Mercury in the Antarctic pelagic ecosystem – *Pygoscelis* penguin and krill *Euphausia superba* – transfer from the food to the top predators

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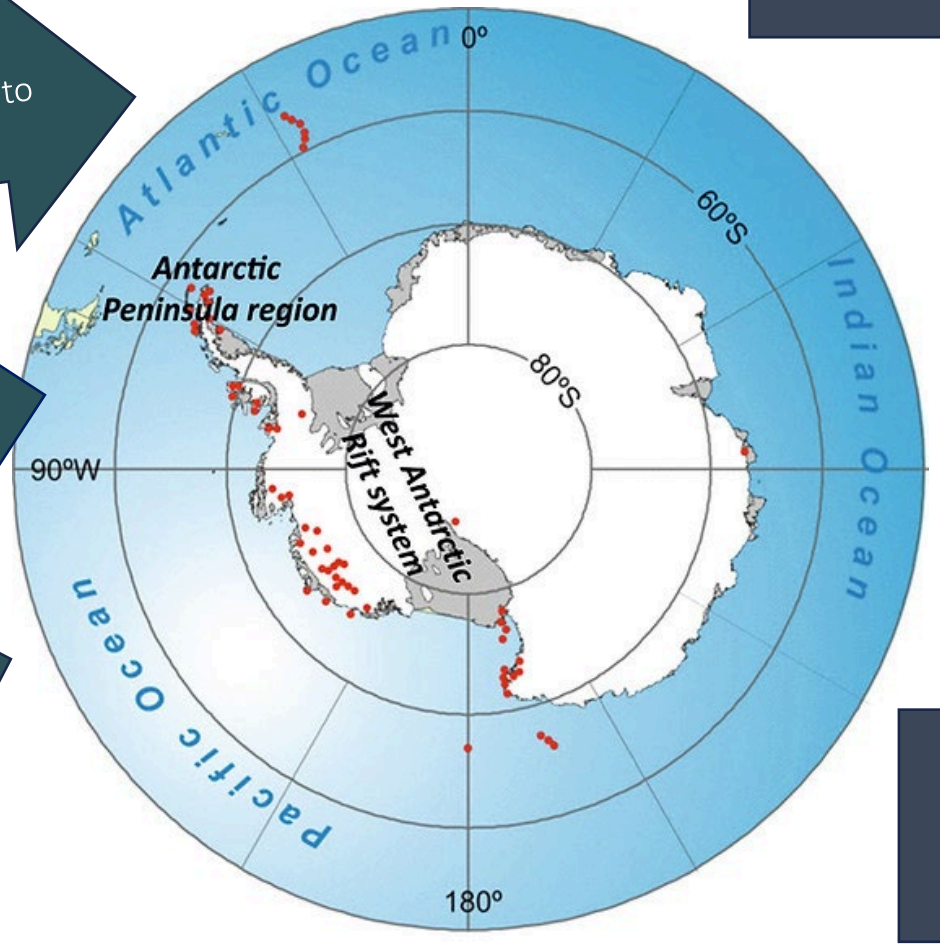
Hg sources in the Antarctic:

From urbanized areas through rivers to the seas and oceans.

Atmospheric transboundary transport.

Migrations of birds and mammals.



Human activities in the Antarctic region:

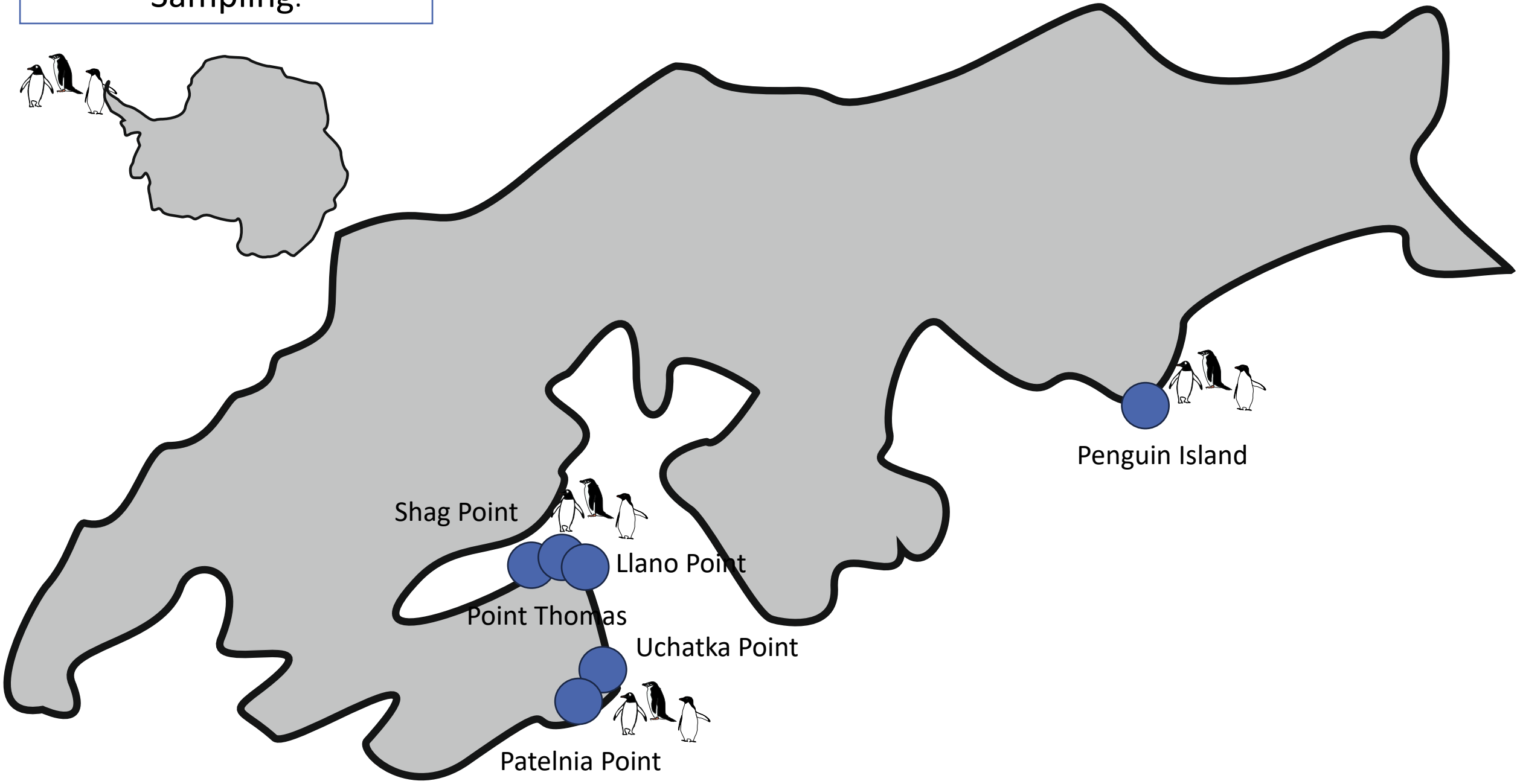
- research stations,
- tourism,
- fishing.

