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Short Communication

First data on uranium uptake in three nototheniid fishes from Antarctica (James Ross Island)

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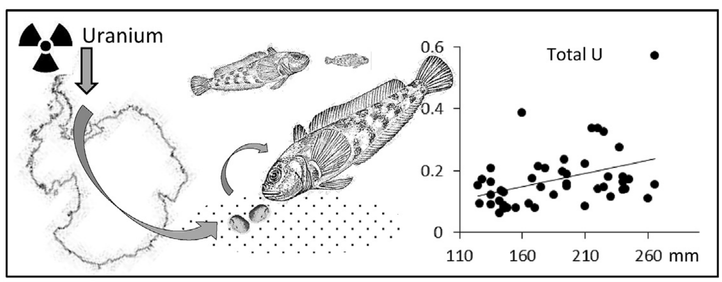
HIGHLIGHTS

- First quantitative baseline uranium levels presented for Antarctic nototheniids.
- Levels low but emerald rockcod show evidence of bioaccumulation.
- Bioaccumulation linked with dietary specialisation on molluscs?
- Possible links with atmospheric deposition and climate change.
- In depth trophic studies needed on Antarctic food-web dynamics.

GRAPHICAL ABSTRACT



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ABSTRACT

Recent studies have confirmed historic atmospheric deposition of uranium in Antarctica, with a steep and significant increase in levels deposited since the 1980s in Antarctic Peninsula ice core samples. To date, however, there has been little or no attention paid to uranium in the Antarctic food web. Here, we present results for uranium content in scales of three common nototheniid species (*Trematomus bernacchii*, *Gobionotothen gibberifrons*, *Notothenia coriiceps*) from coastal waters off James Ross Island (Antarctic Peninsula). While mean total uranium levels (mean ± SD) were low and similar between species (*N. coriiceps* 0.08 μg g^{-1} ± 0.01, *T. bernacchii* 0.17 μg g^{-1} ± 0.10; *G. gibberifrons* 0.11 μg g^{-1} ± 0.04), linear regressions against standard length indicated bioaccumulation in *T. bernacchii* (ANOVA, $F = 7.8349$, $P = 0.0076$). We suggest this may be the result of dietary specialisation on prey with calcareous shells that accumulate uranium. To the best of our knowledge, this paper provides the first quantitative baseline data on uranium levels in coastal Antarctic nototheniids. While the low levels recorded are unlikely to represent a threat within the food chain, we suggest that further long-term trophic studies (including stable isotope analysis) are needed, recognising that the feeding ecology of individual species (and even individuals) can have a strong effect on overall trends.

1. Introduction

A number of recent studies have noted a worrying increase in the level of uranium in Antarctic snow and ice cores (e.g. Planchon et al., 2002a, 2002b). Most recently, Potocki et al. (2016), using ice core data from the northern tip of the Antarctic Peninsula (see

