Use of trait-based approaches to reveal the complexity of trophic ecology in deep-pelagic fishes

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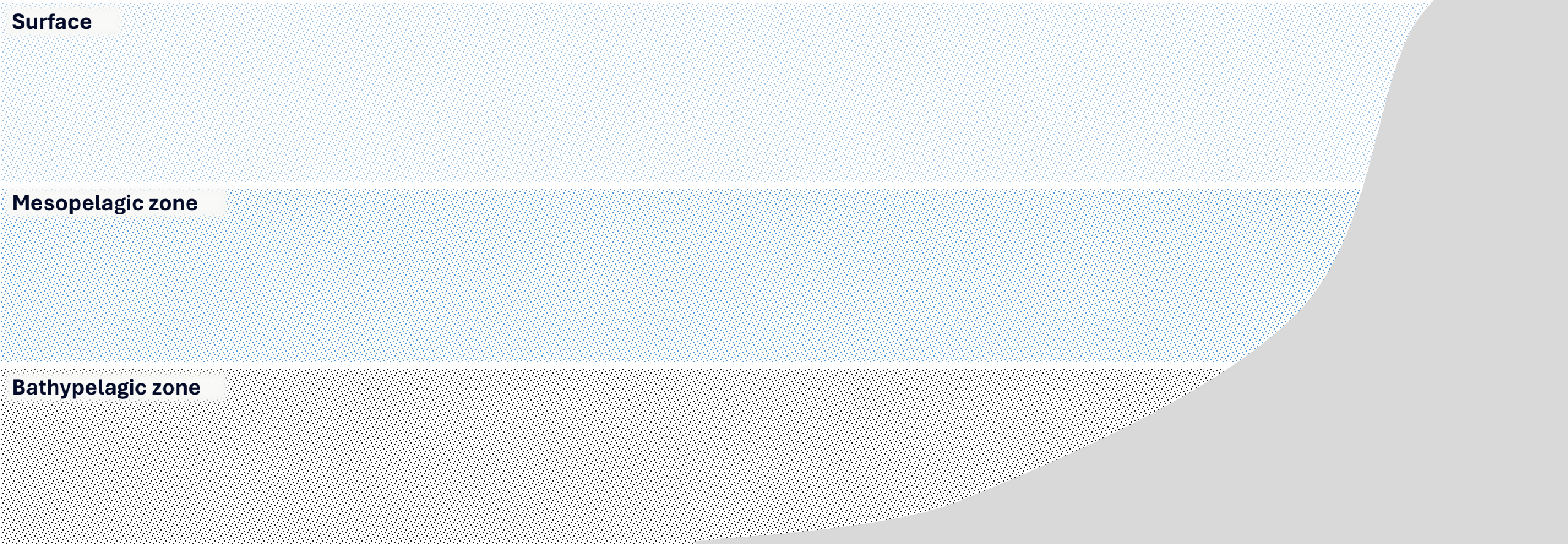
Small Pelagic Fish Symposium, Mexico 2026

The deep-pelagic trophic food web

Challenges:

- Largest ecosystem by volume
- Strong environmental gradients
- Wide diversity of species



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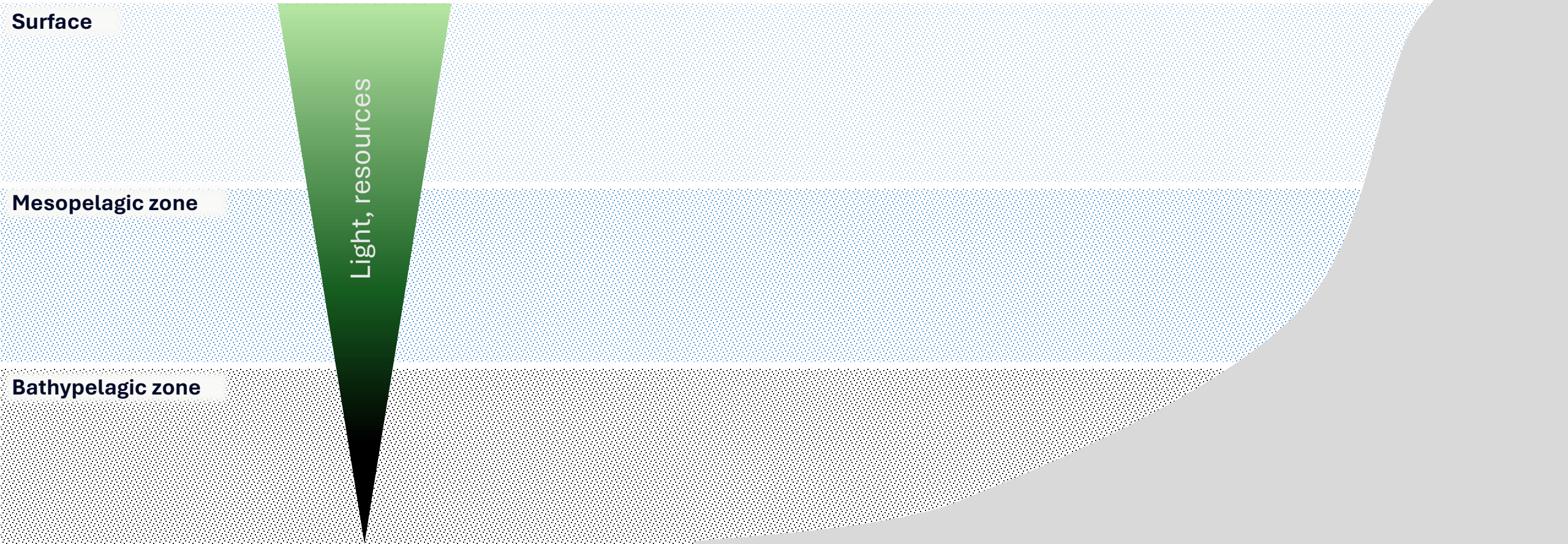

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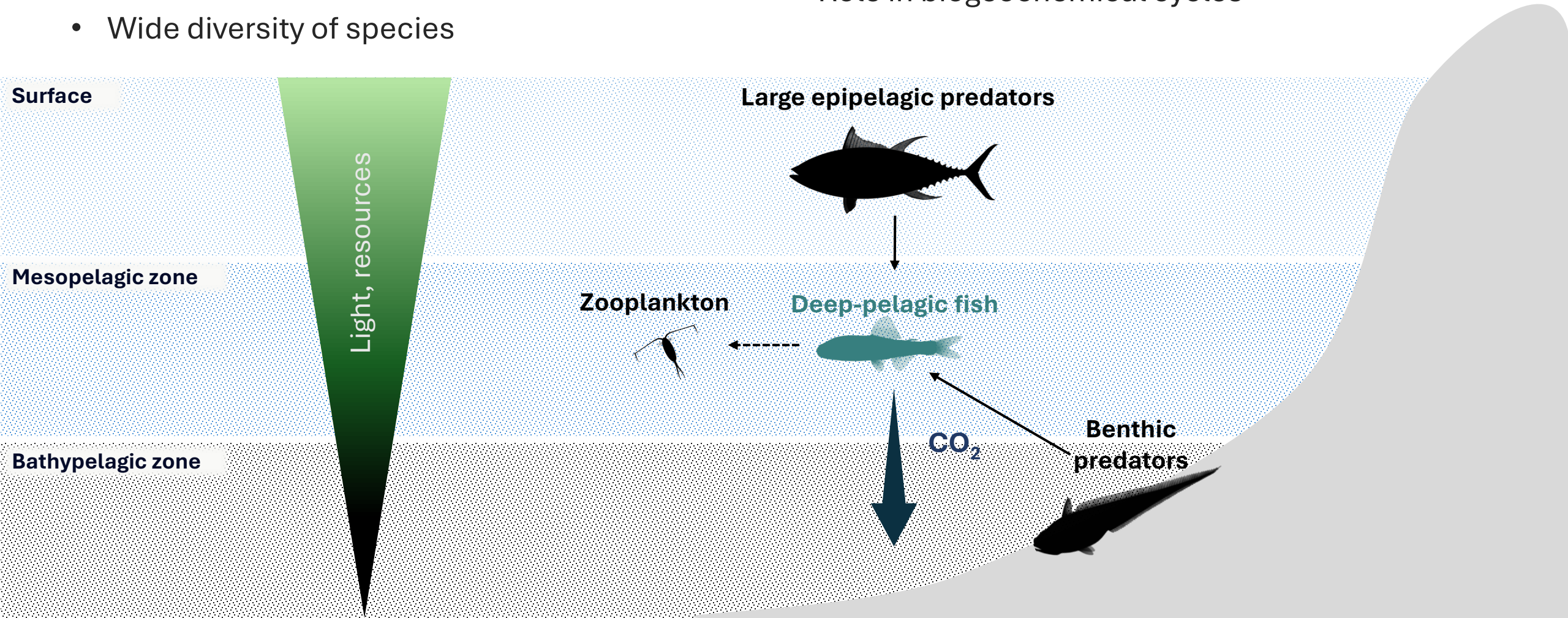
Importance:

- Key intermediate link in food webs
- Role in biogeochemical cycles



What are the main drivers of the trophic variability in deep-pelagic fish species?

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Trait-based approach

Traits linked to foraging strategies

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Stable isotopes ratios

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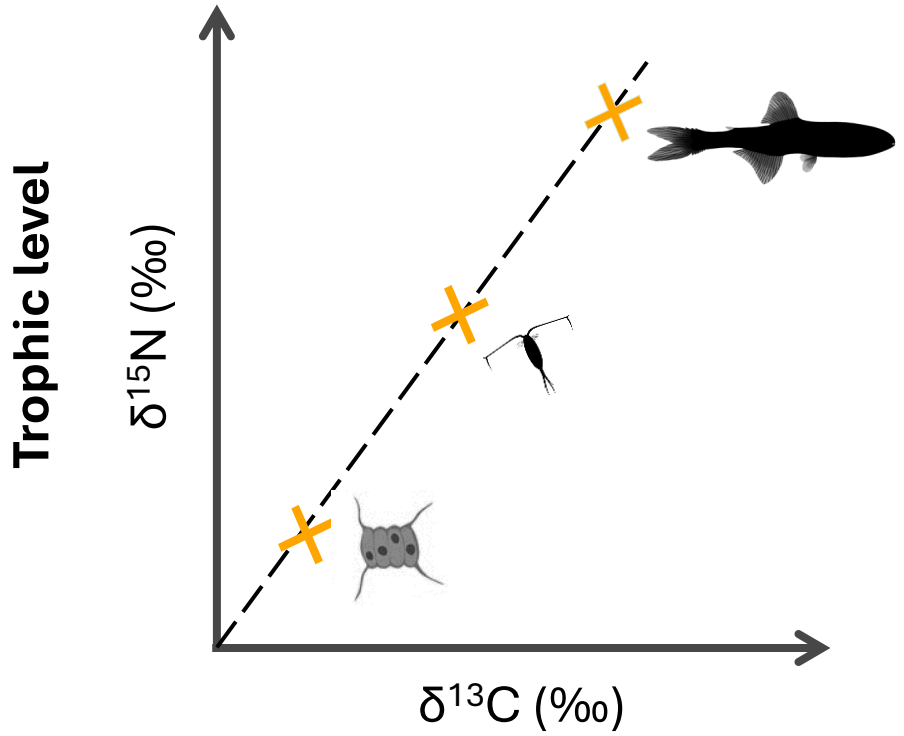

Carbon sources/habitat use

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Intraspecific

Are changes in the vertical distribution and trophic ecology of species driven by size?

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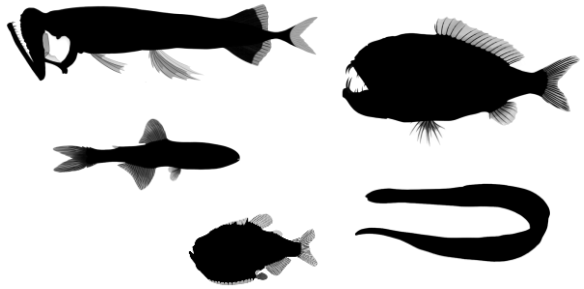

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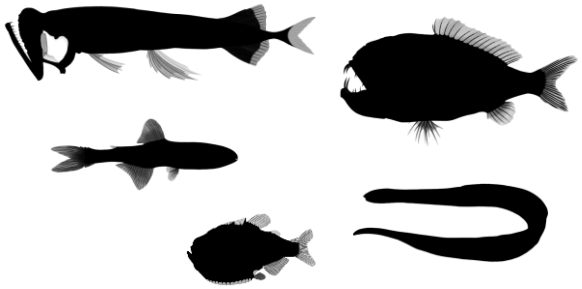

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Global

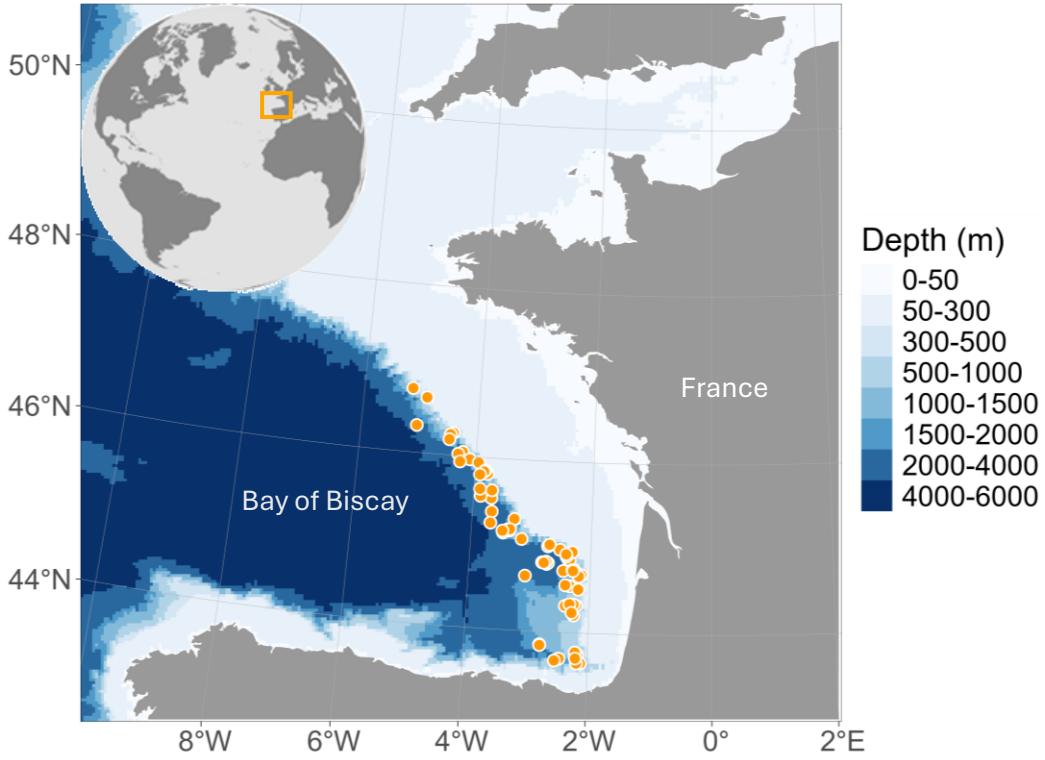
Can we apply the trait-based framework to compare the trophic structure of food webs across biogeographical regions?