Natural sources:

- volcanoes

[www1]

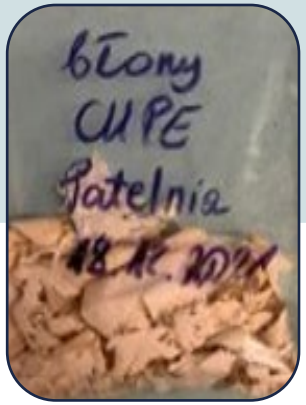
Sampling:


Penguin Island
Shag Point
Llano Point
Point Thomas
Uchatka Point
Patelnia Point

In the laboratory:

Samples: feathers, guano, eggshells

Analysis (Hg): Thermodesorption and atomic absorption spectrometry using a Hg analyzer (DMA 80)

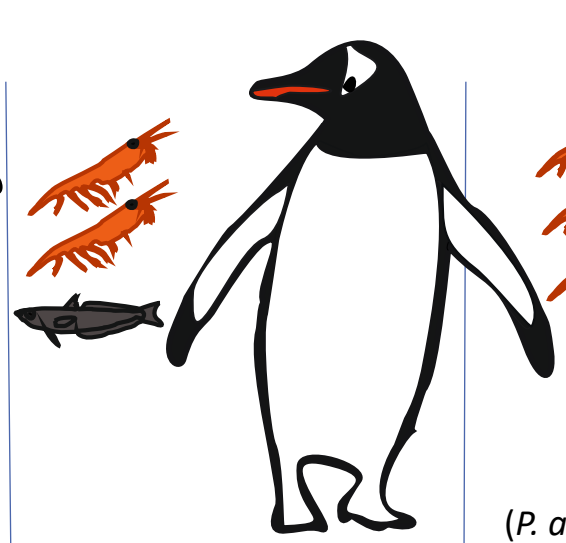


Pygoscelis penguins: **Adélies** (*P. adeliae,* Hombron & Jacquinot, 1841), **chinstraps** (*P. antarctica,* Forster, 1781) and **gentoos** (*P. papua,* Forster, 1781)

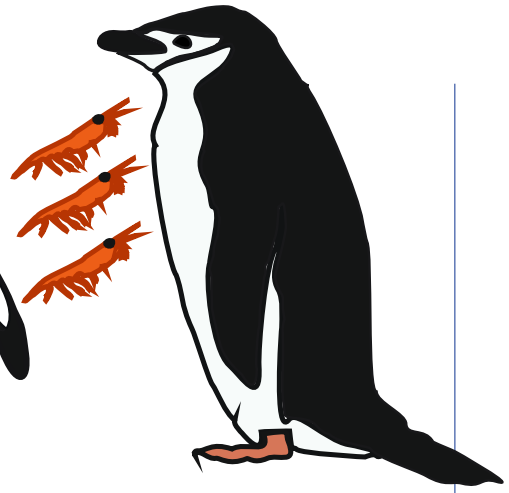
Why penguins

- ✓ easy access to colonies, stable breeding and feeding sites (Burger i Gochfeld, 2004; Elliott i Elliott, 2013),
- ✓ apex predators, well studied physiologically and behaviorally (Ainley, 2002, Boersma, 2008),
- ✓ inhabit the same geographic area but differ in many behavioral and ecological aspects, such as feeding habits, migration patterns, and breeding periods (Ancel i in., 2013, Black, 2016),
- ✓ their eggshells, guano and feathers are good, research-backed markers for studying environmental contamination.(e.g. Yin i in., 2008, Metcheva i in., 2011, Celis i in., 2012, Espejo i in., 2014), the collection of these samples is non-invasive.

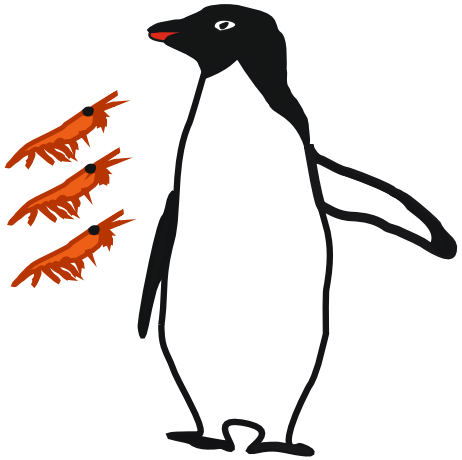
Pygoscelis penguins: **Adélies** (*P. adeliae,* Hombron & Jacquinot, 1841), **chinstraps** (*P. antarctica,* Forster, 1781) and **gentoos** (*P. papua,* Forster, 1781)



(*P. papua,* Forster, 1781)



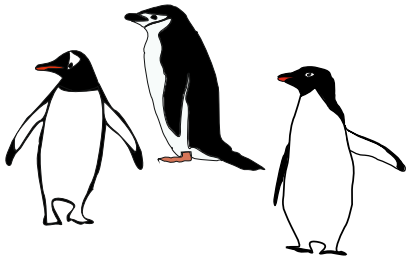
(*P. antarctica,* Forster, 1781)



(*P. adeliae,* Hombron & Jacquinot, 1841)

	Close to the colony	Drake Passage	Weddell Sea
	November	November – January	November - December
	January	December - February	December - January

Results:



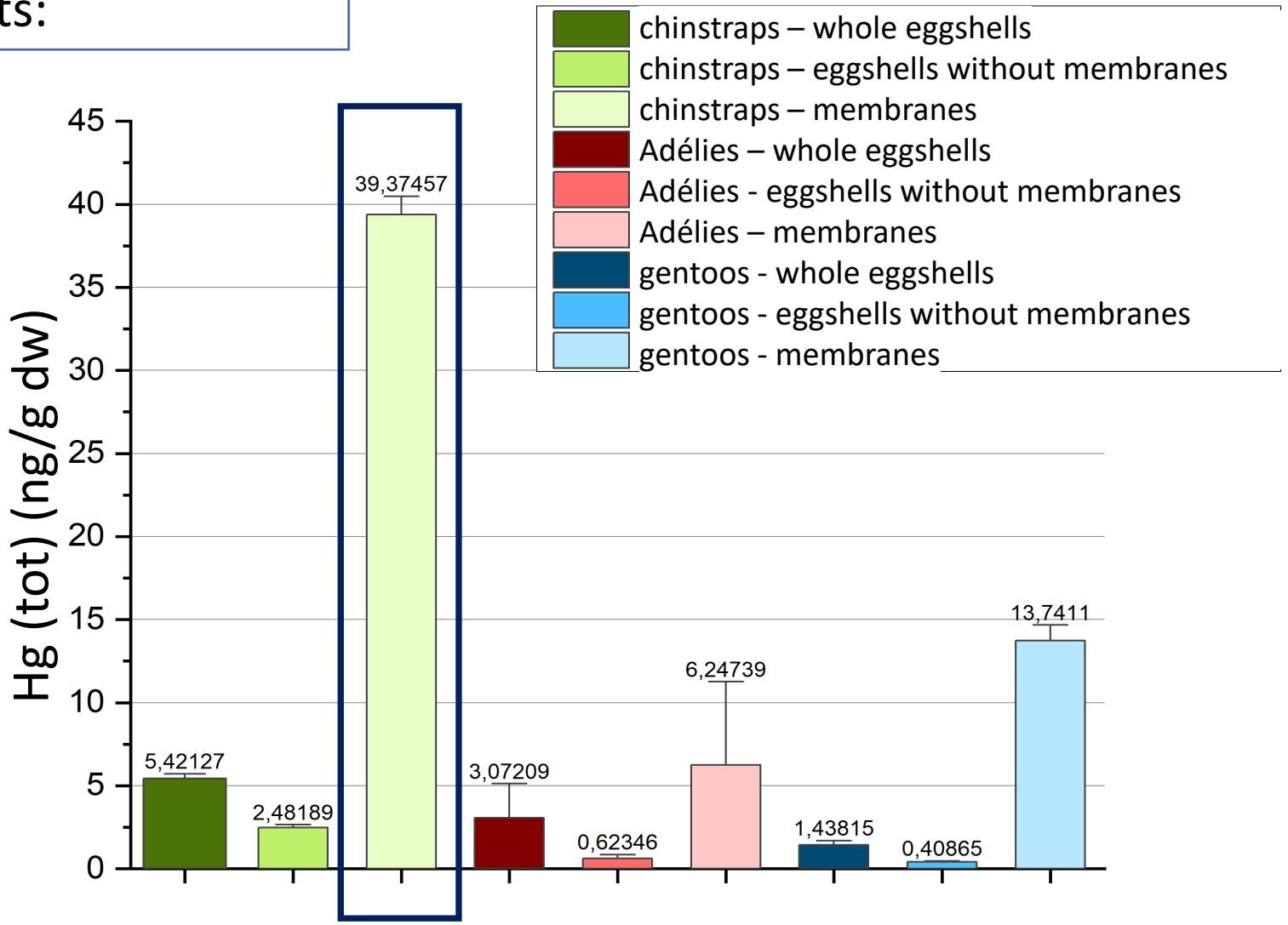
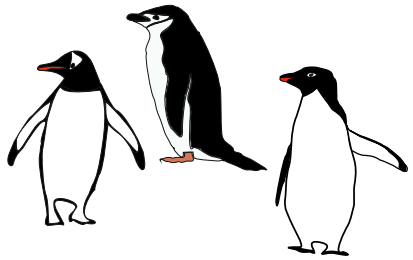


