Biomagnification, biodilution or both? Trophic dynamics of multiple trace metals in coastal food webs from Patagonia and Antarctica

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Introduction

- Antarctic and Patagonian coastal biota is diverse, and both regions considered pristine ecosystems.
- Most of the scientific research have shown that Hg biomagnifies through food webs and has a positive correlation with higher latitudes.
- There is a lack of information for trace metals fate and effects on both regions in the Southern Hemisphere. Especially, biomagnification processes of trace metal in marine food webs from remote/pristine zones in the southeaster Pacific coast are even more scarce.
- The differences of (1) the composition of the food web structure between Antarctica and Patagonia, (2) along with physiochemistry processes and (3) the input of freshwaters to coastal systems might influence trophodynamics of Hg, Cd, Ta, Pb.

Objectives

- To characterize the coastal trophic food web in 4 different locations from Patagonia and Antarctica through C and N stable Isotopes. (Fig. 1 and 2)
- To analyse the concentrations of Hg (MeHg), Cd, Ta and Pb in benthic invertebrates, fish, marine birds and mammals.
- To calculate possible trophic dynamics of these trace metals using trophic position and/or $\delta^{15}N$ signatures
- Estimate possible sources of the present trace metals through stable isotopes analysis.

Methods

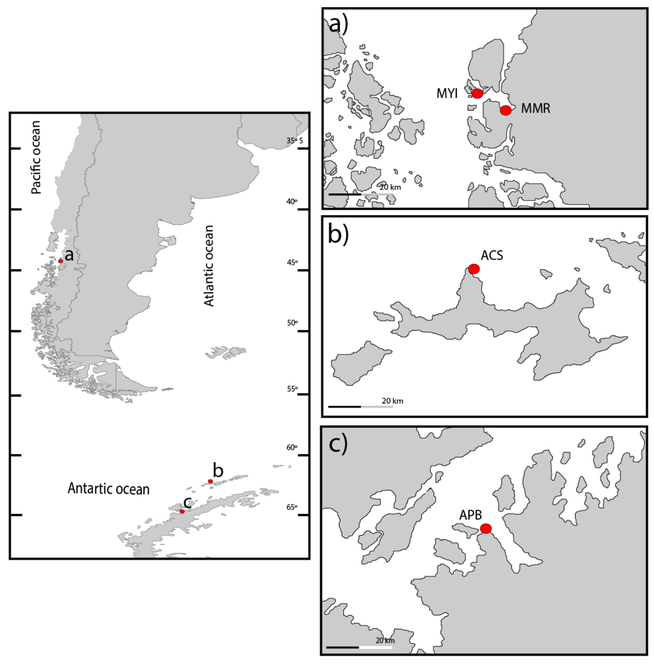

Figure 1.- Sampling sites in (a) Chilean Patagonia-Melimoyu Bay, (MYI: Melimoyu at Yalac Island; MMR: Melimoyu at Marchant River mouth; b) Livingstone Island, Cape Shirreff, (ACS Antarctica at Cape Shirreff); and (c) Antarctic Peninsula, Paradise Bay (APB: Antarctica at Paradise Bay).