Sampling in the Bay of Biscay - Northeast Atlantic Ocean

Night-time pelagic trawling in the canyons, between 20 and 2000 m depth

Match the time when migratory species feed

Pelagic trawl recovery aboard the R/V Thalassa



Intraspecific variability

➔ Selection of 12 fish targeted species (7 migratory, 5 non-migratory)

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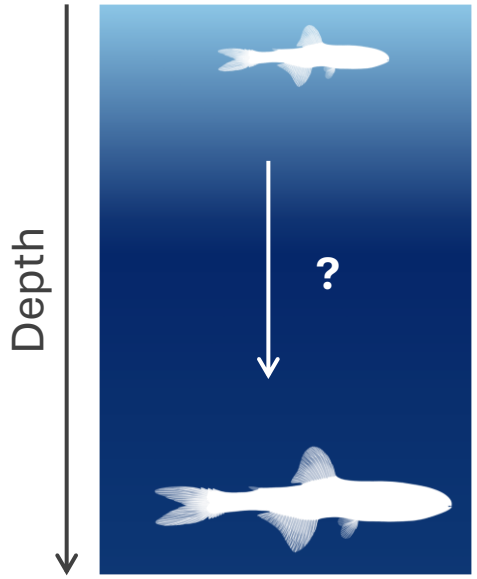
Size – depth relationship



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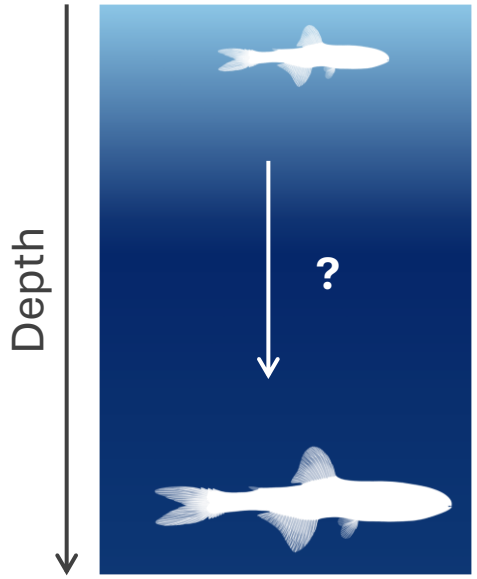
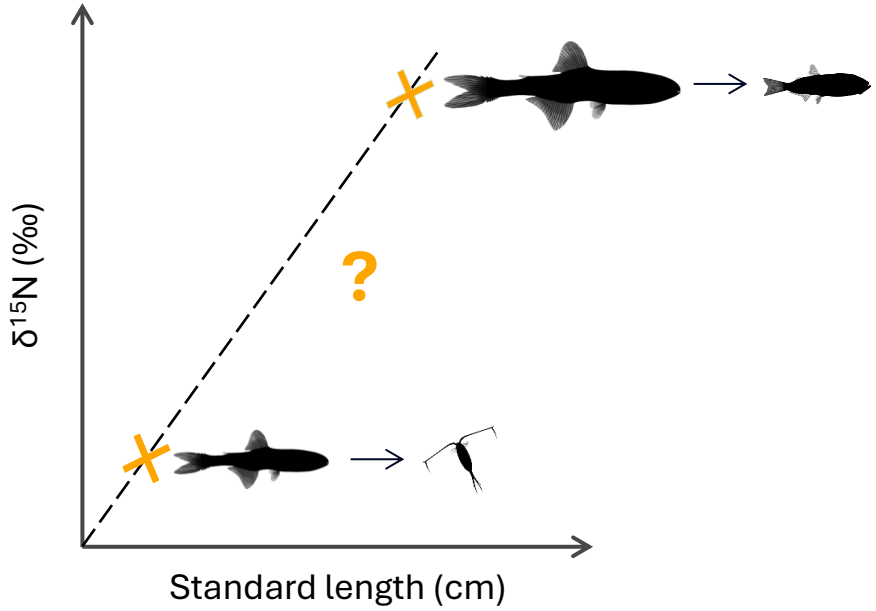


$\delta^{15}N$ - size relationship



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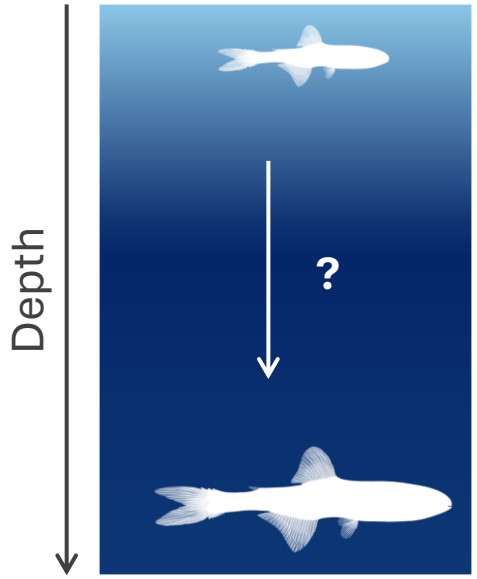

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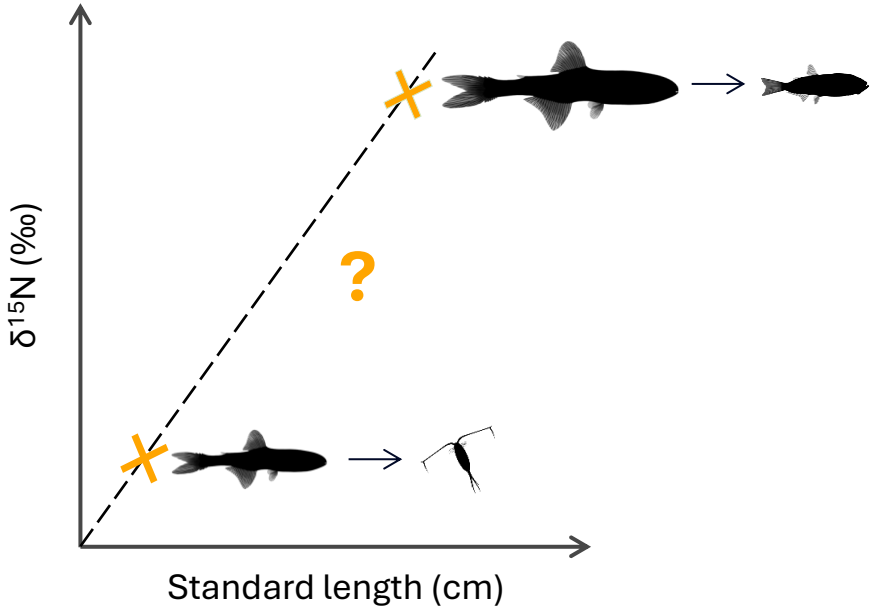
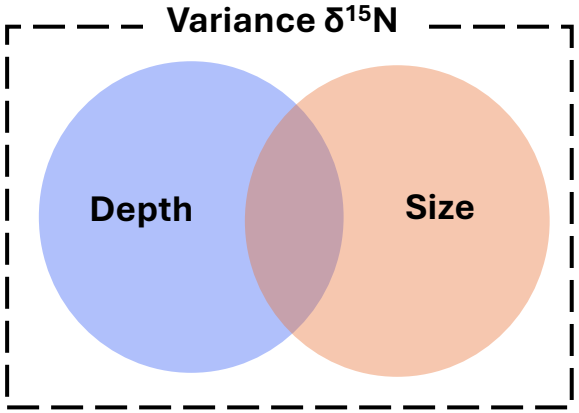
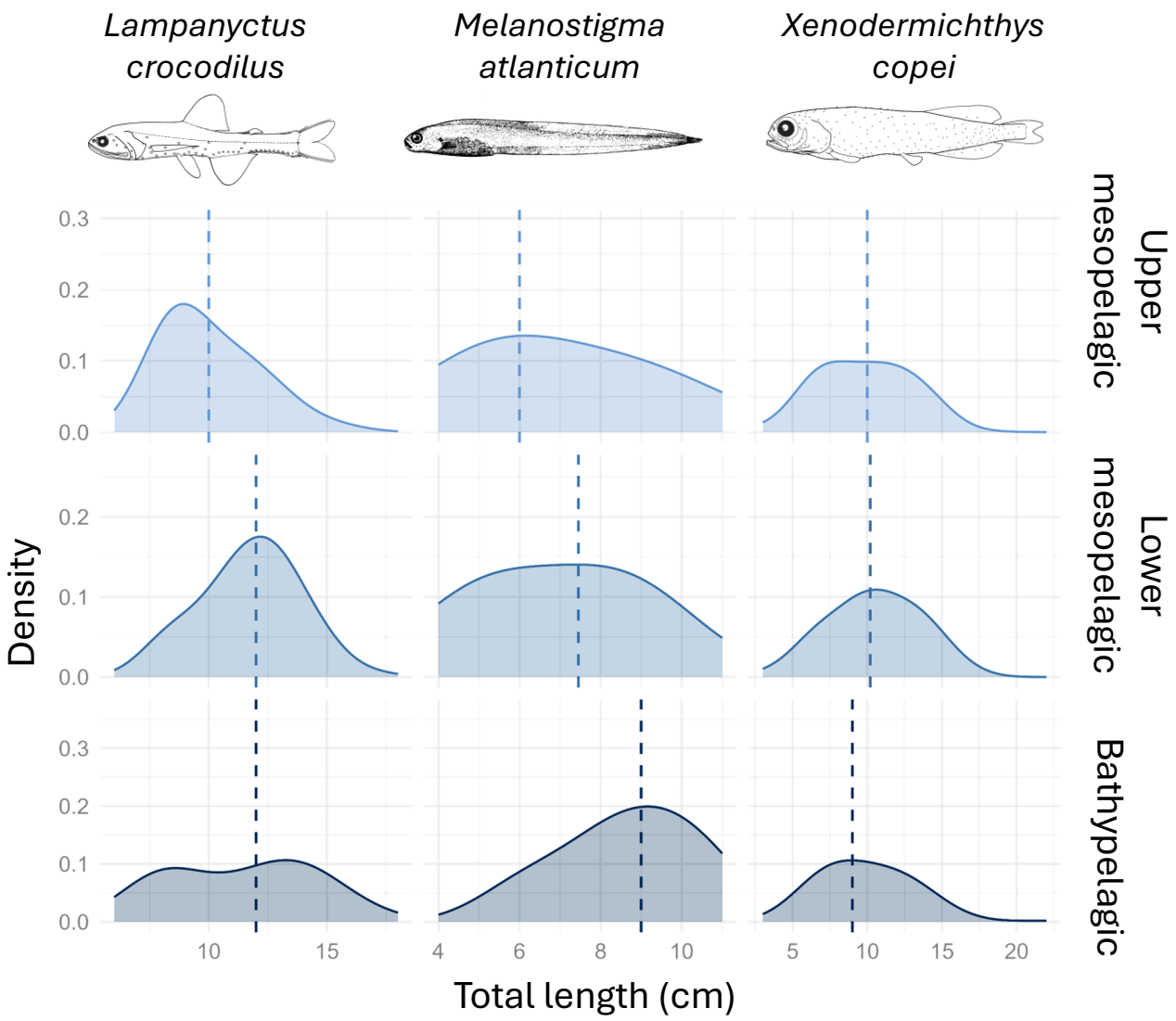


Variance partitioning analysis



Intraspecific variability – depth-size distribution



- Three of the twelve species presented an increase in size with increasing trawling depth
- *L. crocodilus*: adults that stop migrating and reside at depth (Stefanescu and Cartes, 1992; Valls et al., 2014)
- *M. atlanticum* & *X. copei*: demersal reproduction (Markle and Wenner, 1979)

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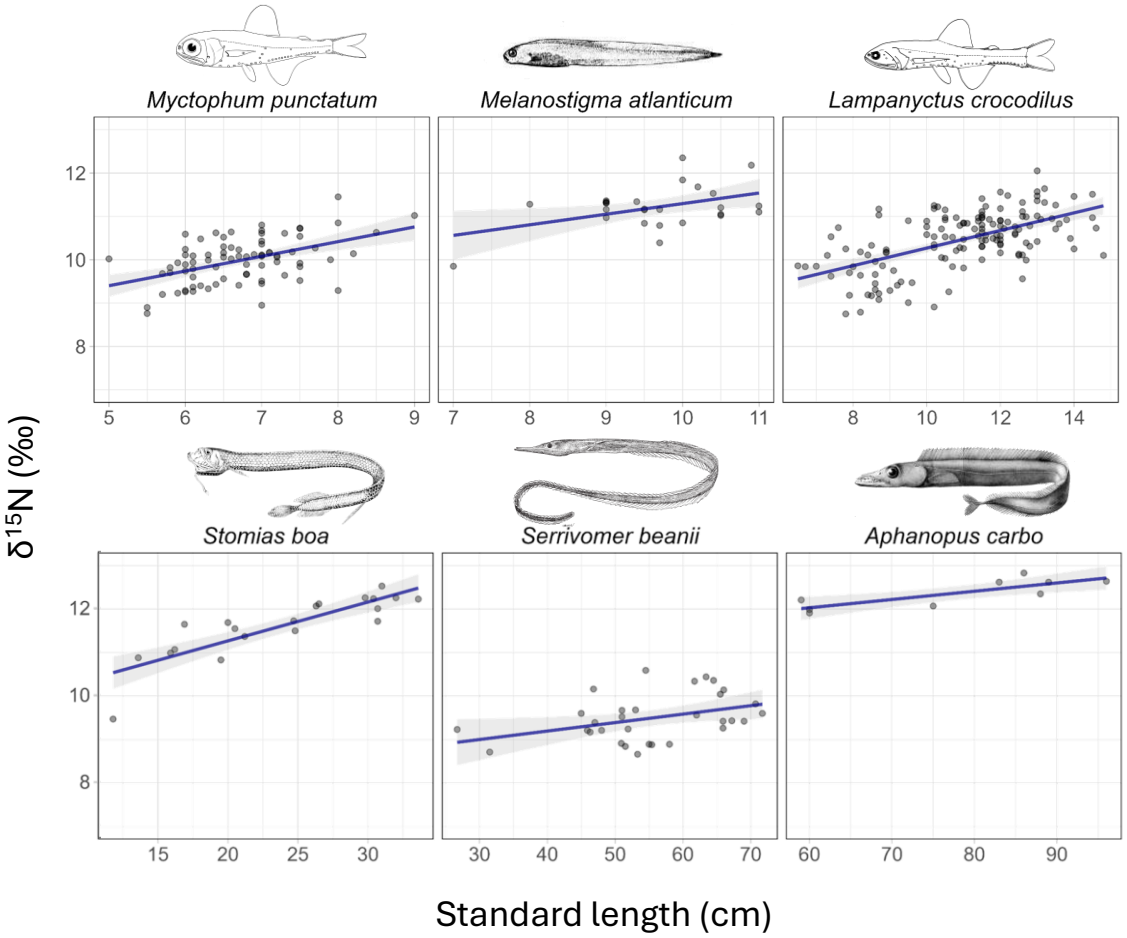
Intraspecific variability – $\delta^{15}N$ values variability



- Half of the twelve species presented an increase in $\delta^{15}N$ values with increasing size
- Consequence of the species' ability to capture larger prey