Figure 1. Average Hg(tot) concentration in eggshells (divided into: shells without membranes, whole shells, membranes only) of penguins of the genus *Pygoscelis.*

Results:



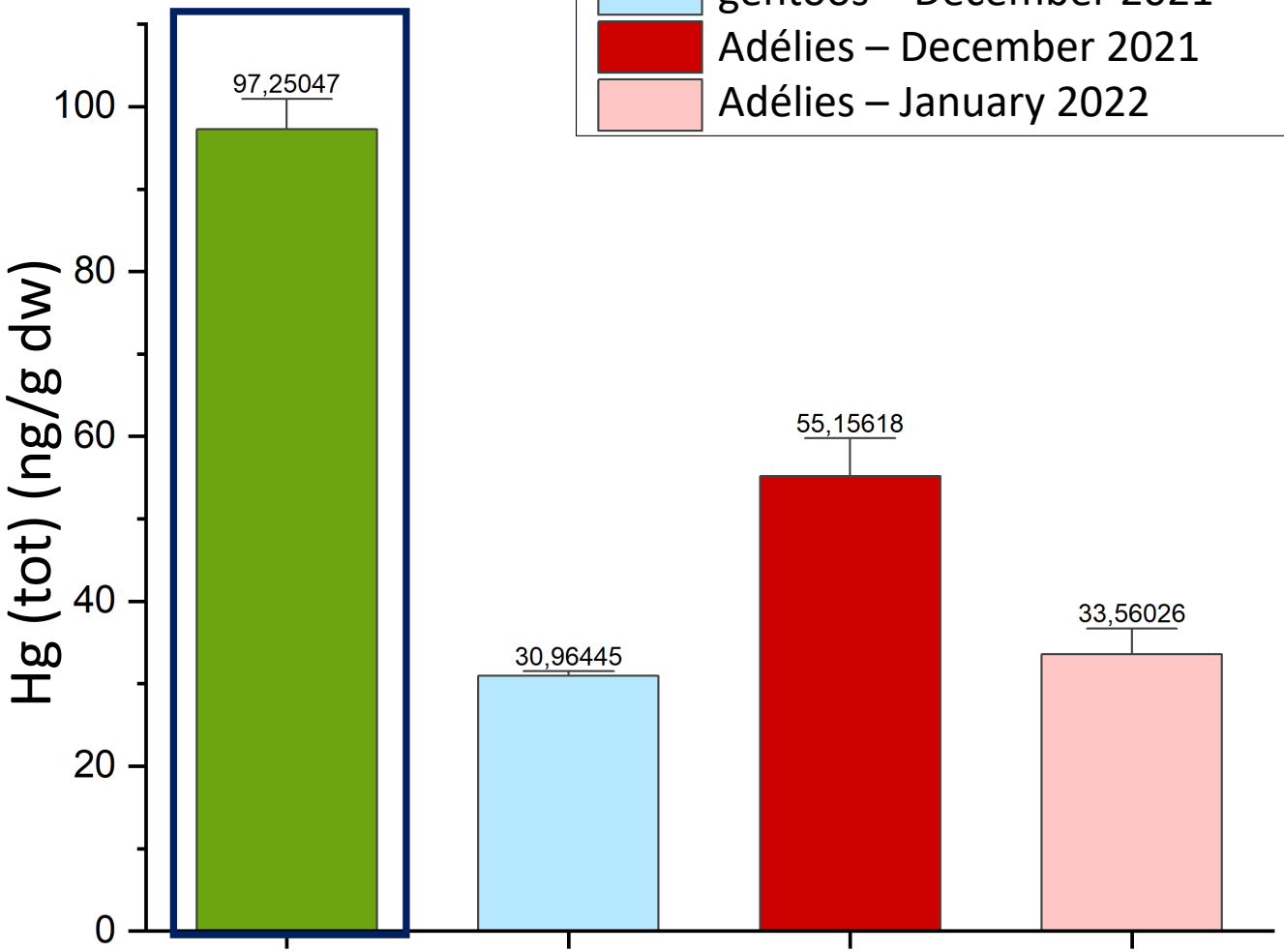
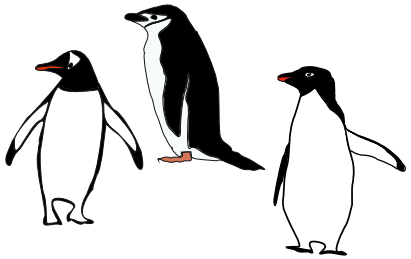


Fig 2. Average Hg(tot) concentration in guano of penguins of the genus *Pygoscelis*.