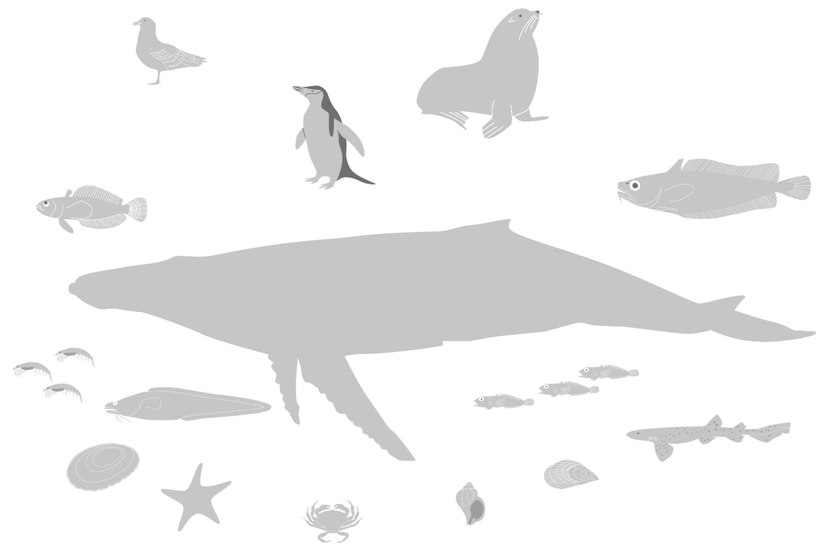

Figure 2.- Sampled biota in Patagonia and Antarctica. Biopsies, feathers, muscle tissue, soft tissue, depending on the sampled organisms. (Illustrations by Maria Jose Bunster)

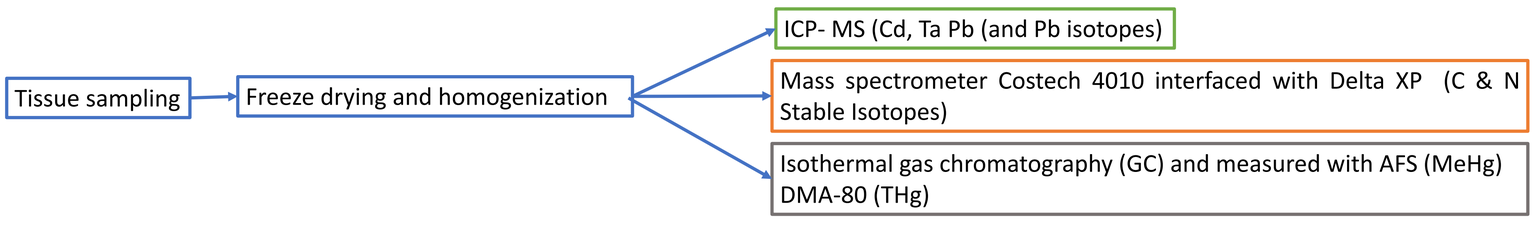

Figure 3.- Scheme of the methodology used to quantify trace metals and stable isotopes

Results & Discussion

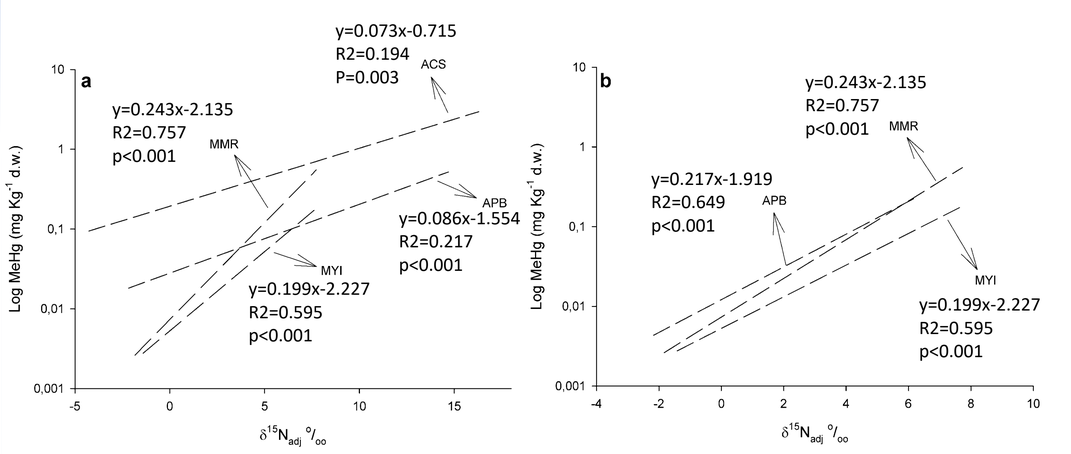

Figure 4.- Biomagnification slopes for MeHg, using data for a) whole food web and b) macroinvertebrates and fish only. (MMR: Melimoyu-Marchant River; MYI: Melimoyu Yalac Island; APB: Antarctica Paradise Bay; ACS: Antarctica Cape Shirreff).