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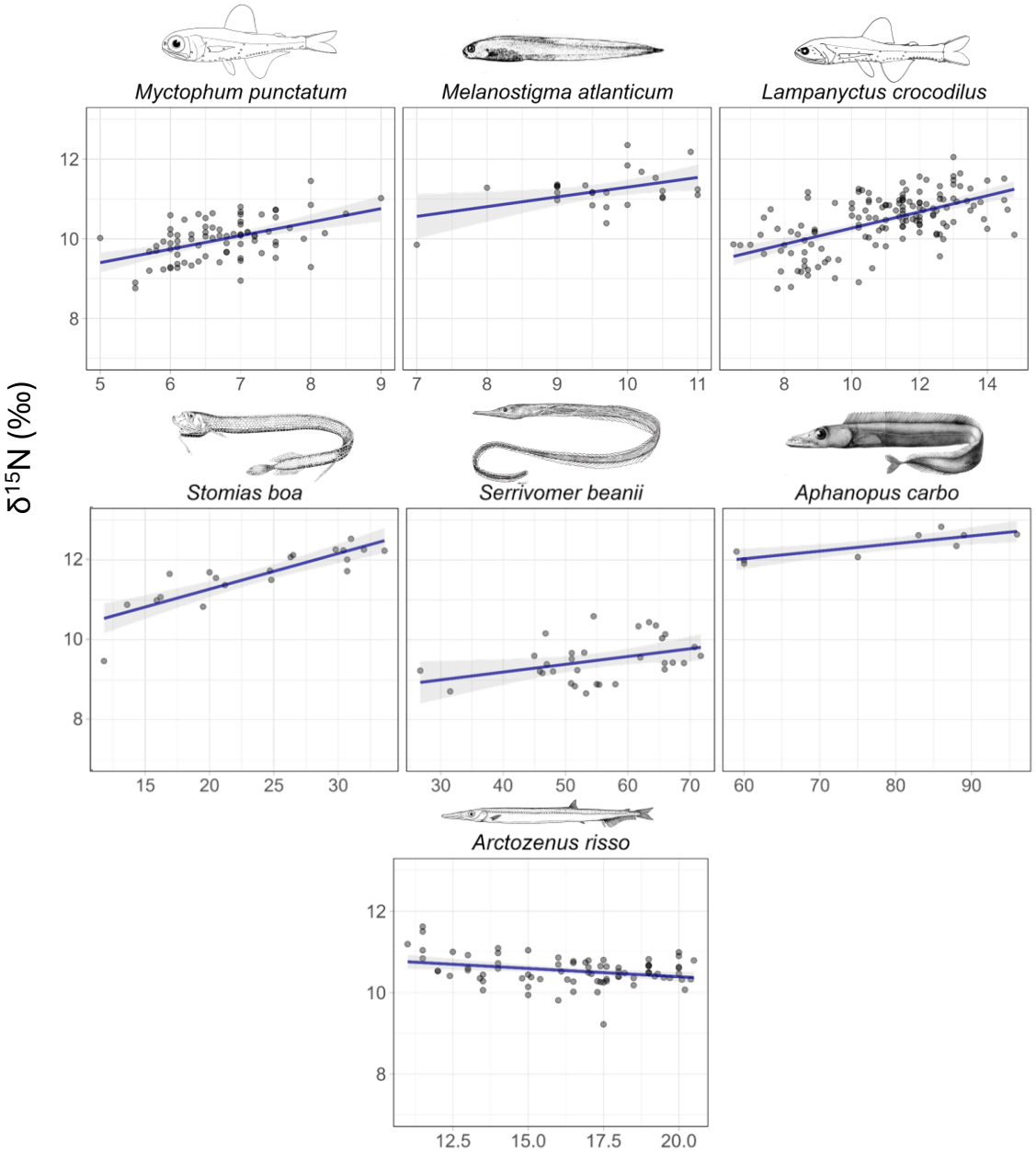

- Half of the twelve species presented an increase in $\delta^{15}N$ values with increasing size
- Consequence of the species' ability to capture larger prey
- Decrease for *A. risso*: loss of teeth, which could lead to changes in diet (Ho et Duhamel, 2019; Devine et Van Guelpen, 2021)

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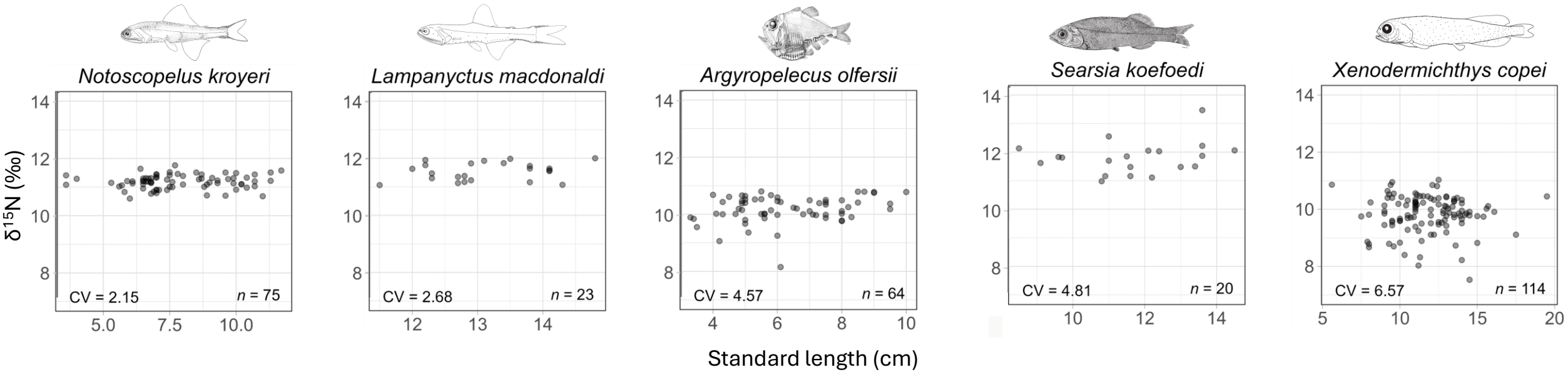
Intraspecific variability – $\delta^{15}N$ values variability

- The variability of $\delta^{15}N$ values differs among species



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Intraspecific variability – $\delta^{15}N$ values variability

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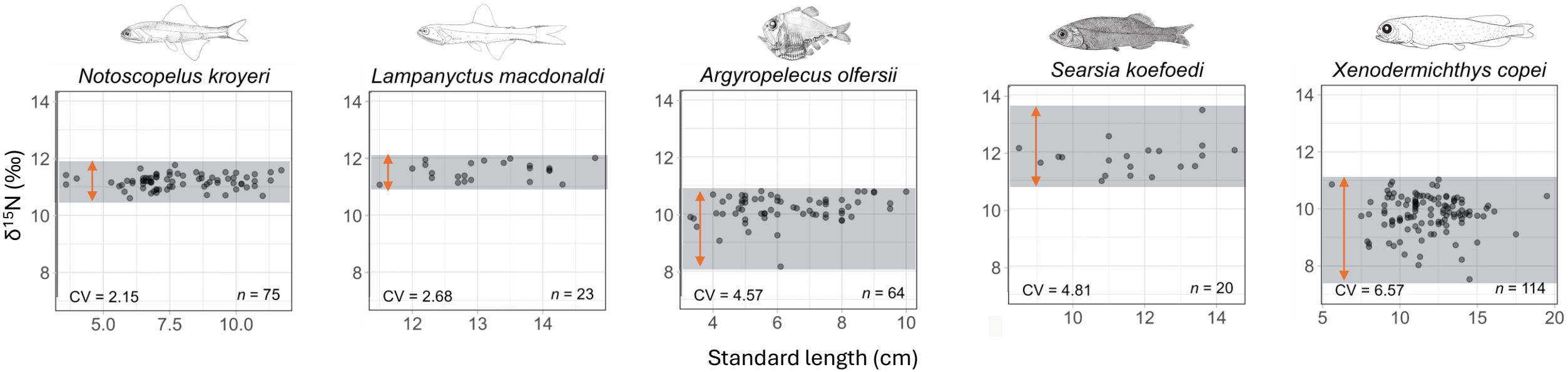
- Translate differences in feeding strategies?



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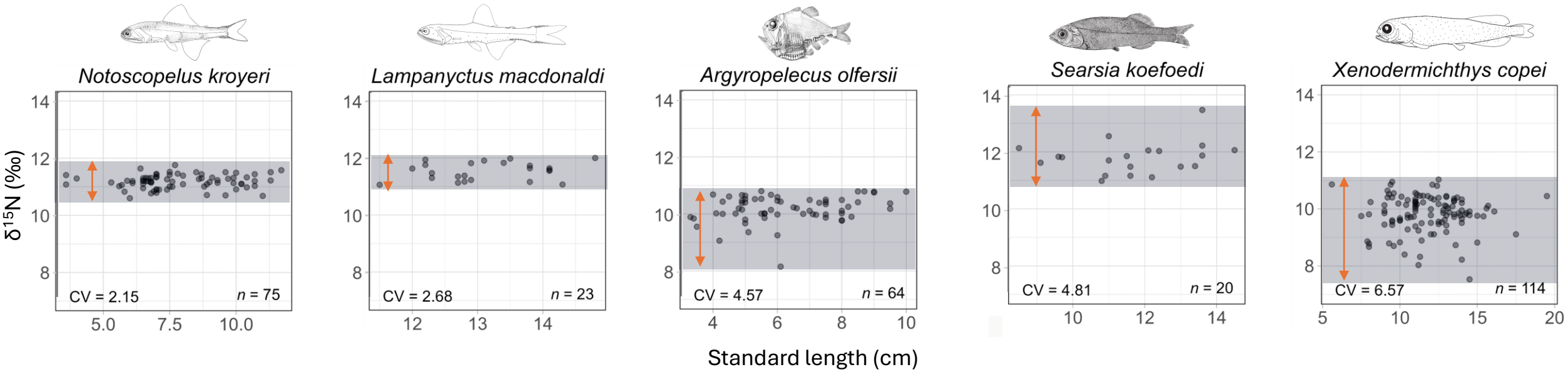

Specialized diet

Variability of $\delta^{15}N$ values

Greater dietary plasticity

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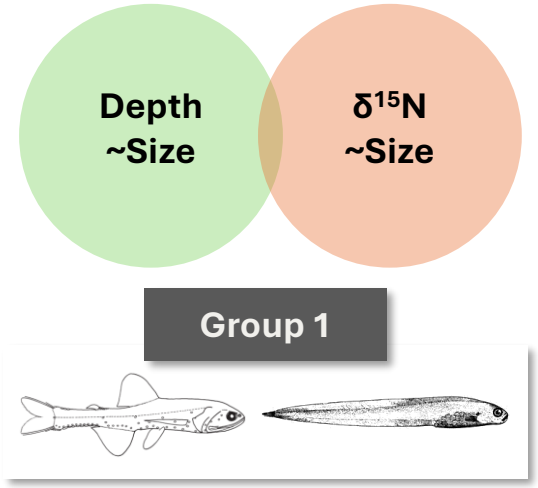
Intraspecific variability - summary

- Size is one of the species traits driving a shift in the trophic ecology of the species



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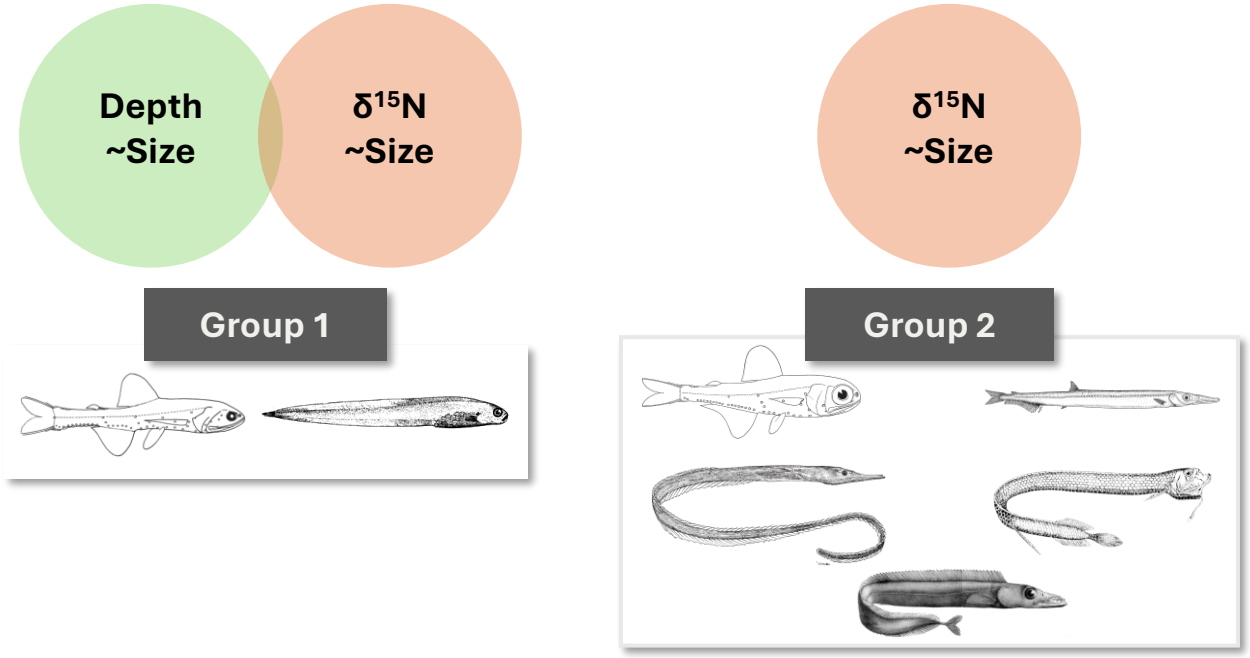

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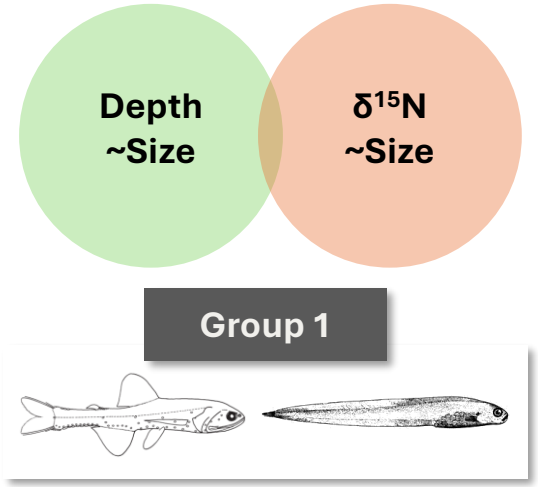

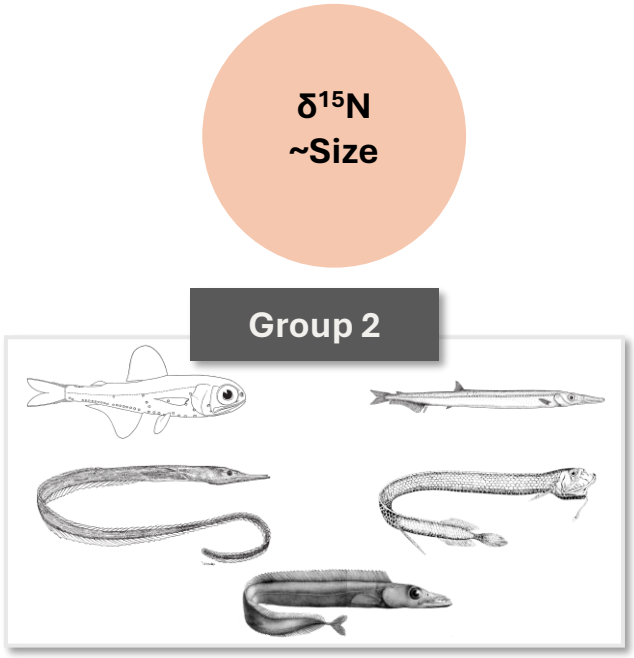

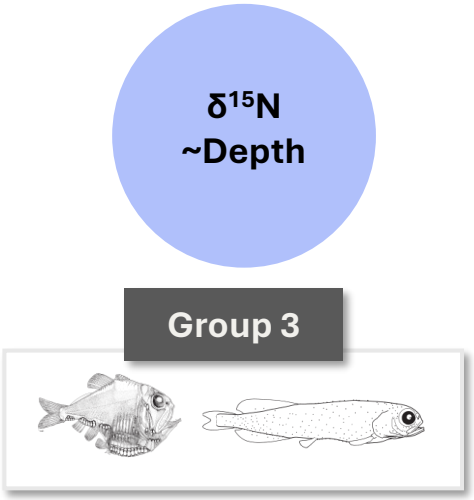

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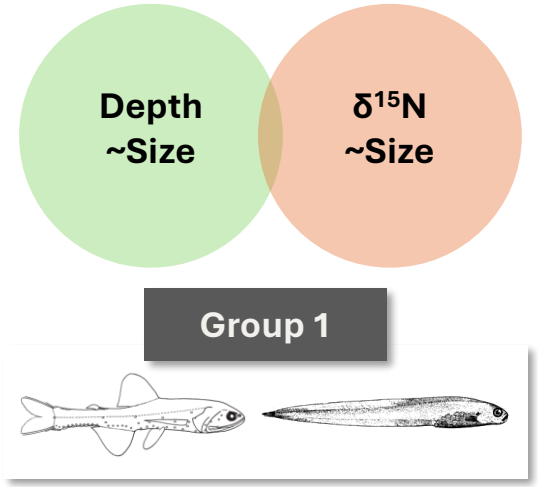