Results:



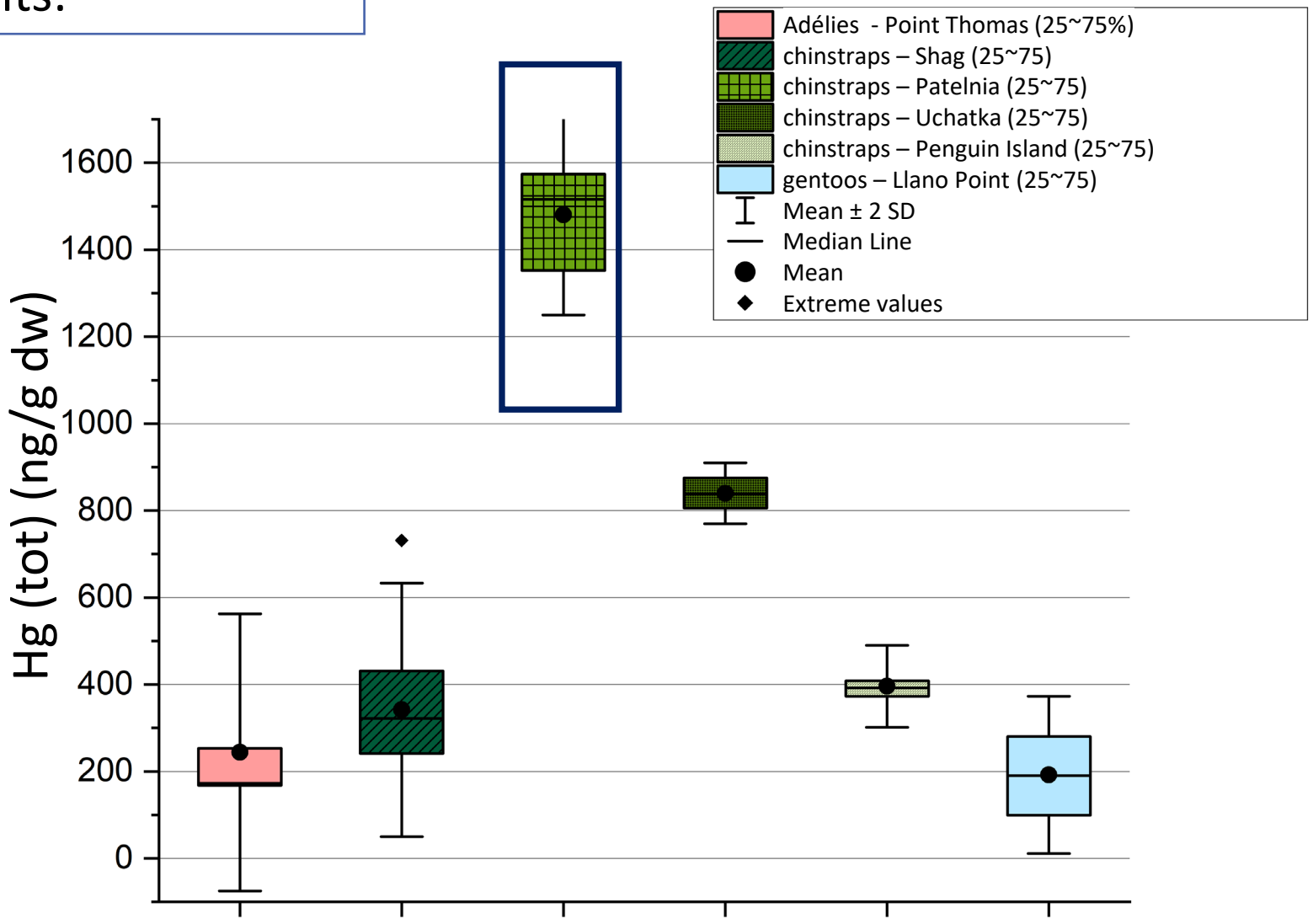
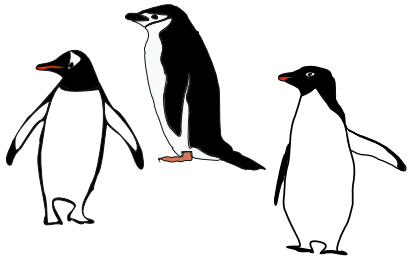


Fig 3. Mean Hg(tot) concentration in feathers of adult penguins of the genus *Pygoscelis*.

Results:



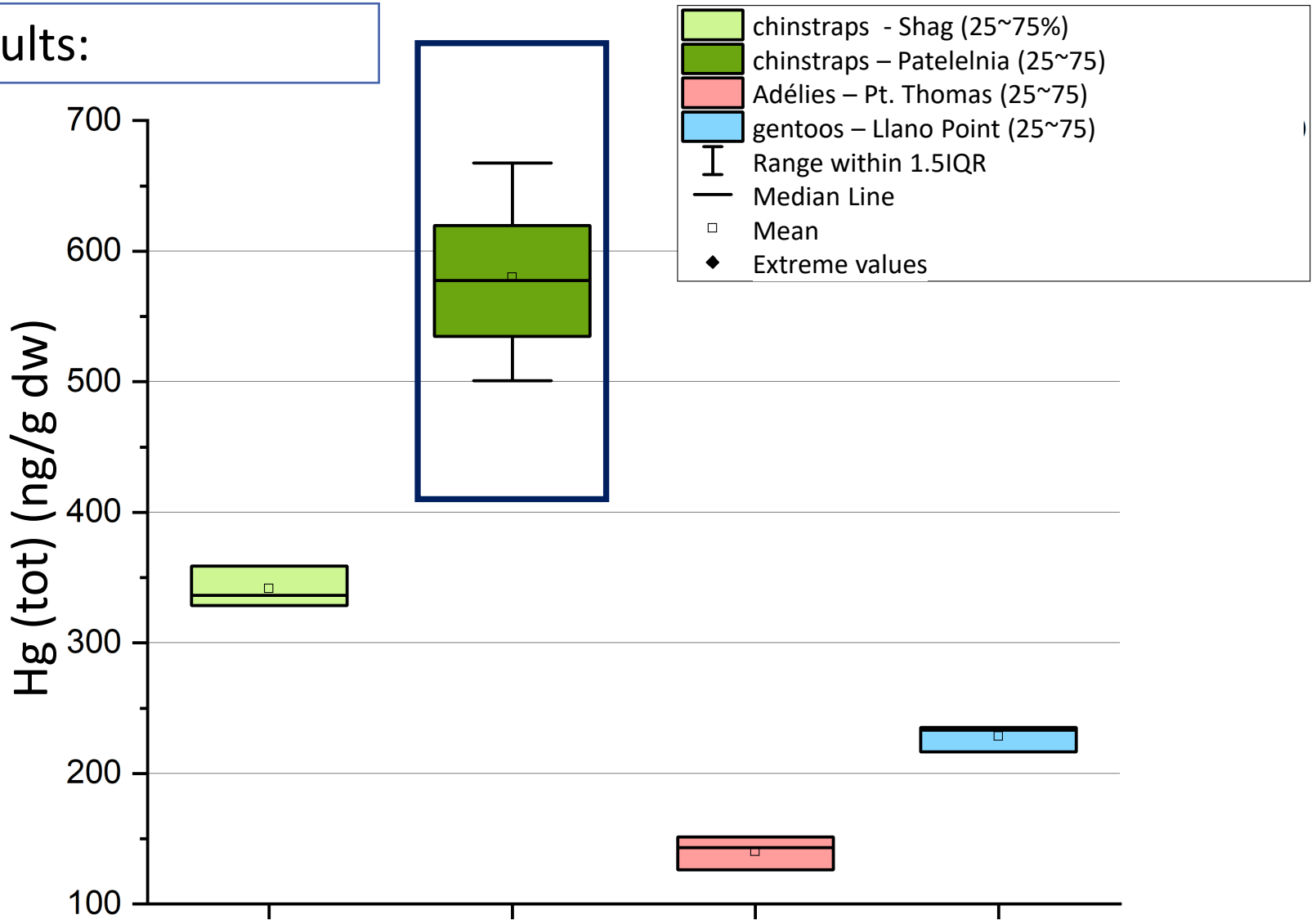
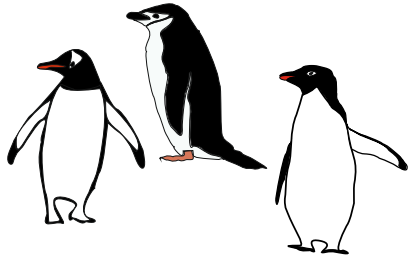


Fig 4. Mean Hg(tot) concentration in feathers of *Pygoscelis* chicks. Differences between all results are statistically significant.

