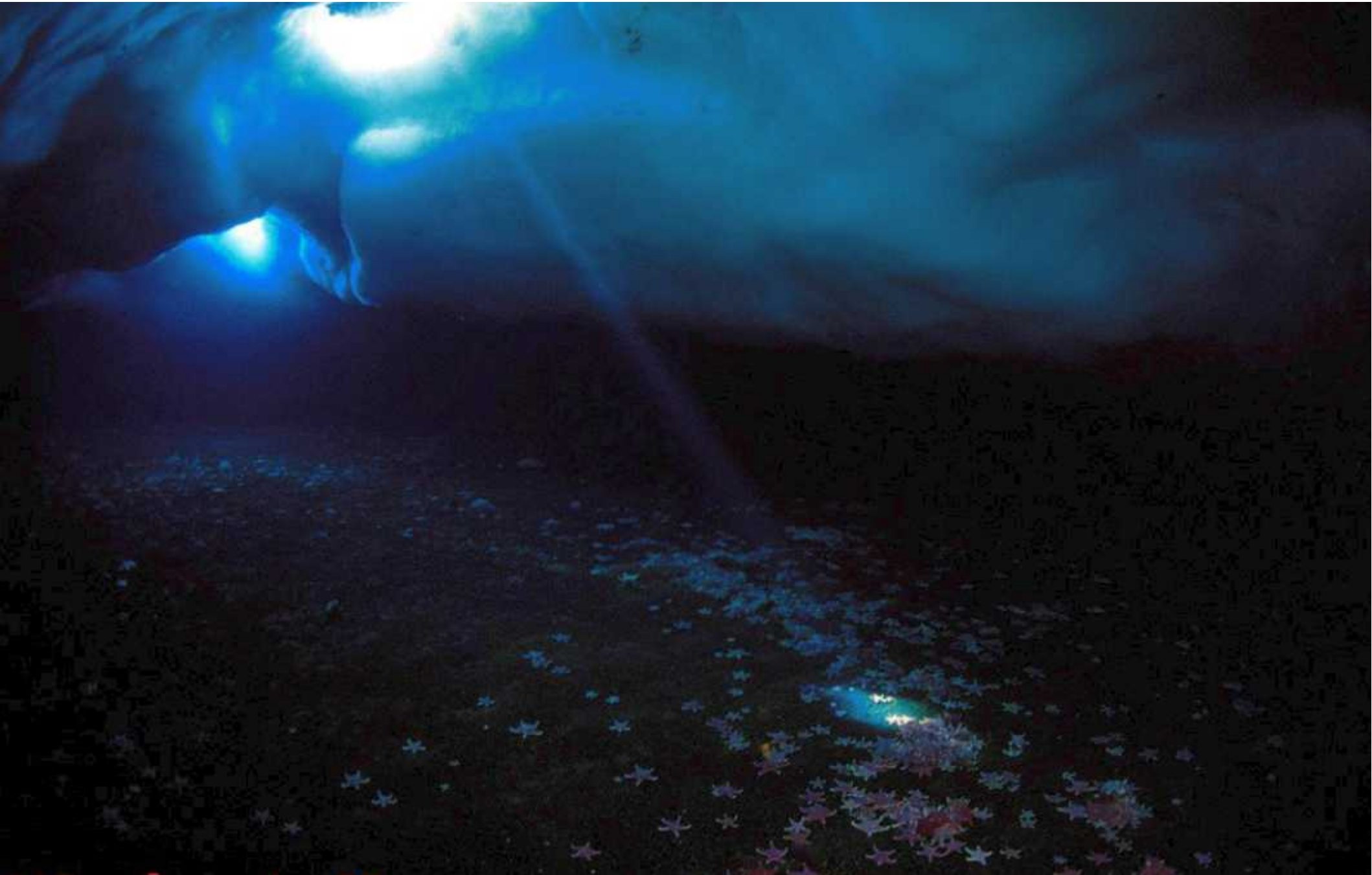
Thank you for your attention



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