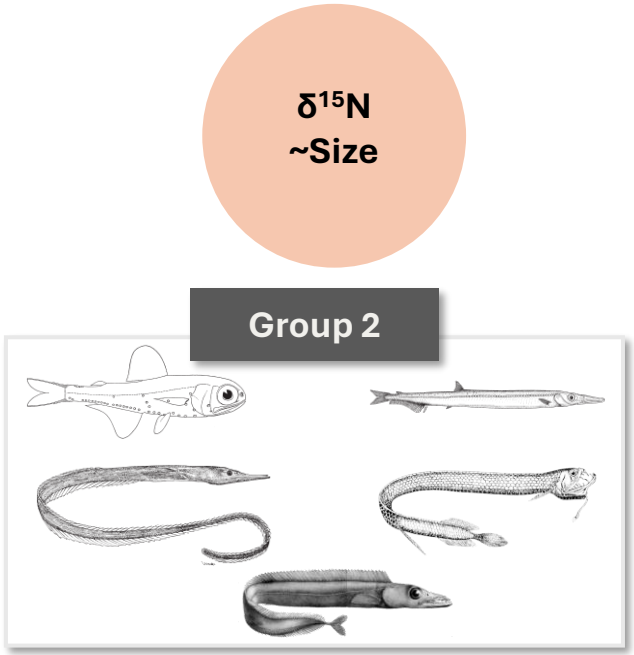

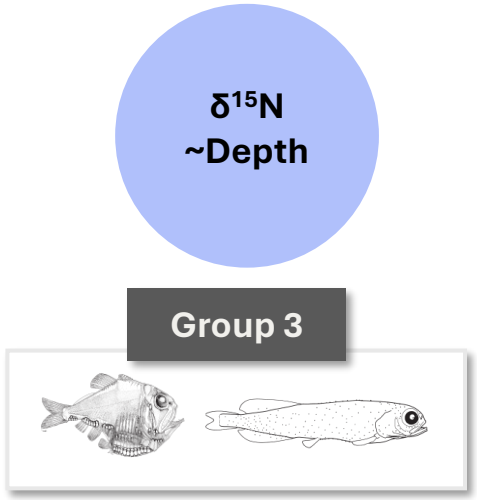

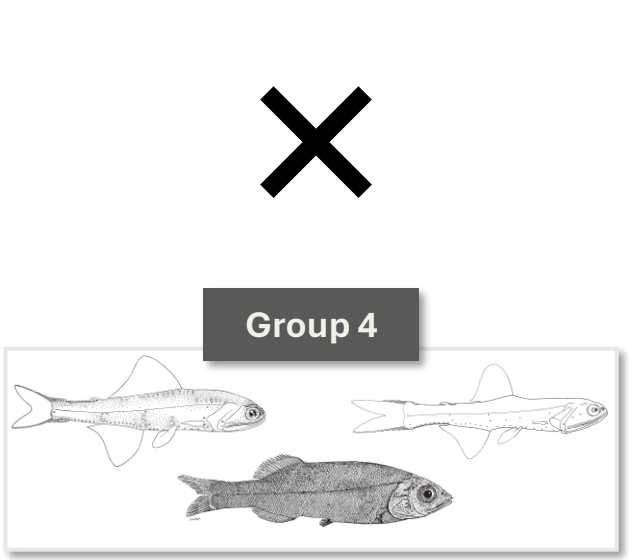

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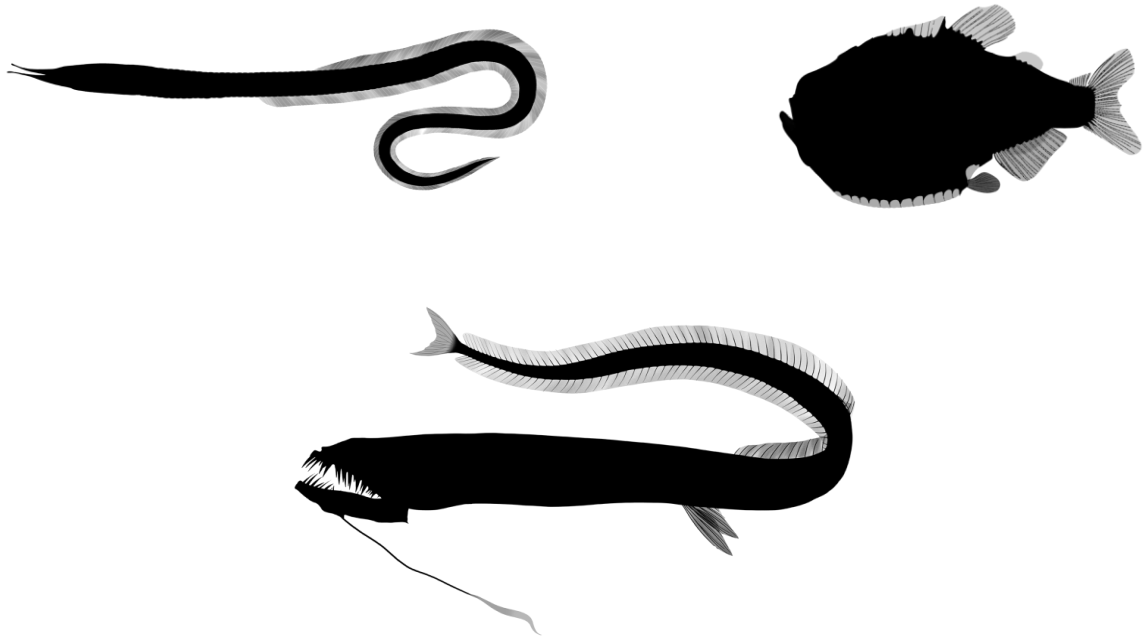
Functional diversity of foraging strategies at the community level

Measure of 27 morphological traits related to food acquisition, 42 species (n = 722 individuals)



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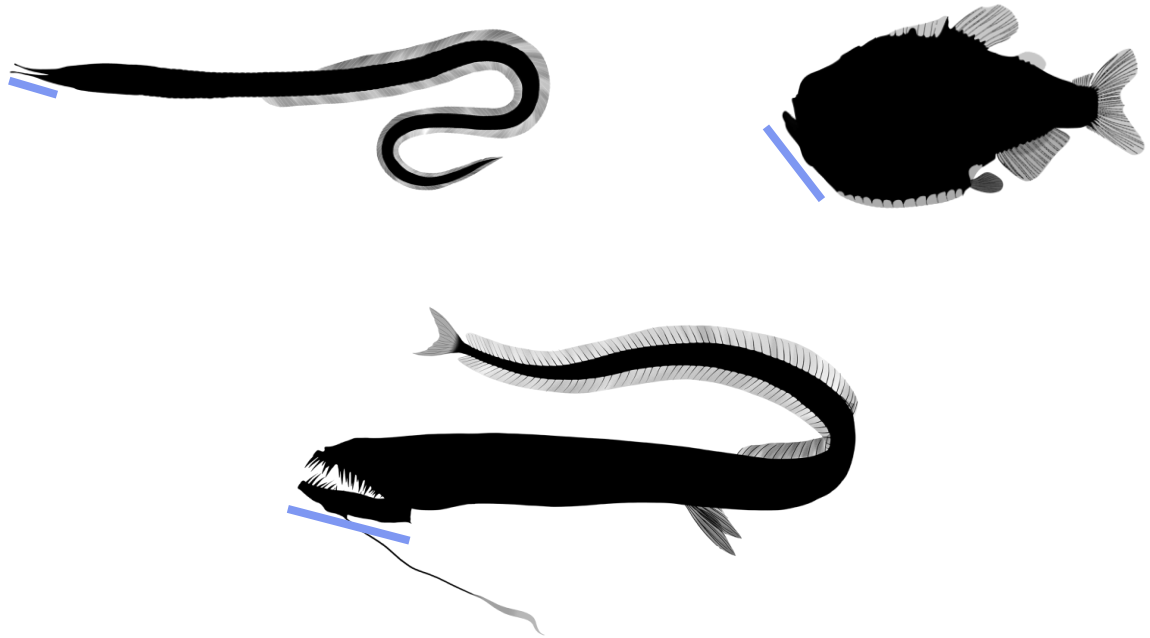

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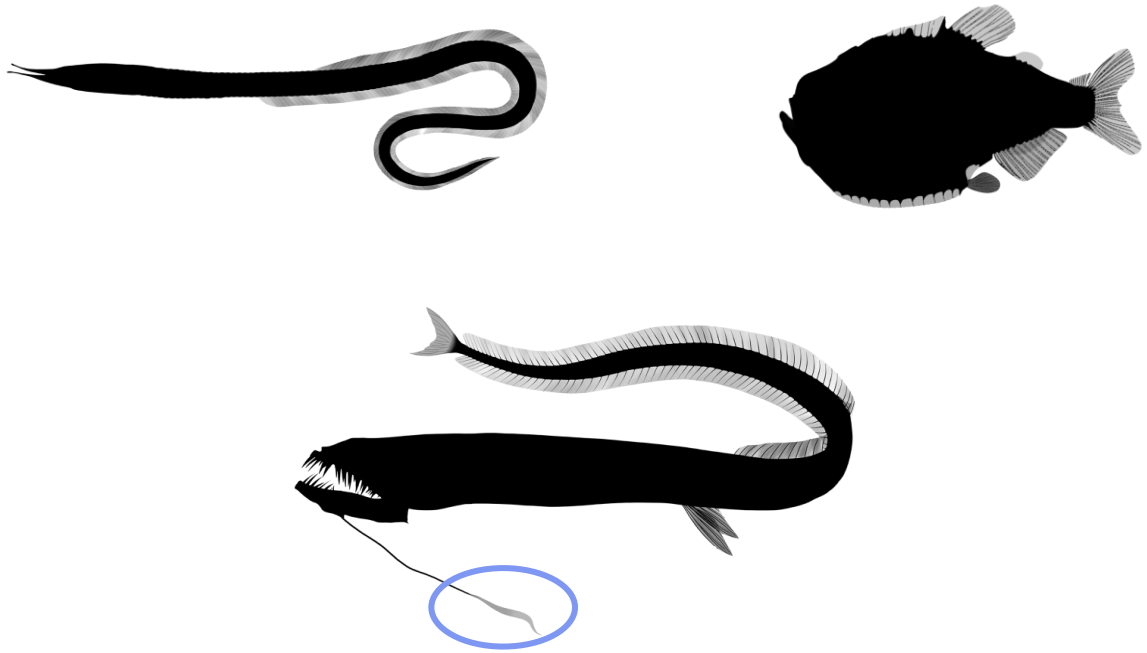

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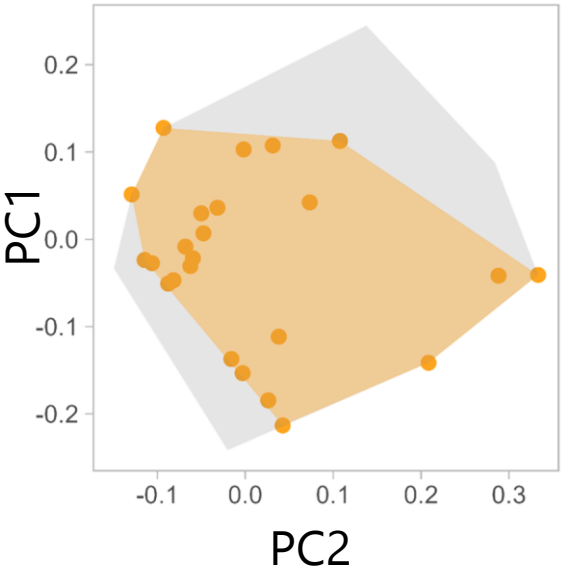
(20-175 m)



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Upper-mesopelagic
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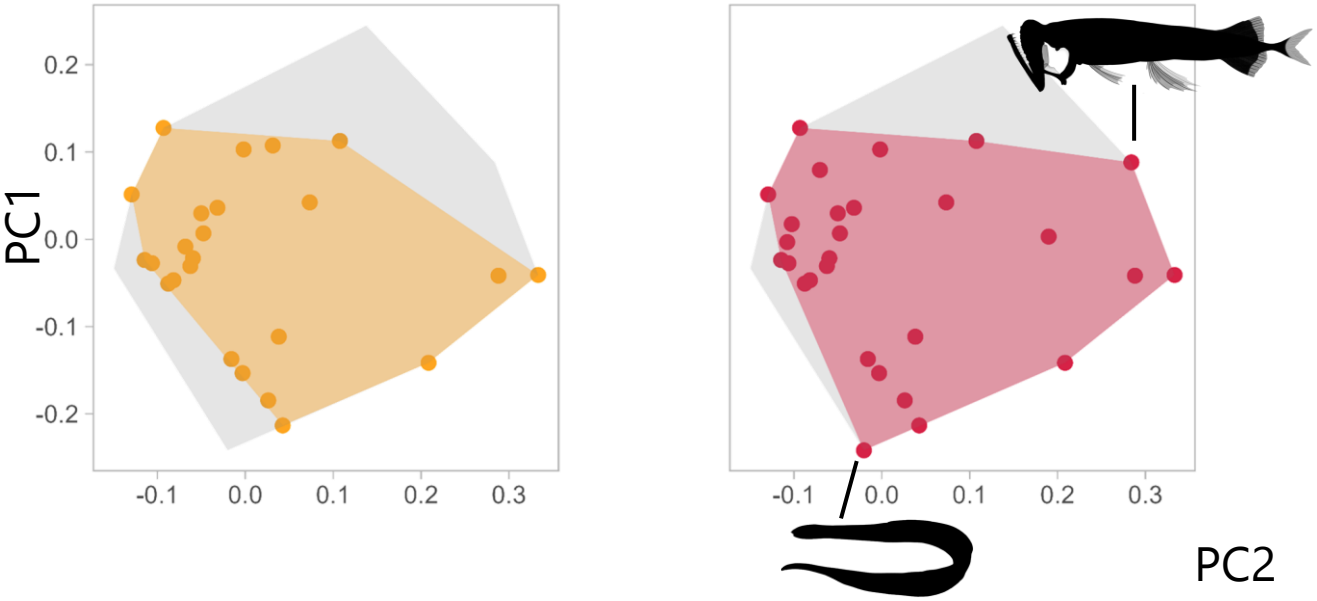