Results:

Differences in Hg contamination between colonies



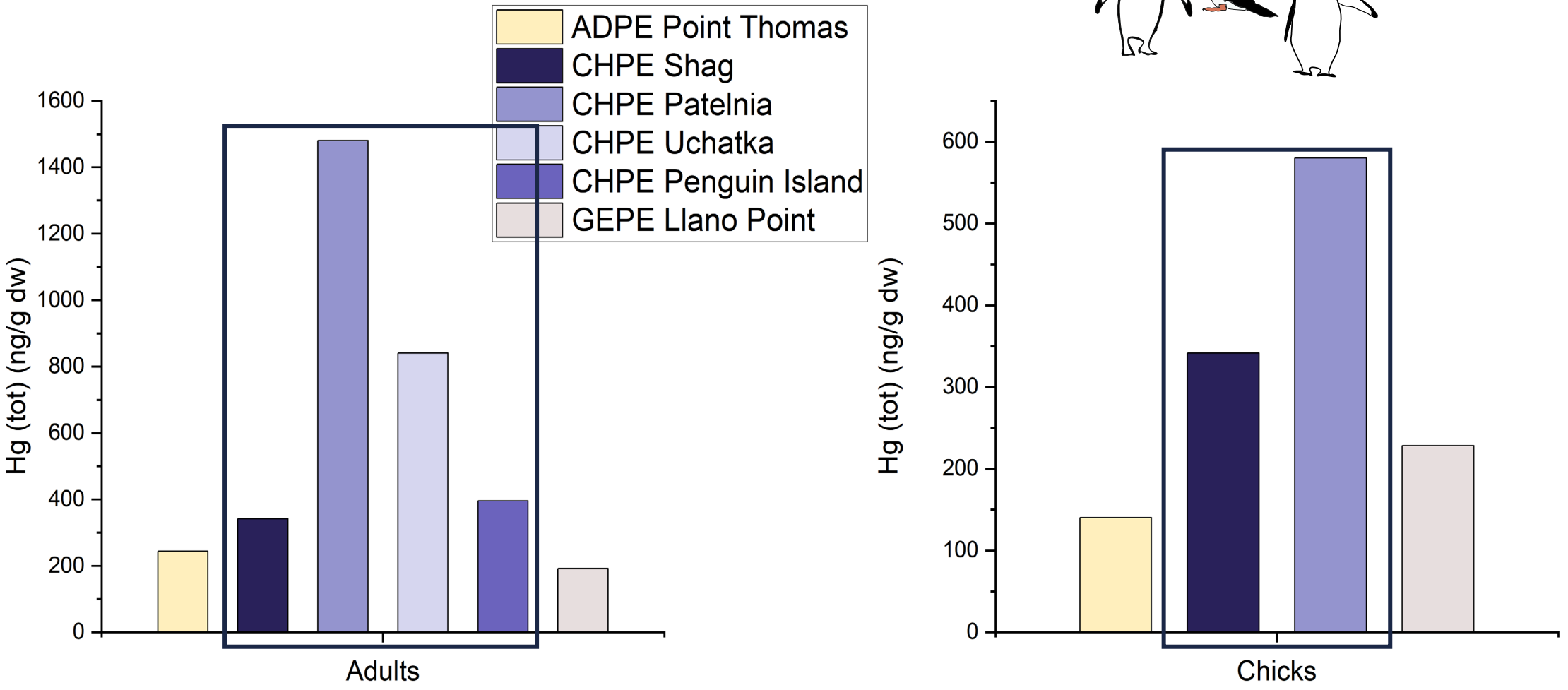
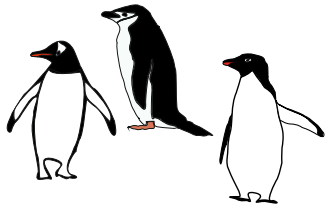


Fig. 5. Mercury concentrations in feathers of *Pygoscelis* penguins chicks and adults from different colonies at King George Island.