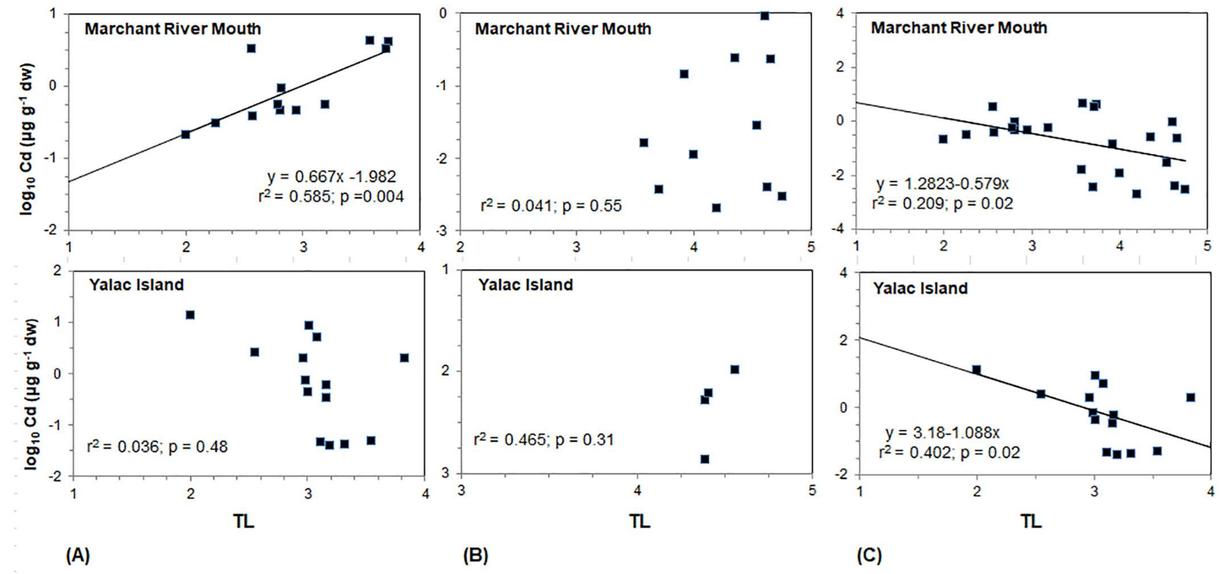

Figure 5.- Relationships between Cd concentration in organisms sampled at different locations of the Western Patagonia: Marchant River Mouth and Yalac Island) and their trophic level. (A) a simpler food web (data of macroinvertebrates); (B) data of fishes; (C) a more diverse food web (data of the whole food web).