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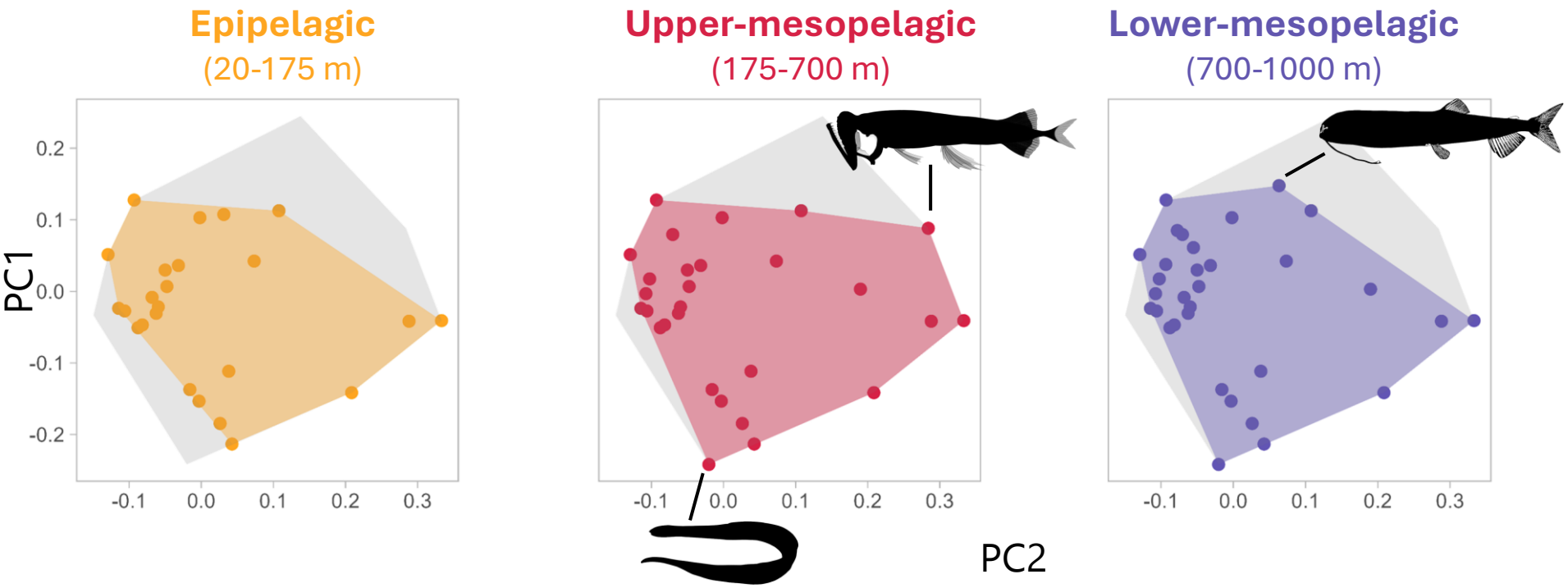

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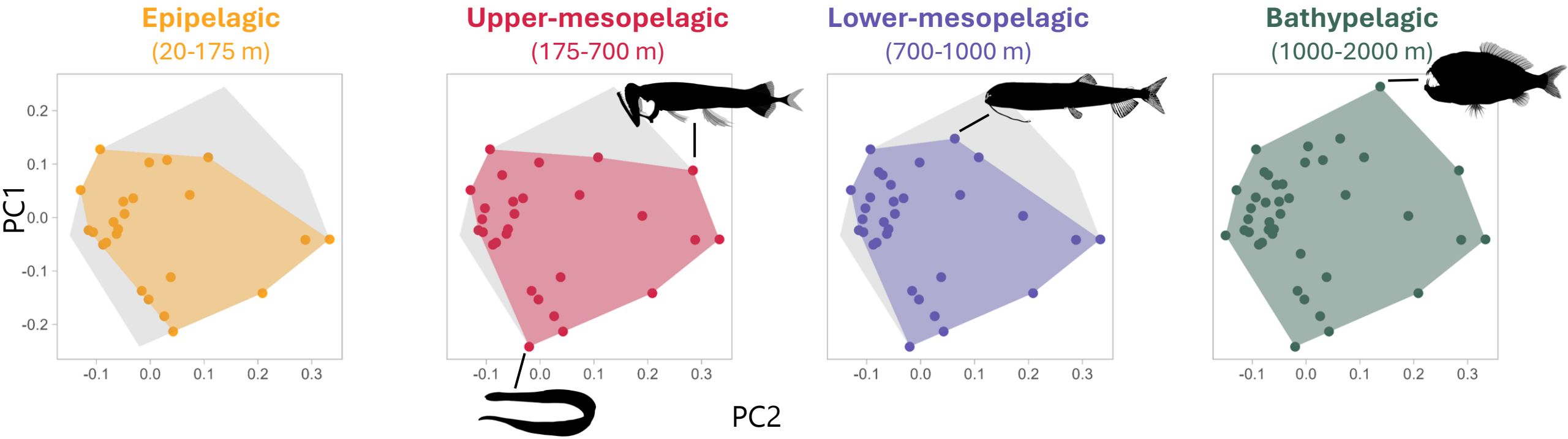

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Upper-mesopelagic
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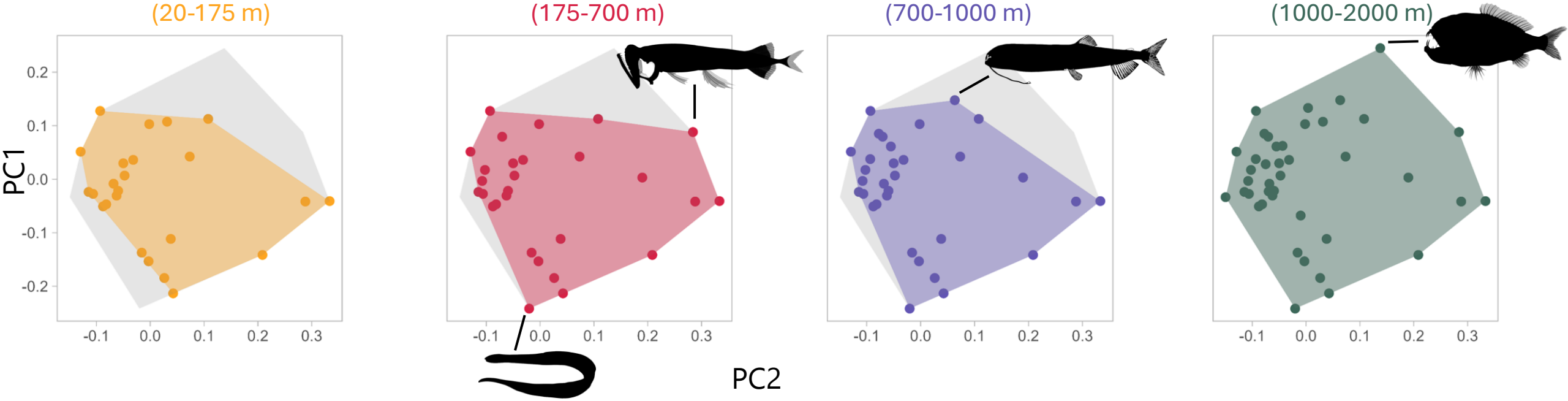
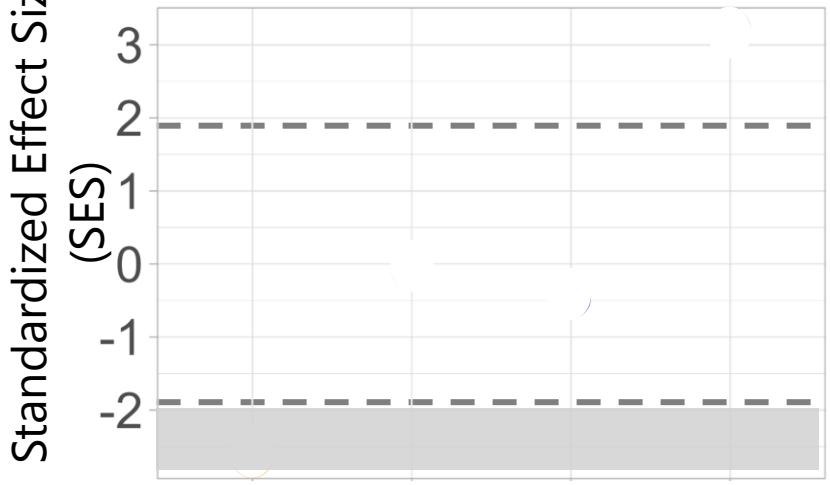
Lower-mesopelagic
(700-1000 m)

Bathypelagic
(1000-2000 m)



Functional richness



← Trait **convergence**, high functional **redundancy**

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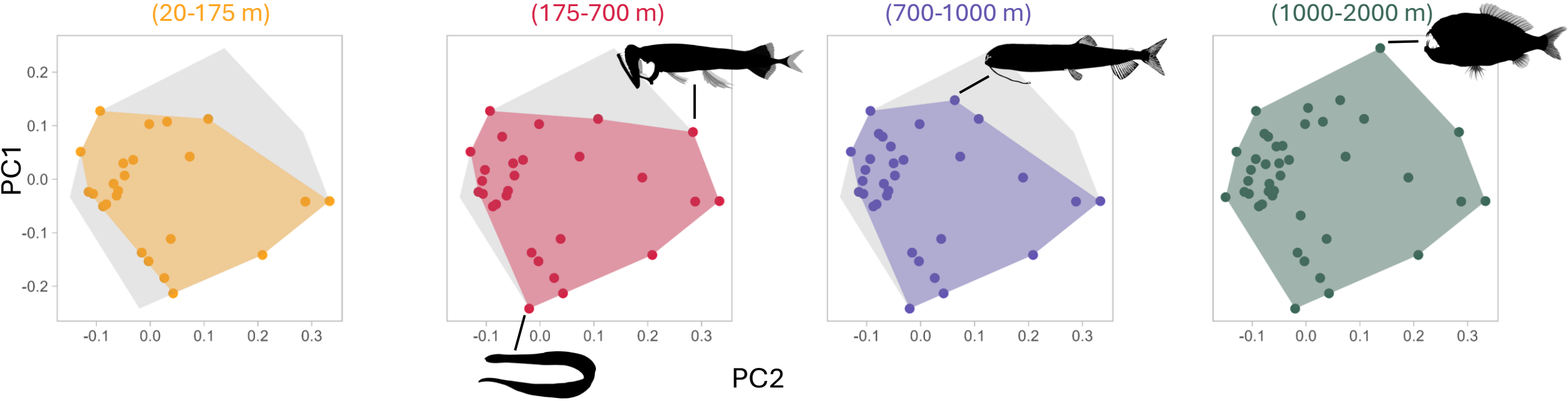

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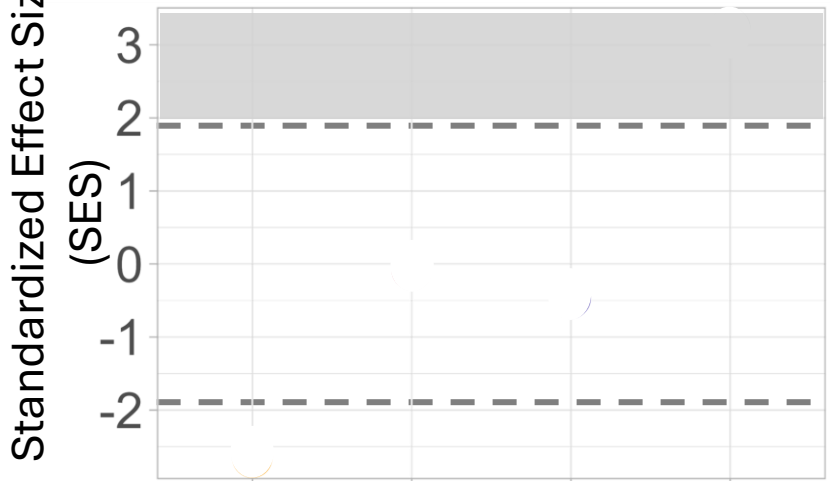

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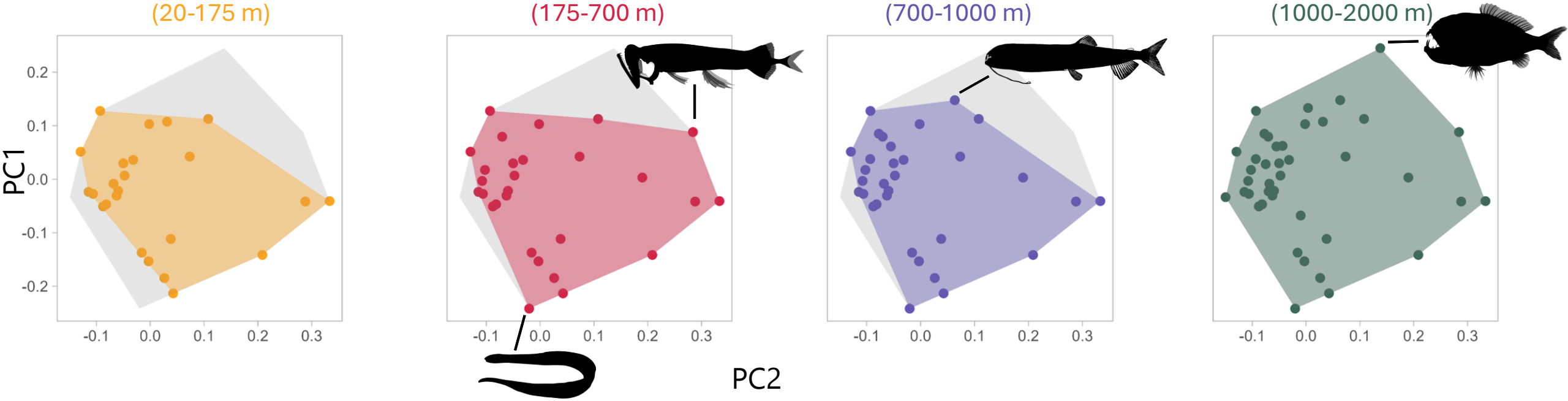

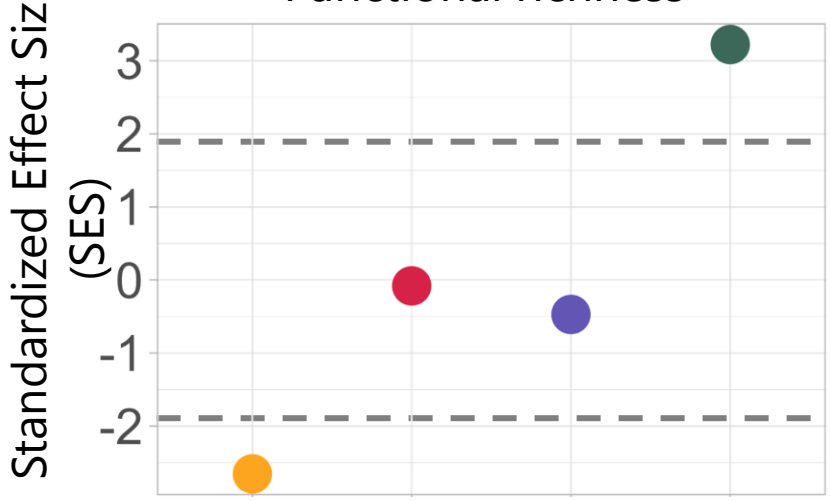

Trait **divergence**, high functional **specialization**

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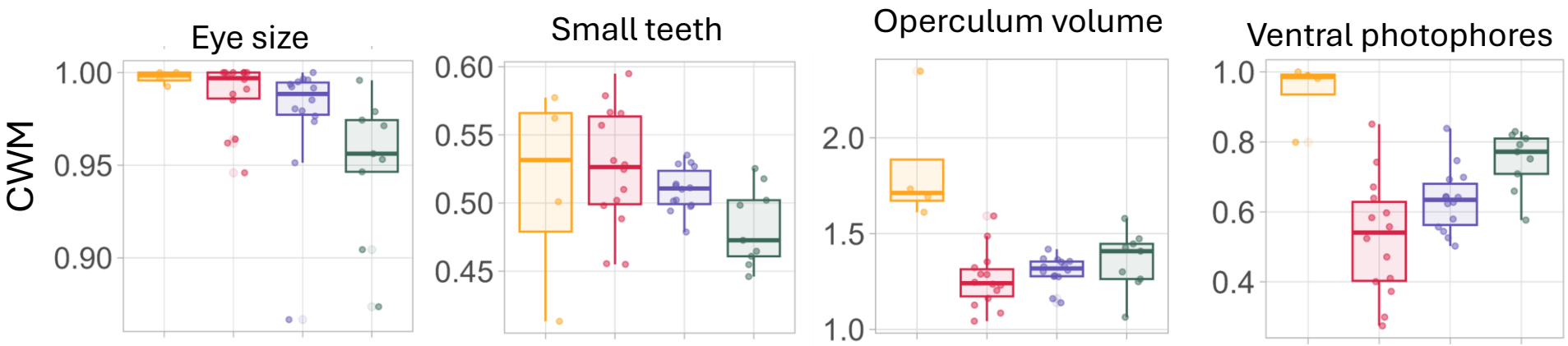
Functional diversity of foraging strategies at the community level