Discussion and conclusions: Research region *vs* other Antarctic areas



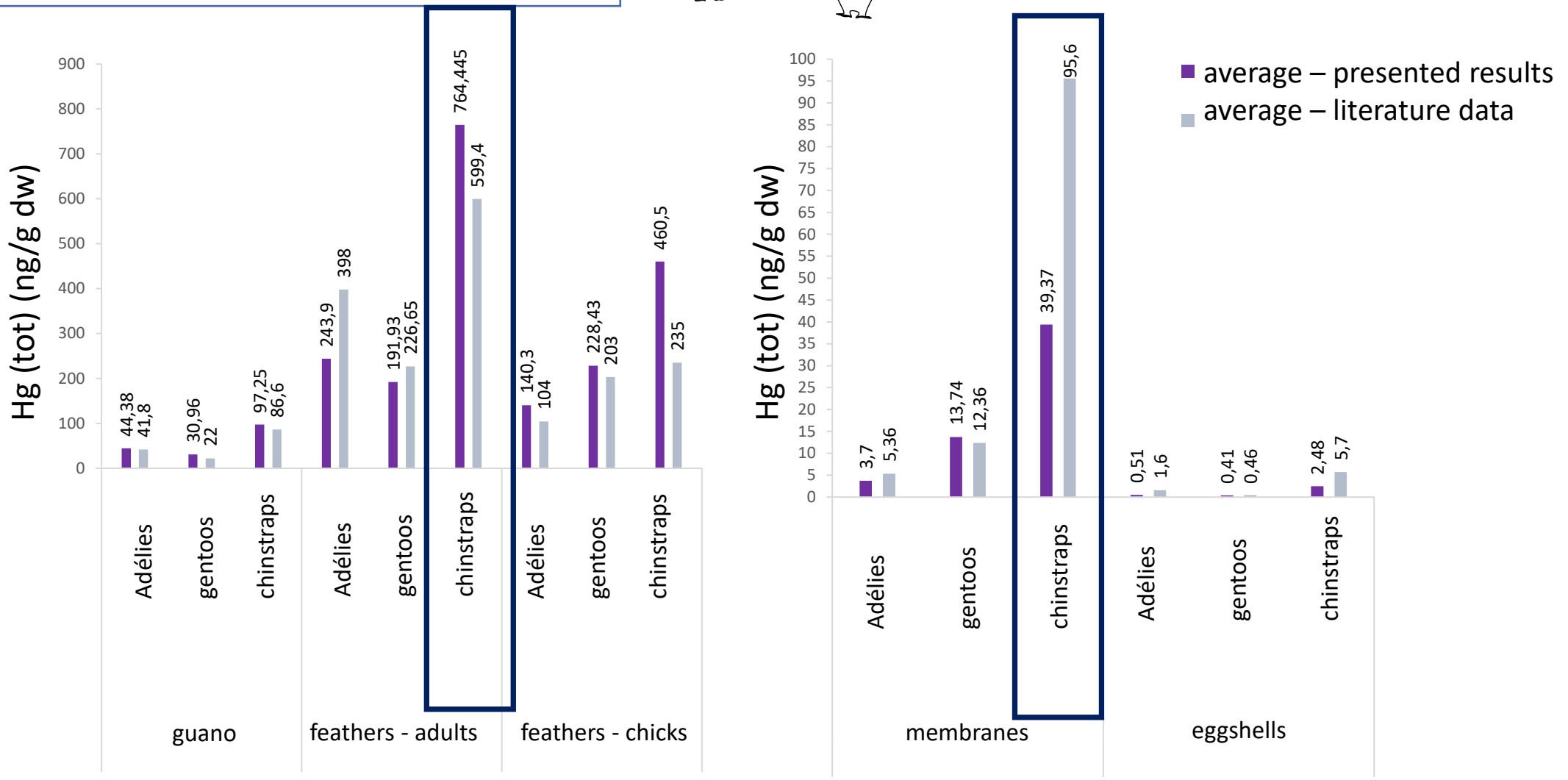
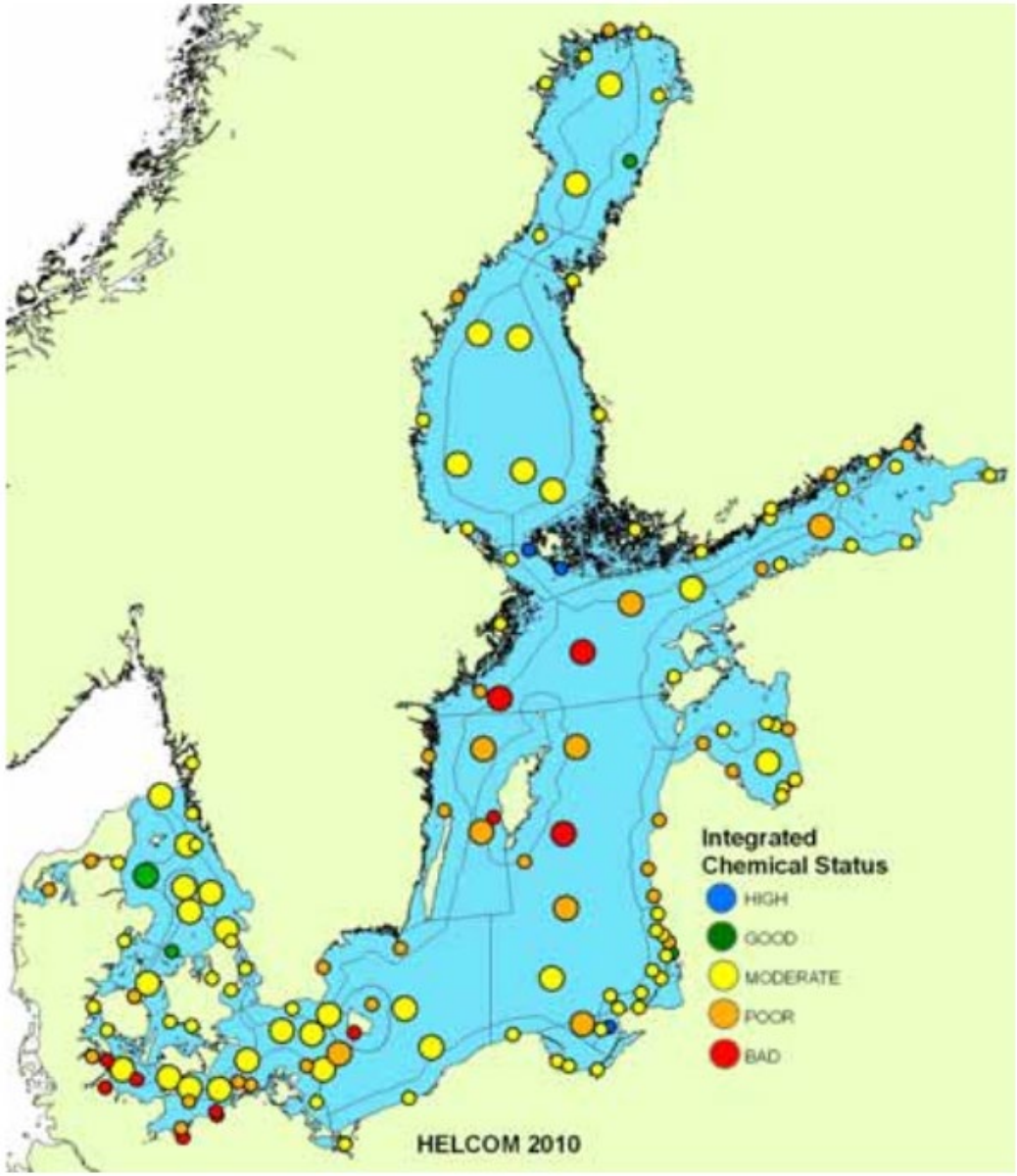


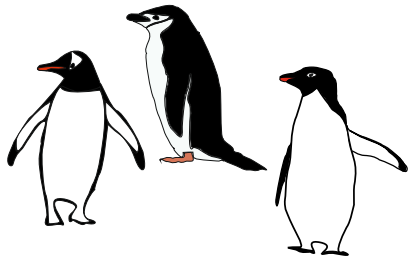
Fig. 6. Comparison of the obtained results with literature data.