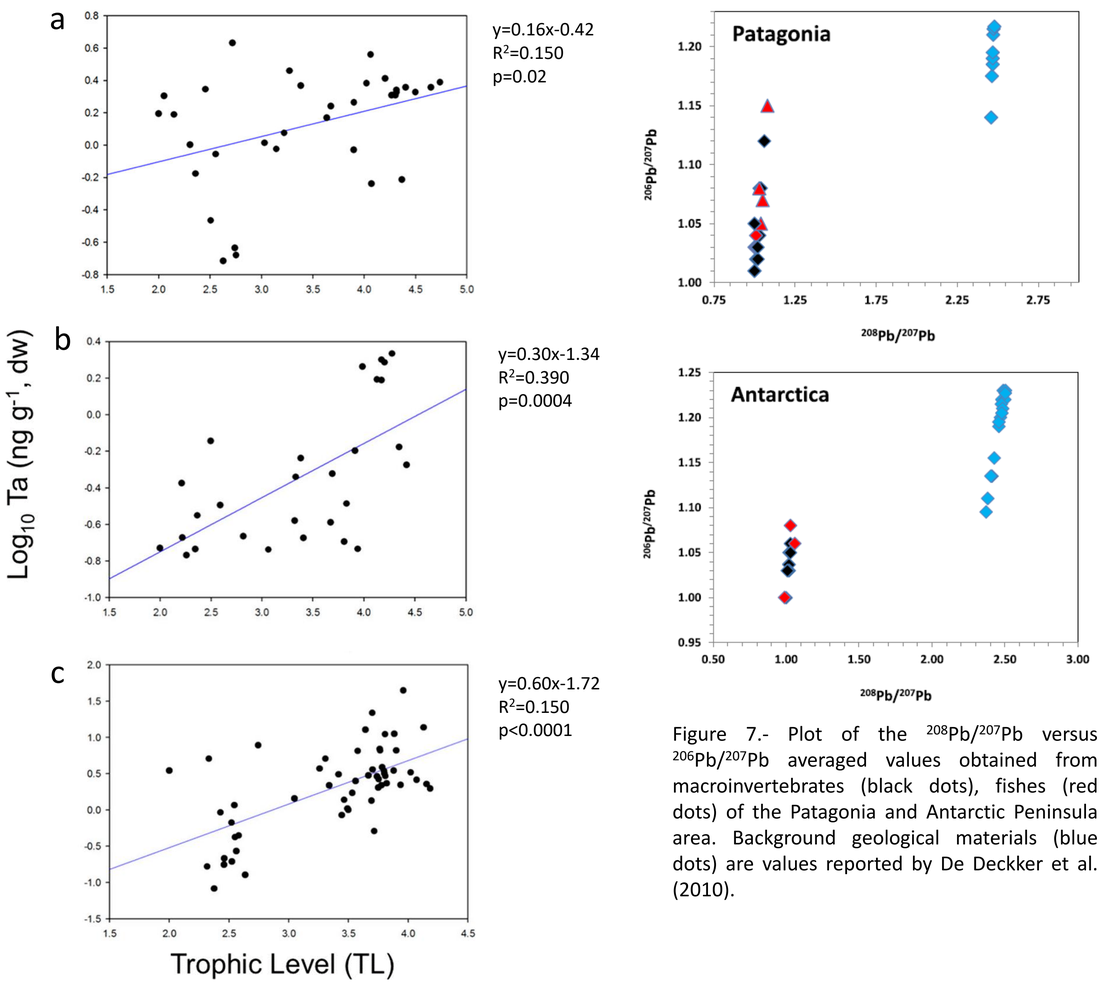

Figure 6.- Regressions of log Ta versus trophic level (TL) for fishes and macroinvertebrates collected from coastal, marine food webs in (a) Melimoyu-Marchant River Mouth; (b) Melimoyu La Leona Island: and (c) Antarctica- Fildes Bay).

Figure 7.- Plot of the $^{208}Pb/^{207}Pb$ versus $^{206}Pb/^{207}Pb$ averaged values obtained from macroinvertebrates (black dots), fishes (red dots) of the Patagonia and Antarctic Peninsula area. Background geological materials (blue dots) are values reported by De Deckker et al. (2010).

Conclusions

- For MeHg, there is a biodilution effect, as we include marine mammals and seabirds in the regressions (Fig. 4a).
- When we exclude those vertebrates, TMS are similar between the sites near freshwater inputs (MMR and APB), showing higher TMS than the offshore site (Fig. 4b).
- Cadmium shows biomagnification process, but it will depend on the site and foodweb structure and/or foodweb analysis:
  - In sites near freshwater inputs (MMR) it showed a positive BMF only when marine invertebrates were included (Fig. 5a).
  - When fish were included in the analysis, the BMF was negative → biodilution (Fig. 5c).
- We showed that a novel trace element as Ta biomagnifies in Patagonia and Antarctica (Fig. 6). It has a different environmental behaviour as evidence is showing BMF is lower near freshwater inputs and doubles from Patagonia to Antarctica.
  - There is still a question about effect of these novel, technologically critical elements in nature, as extraction is higher.
- As a proxy, stable isotopes ratio from Pb shows that Pb has a very different source from the geological background, both in Patagonia and Antarctica, probably anthropogenic (fig. 7).
- These results show the impact of human activities in biogeological cycles, even in isolated areas like Patagonia and Antarctica.

Acknowledgements

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