- **Community Weighted Mean** of each trait by species biomass



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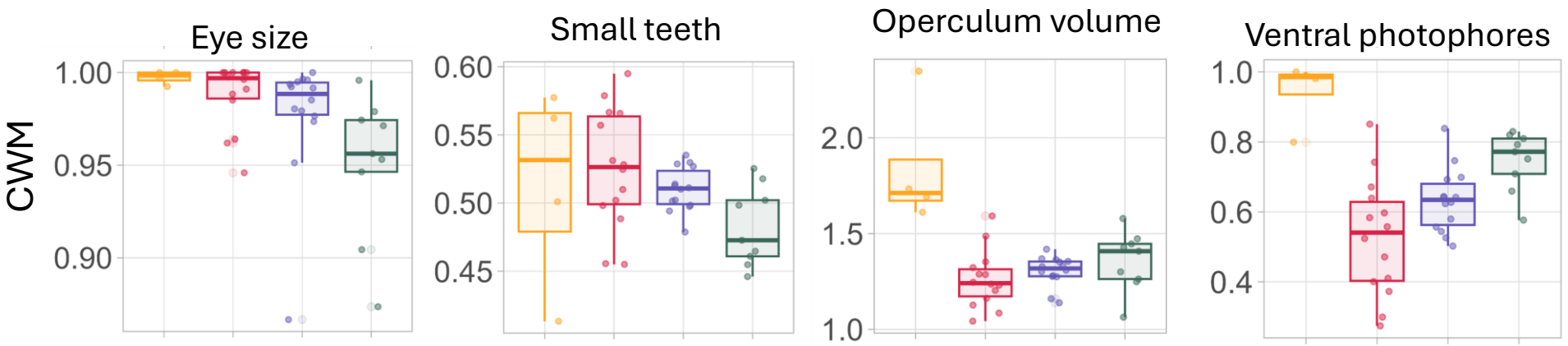
- **Epipelagic species:** stalk and pursue their prey



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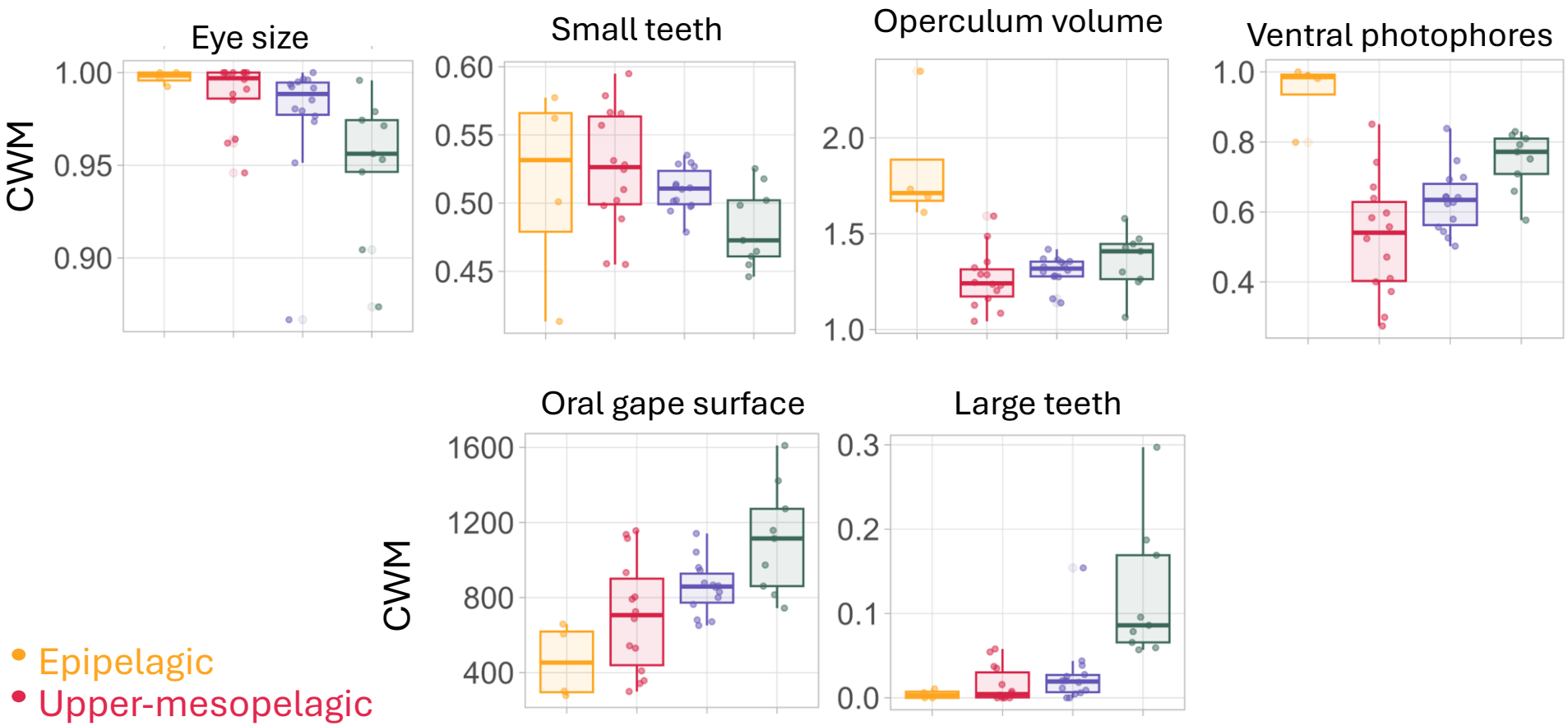

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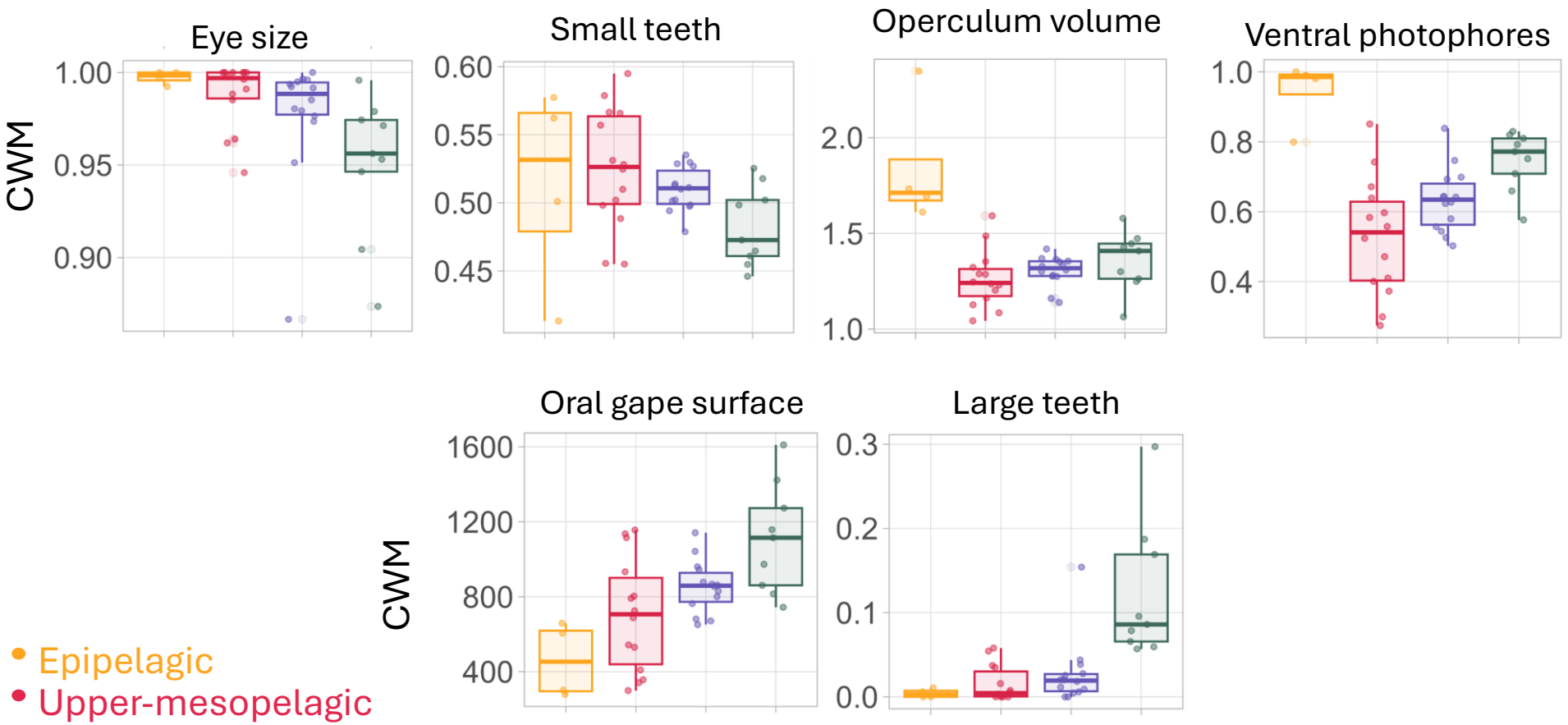
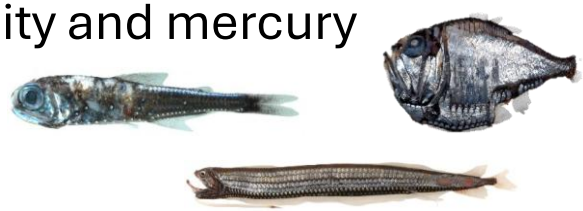
- **Community Weighted Mean** of each trait by species biomass
- **Epipelagic species:** stalk and pursue their prey
- **Deep species:** ambush predators



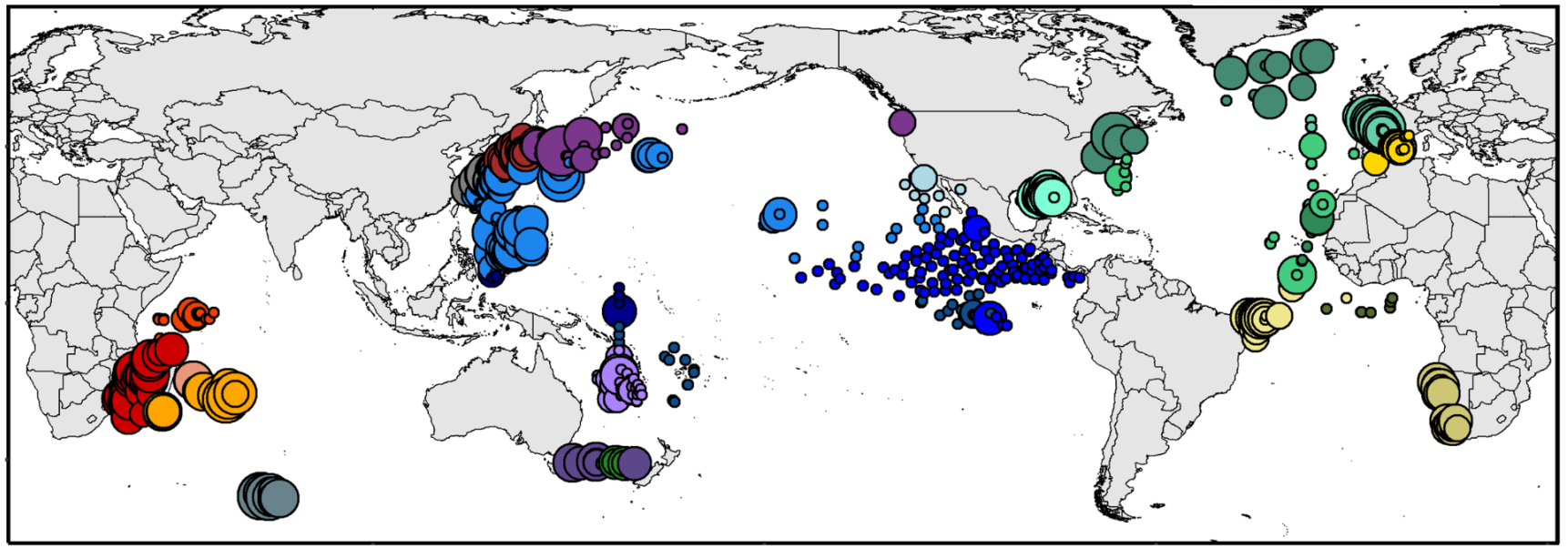
Investigating global micronekton trophic linkages in the mesopelagic zone

Aim: Understand the spatial patterns and environmental drivers of trophic diversity and mercury concentrations in abundant mesopelagic organisms



> 40 members; 7 countries;
> 17 research institutions

Co-leaders
Anaïs Médieu, Anela Choy



> 8,900 stable isotope records: estimates of trophic positions ($\delta^{15}N$) and habitat use ($\delta^{13}C$)

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~500 species, **>125 families** of fishes, molluscs, crustaceans and gelatinous taxa

2 migration or DVM patterns (migrant, resident) and **4 vertical foraging layers**

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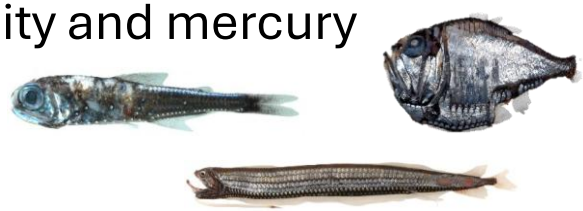