Discussion and conclusions: Baltic Sea area *vs* Antarctic



Discussion and conclusions: Baltic Sea area *vs* Antarctic

Guano and feathers



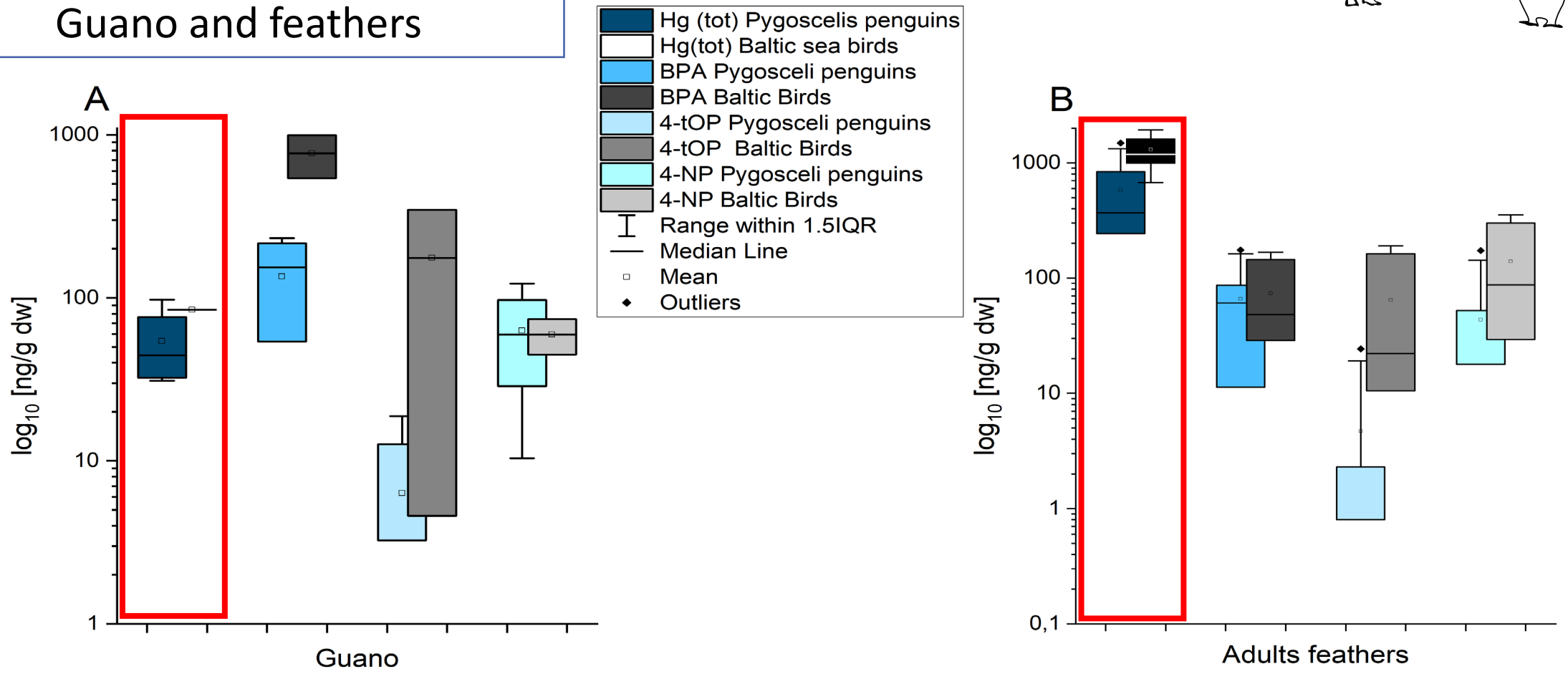
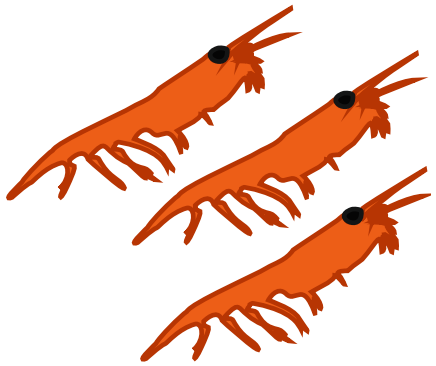
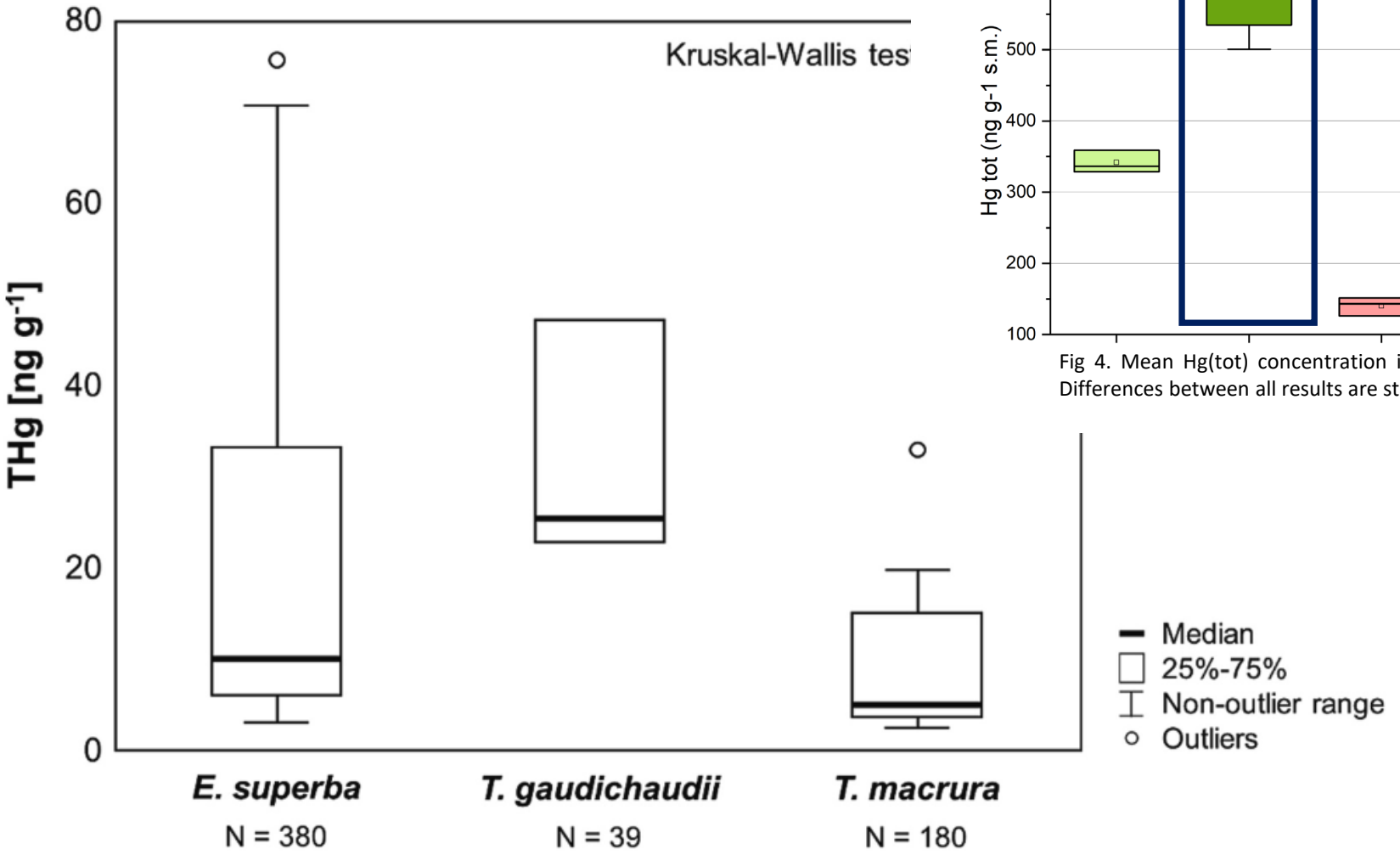


Fig. 7. Average mercury and phenolic compounds concentration in A: guano and B: feathers of *Pygoscelis* penguins from different colonies at King George Island vs bird communities from the Polish Baltic Sea Coast (Staniszewska et al., 2014, 2019; Bodziach et al., 2022, 2023).

Discussion and conclusions:
Hg in the Antarctic krill *Euphausia superba*





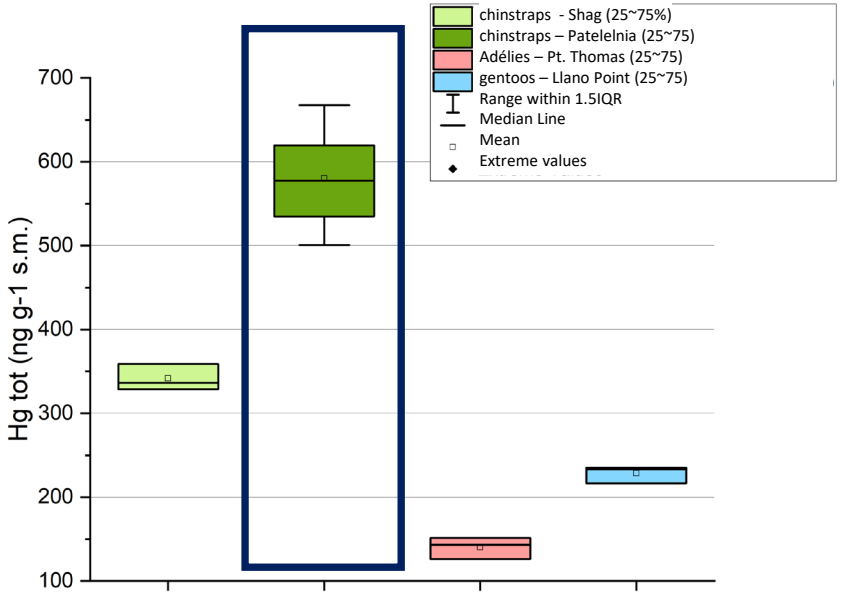


Fig 4. Mean Hg(tot) concentration in feathers of *Pygoscelis* chicks. Differences between all results are statistically significant.

Fig. 8. Total mercury concentration [ng g 1] in *Euphausia superba*, *Themisto gaudichaudii* and *Thysanoessa macrura* from the Western Antarctic Peninsula region, in 2018 (N is a number of organisms which were analyzed).

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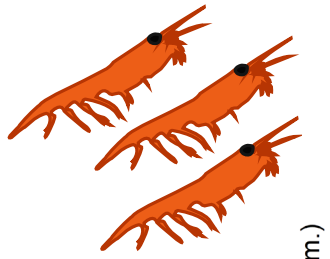
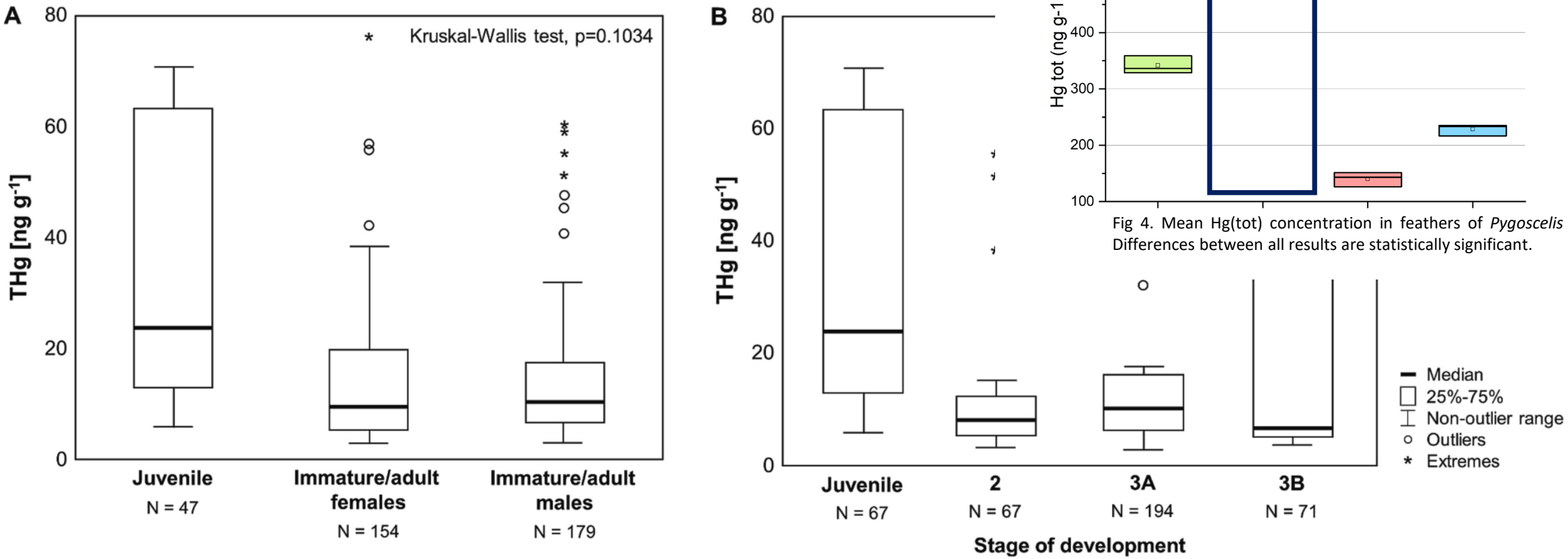
Discussion and conclusions:
Hg in the Antarctic krill *Euphausia superba*





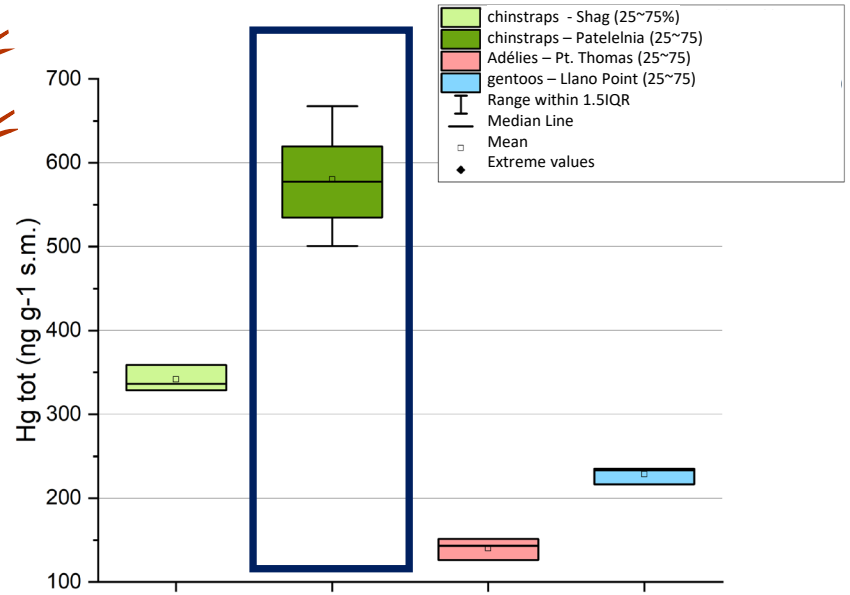


Fig 4. Mean Hg(tot) concentration in feathers of *Pygoscelis* chicks. Differences between all results are statistically significant.

Fig. 9. Total mercury [ng g 1] concentration in relation to sex (A) and developmental stage (B) of the Antarctic krill *Euphausia superba* from the Western Antarctic Peninsula region, in 2018 (N is a number of individuals which were analyzed).

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Discussion and conclusions:

Lower Hg accumulation in tissues of the Antarctic birds than in the Baltic sea (region under strong anthropressure), however, the difference smaller than expected.

The presence of tested contaminants in eggshells and chick feathers – detoxication process through eggs.
Pollution level differences - not only between species but also colonies of one species.

Need for monitoring, because:

1. Seabirds derivatives can be a secondary source of pollutants in their nesting environment
2. Knowledge of current concentrations of compounds with potential toxic effects on organisms provide the basis for determining the possible negative effect
3. Pollutants ability to interact – no data about synergistic effects on biota
4. Early-Warming signs of changes
5. Global Warming = ice melting = big addition of pollutants in the environment

Guano/feathers as useful tools for monitoring of Antarctic environment, however, telling two different stories.

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Thank you for your attention!