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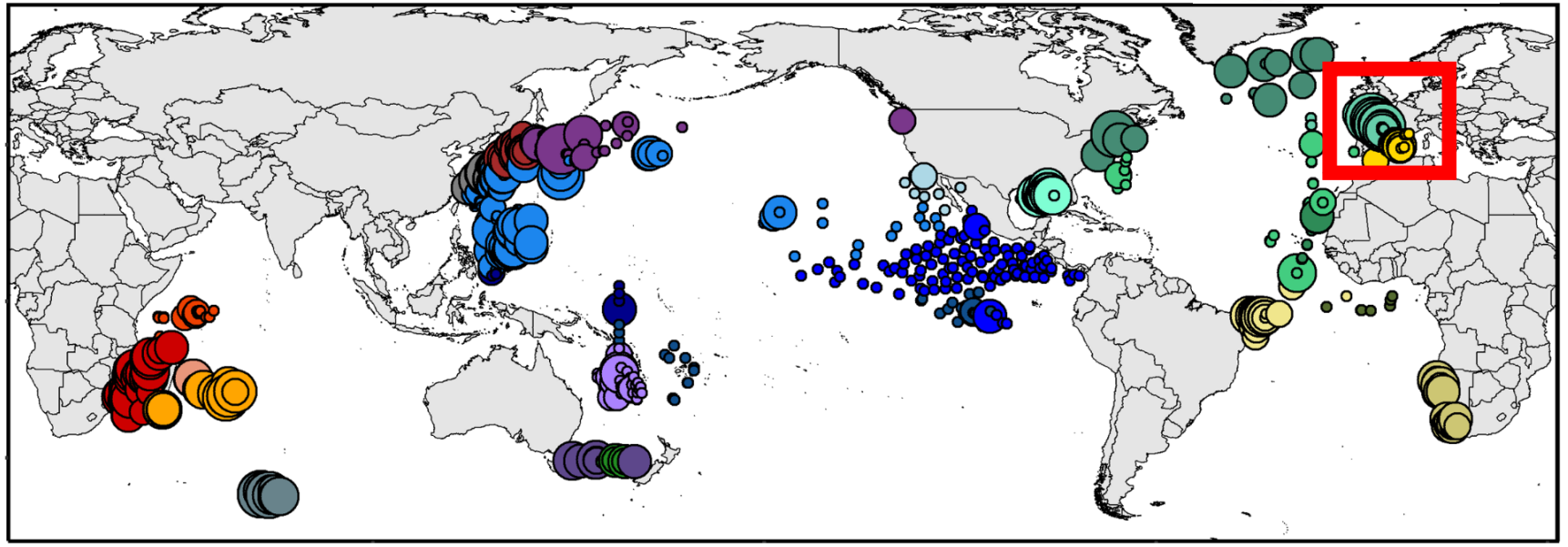

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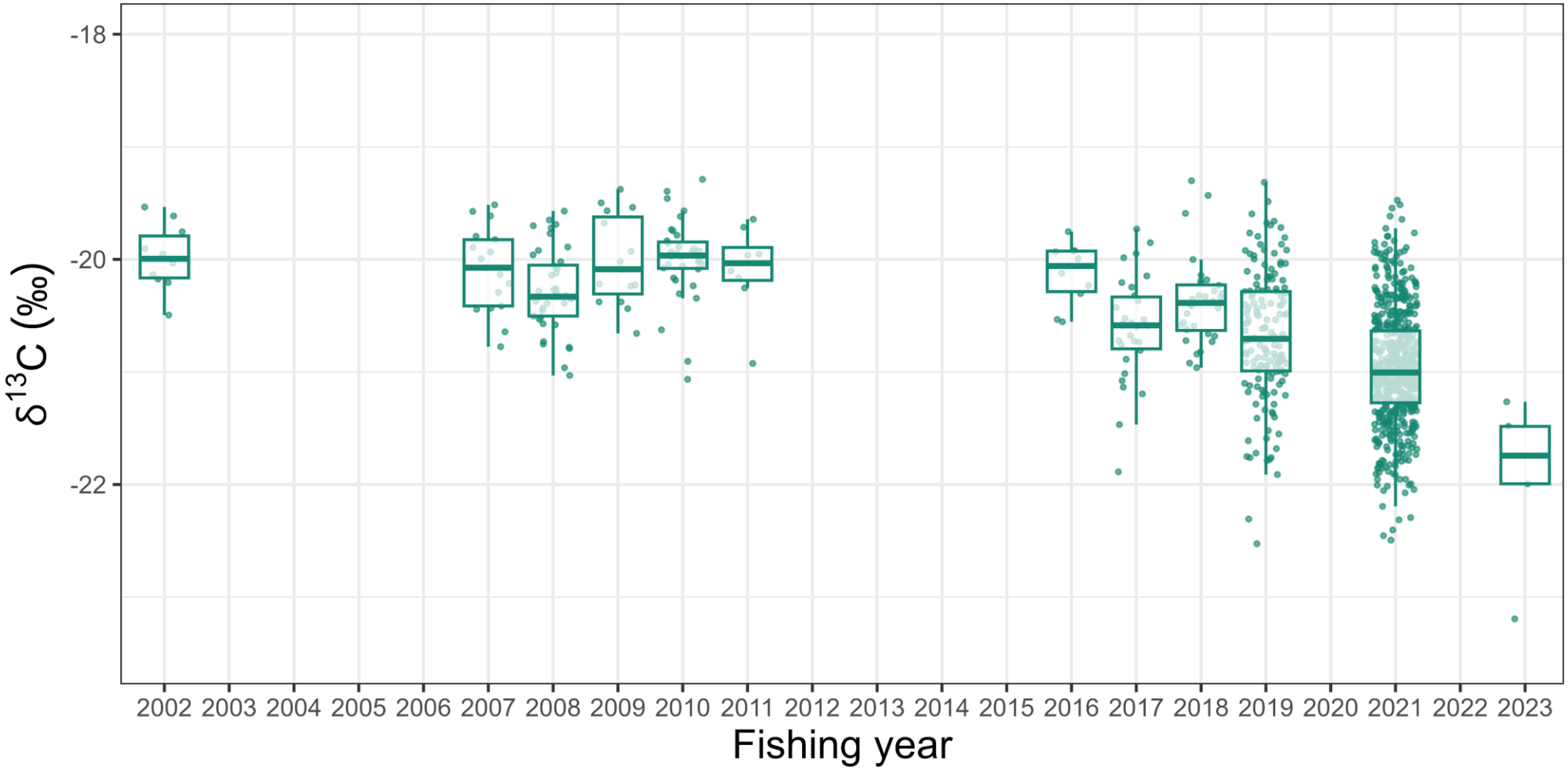

Investigating global micronekton trophic linkages in the mesopelagic zone

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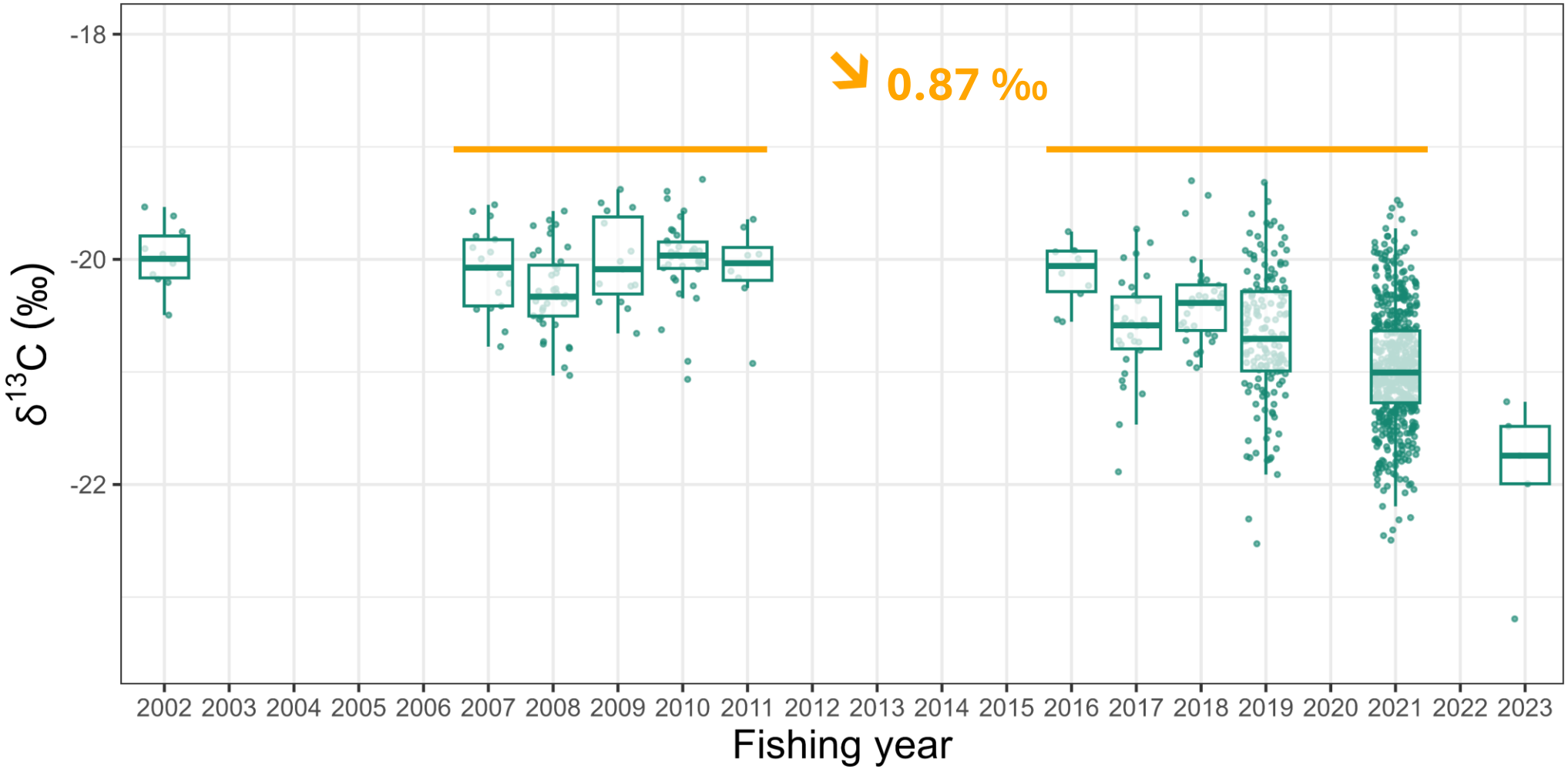
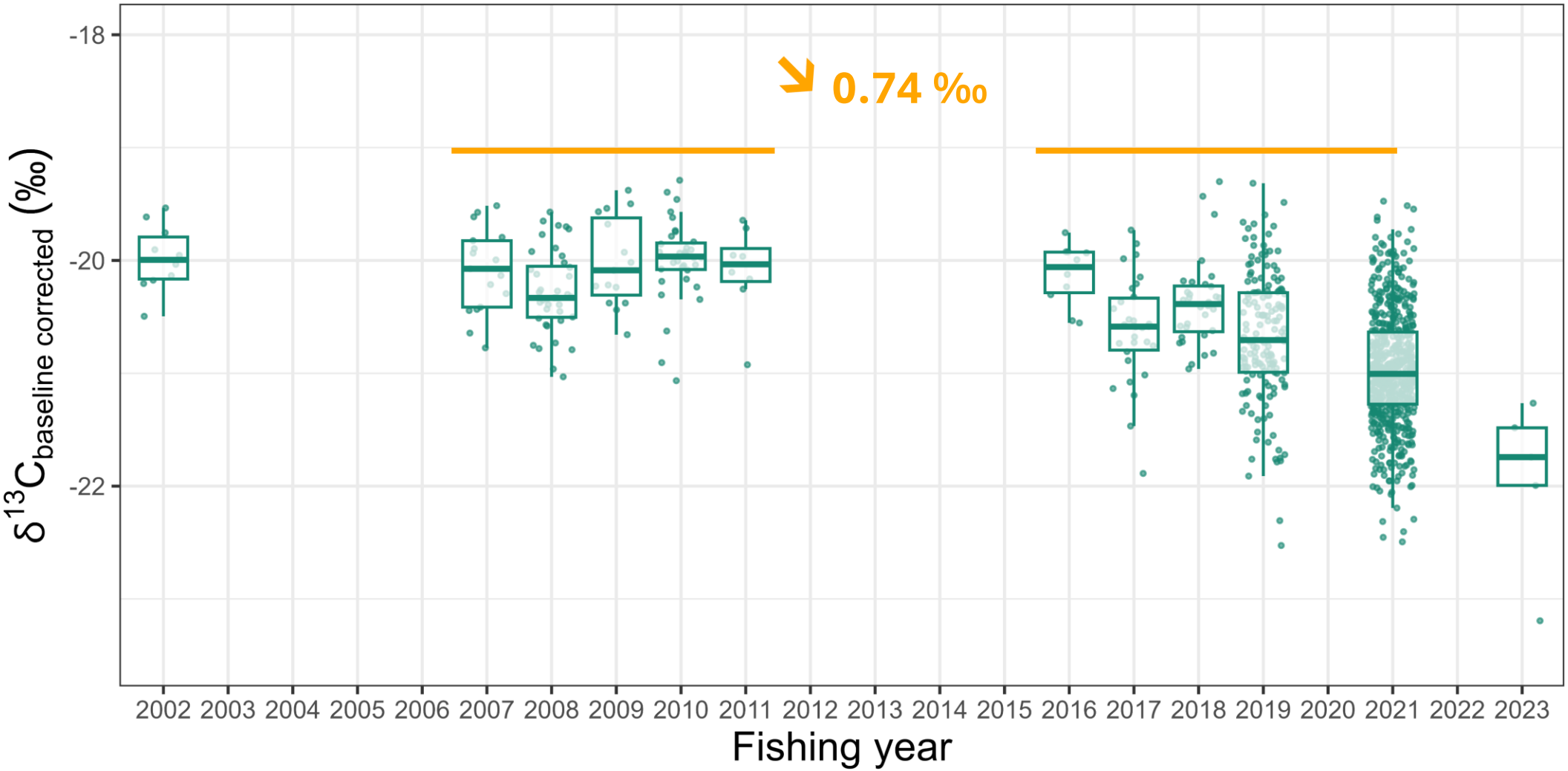


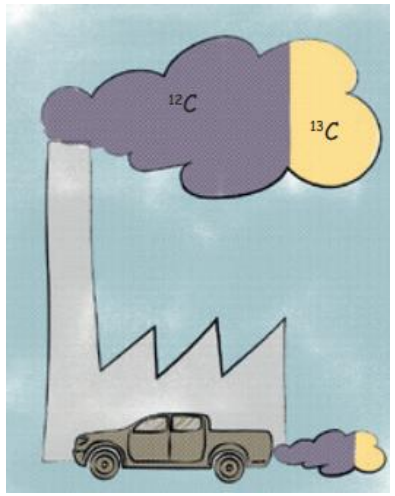
Investigating global micronekton trophic linkages in the mesopelagic zone

- Decrease in $\delta^{13}C$ values of the micronektonic **fish community** over time in the Bay of Biscay
- Even when accounting for the **baseline variations** across years and depths (Somes et al., 2017)



Possible mechanisms behind the decrease in $\delta^{13}C$ values over time:

Suess effect
(Keeling, 1979)



Boris Colas, SPC 2019

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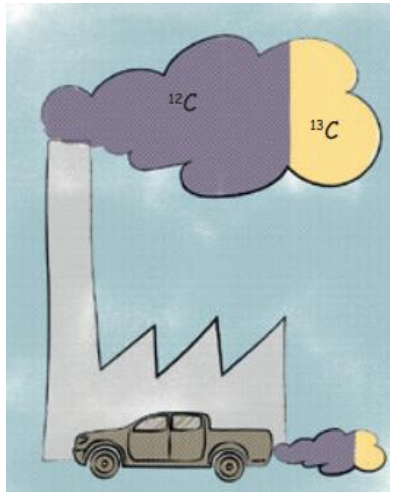

Boris Colas, SPC 2019

↘ $\delta^{13}C_{DIC}$ of **-0.25 ‰** per decade

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(Tagliabue et Bopp, 2008)

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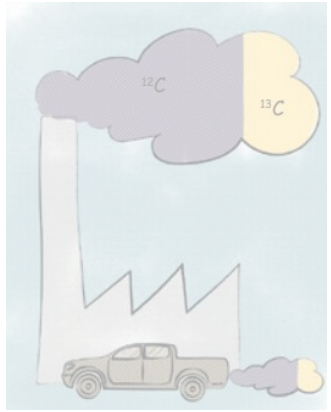

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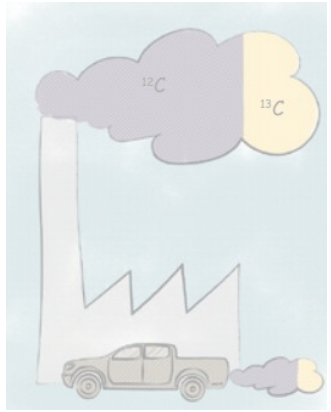

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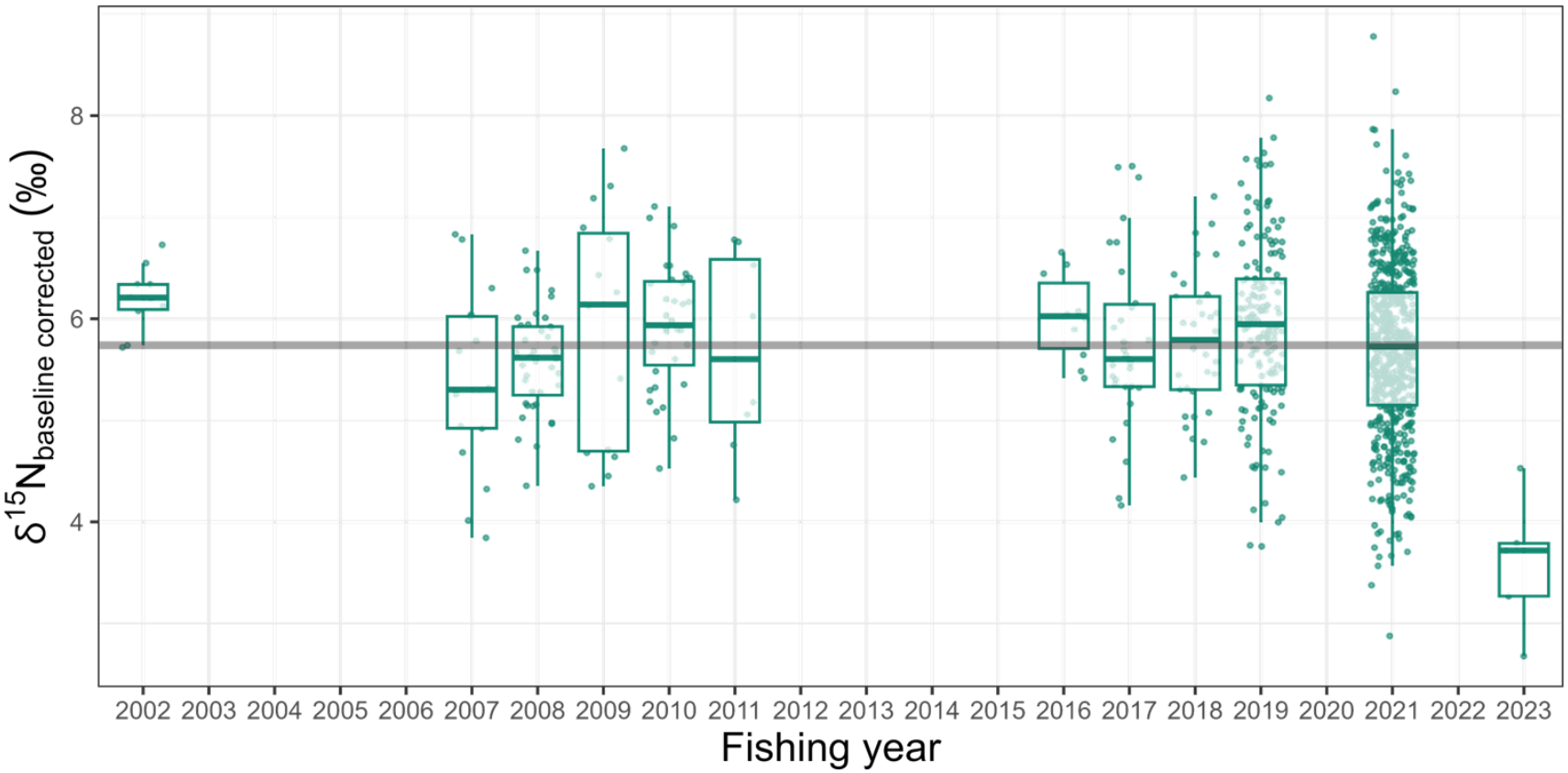

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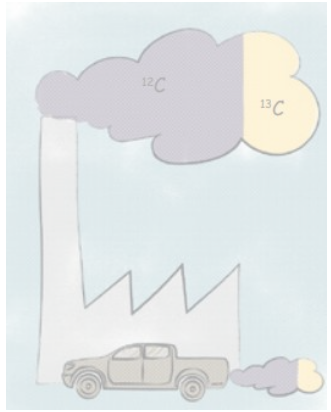

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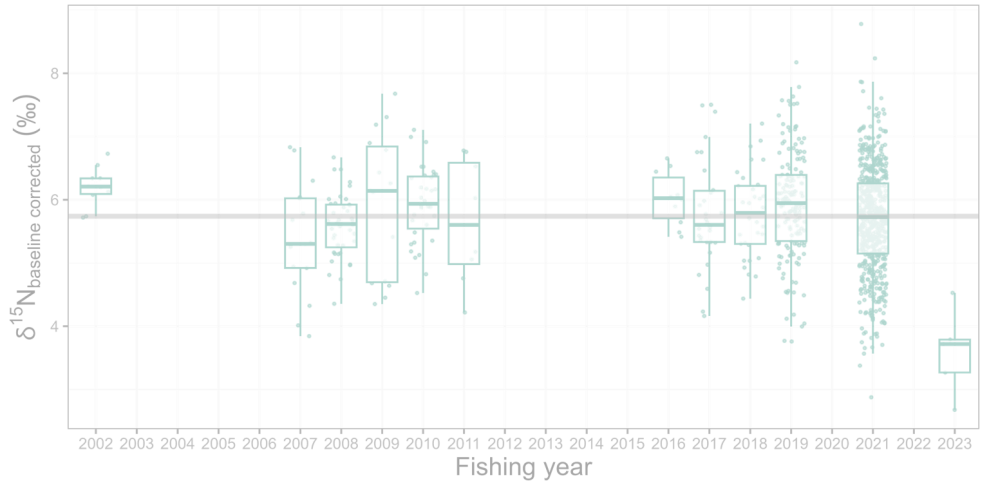
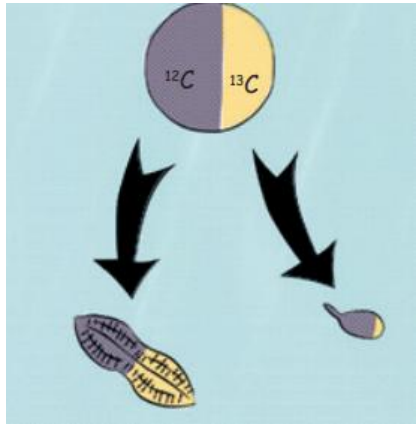


Changes in phytoplankton communities
(Popp, et al ., 1998)



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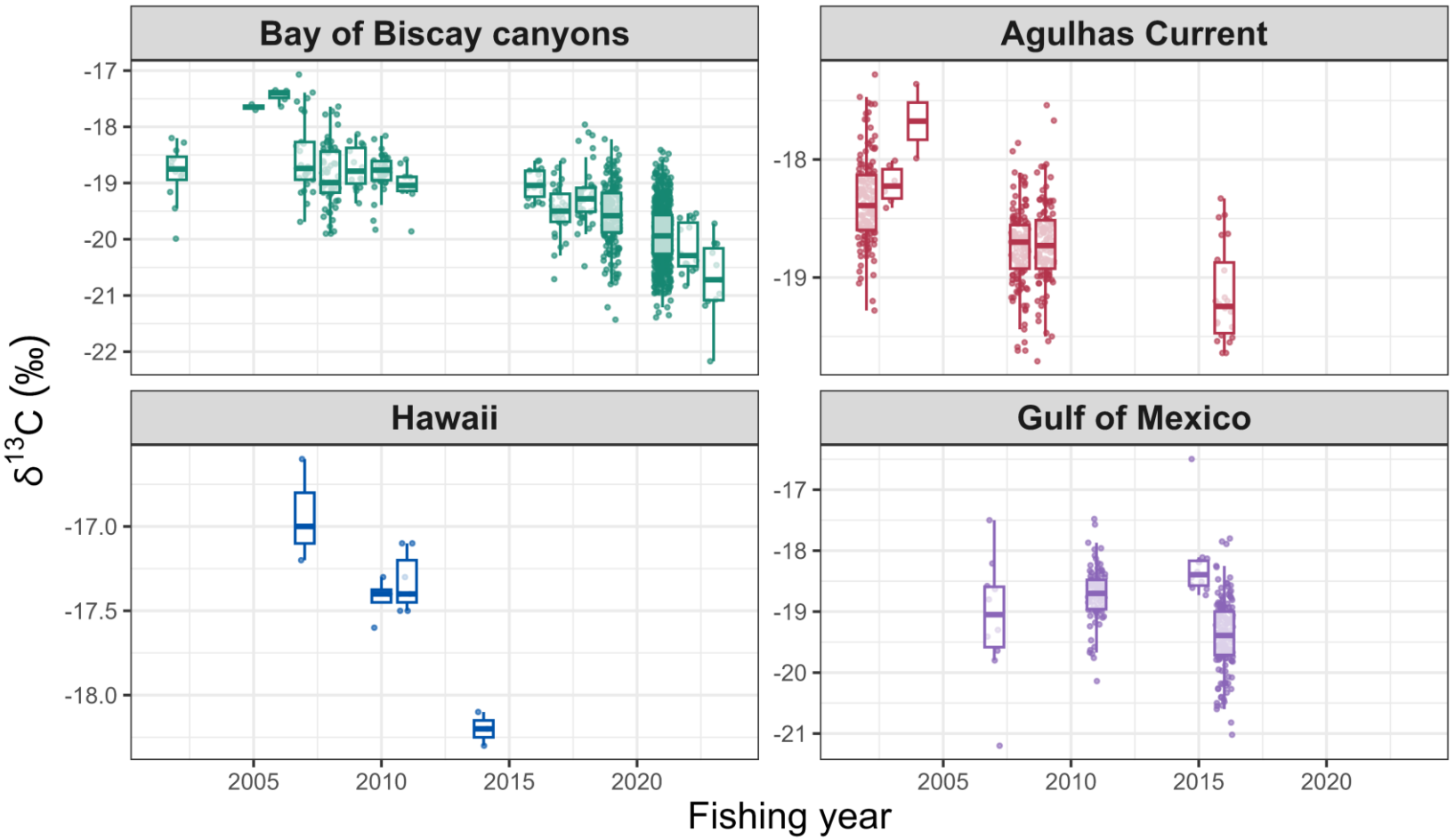
Has already been characterized in tuna species (Lorrain et al., 2020)

Investigating global micronekton trophic linkages in the mesopelagic zone

- Next step: correct the baseline depth-integrated correction across different regions based on the vertical distribution of species (fish, crustaceans, molluscs…)



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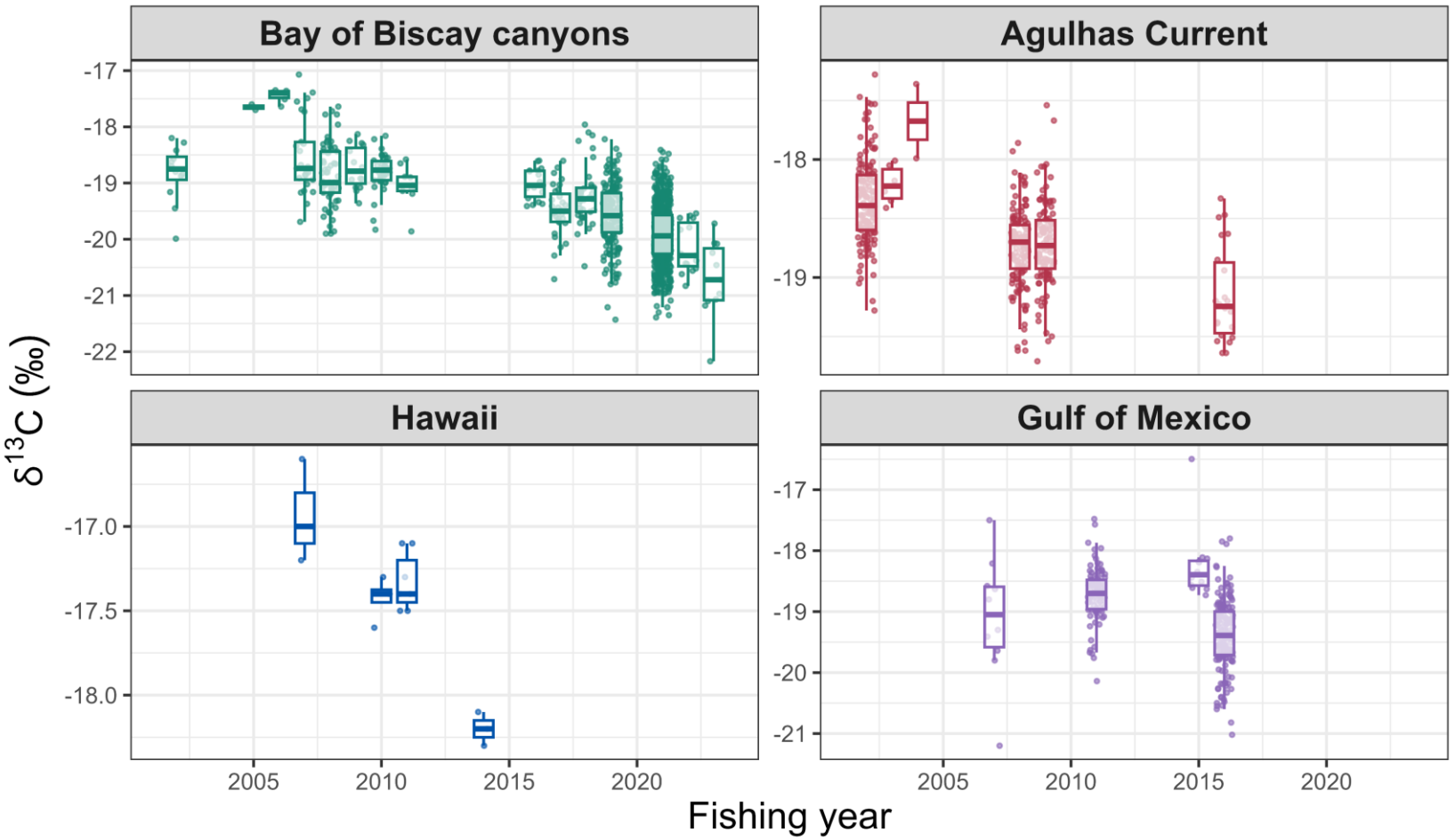

The task team is still compiling SIA and Mercury data!

Anaïs Médieu & Anela Choy

anais.medieu@ird.fr anela@ucsd.edu

- **Individual size strongly shapes vertical distribution and trophic ecology**
- **Depth-related environmental gradients drive distinct feeding strategies**
- **Global changes at the base of the food web are reflected in micronekton species**

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Thank you!

lloutrage@ucsd.edu