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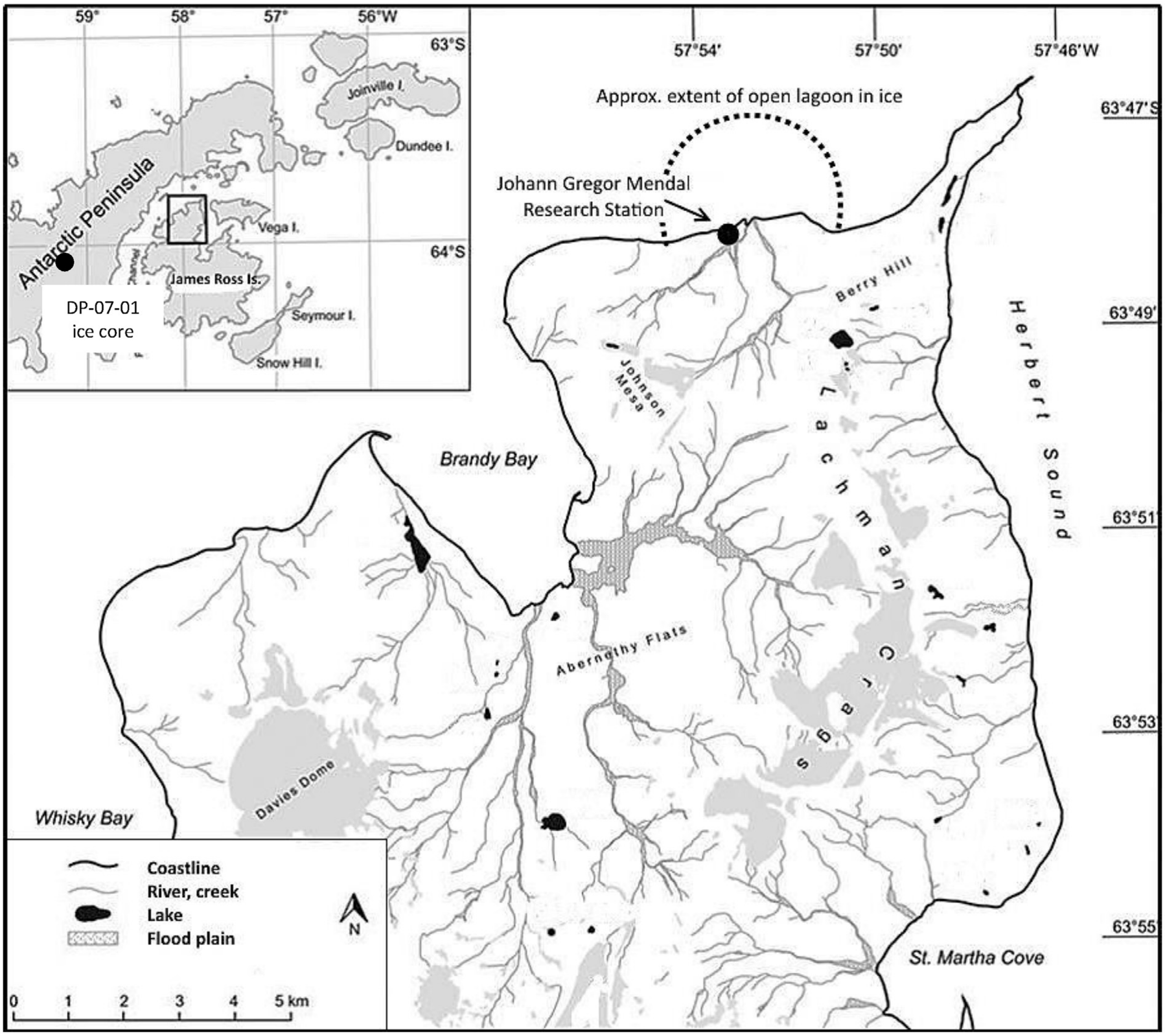

Fig. 1. Position of the Johann Gregor Mendel Polar Research Station on James Ross Island, The black dot in the insert indicates the approximate position of the DP-07-01 ice core on Detroit Plateau, northern Antarctic Peninsula (see Potocki et al., 2016).

Fig. 1), was able to show that there has been a steep and significant increase in atmospheric deposition of uranium over the Peninsula since the 1980s, with Australian mining operations the most likely source. In doing so, the authors stressed the need to assess the impacts of uranium exposure on Antarctic ecosystems, and an urgent requirement for baseline studies into the distribution of anthropogenic pollutants on ecosystem health (Potocki et al., 2016). This is of particular importance given the likelihood of increased meltwater run-off as temperatures and precipitation around the Peninsula increase due to climate change (Park et al., 1998; Simões et al. 1999, 2004; Thomas et al., 2004).

While different heavy metals are known to accumulate more in certain organs than others (e.g. Bustamante et al., 2003), a number of studies have shown that mineralised tissues, e.g. scales and bones, accumulate highest concentrations of uranium in a dose- and duration-dependent manner, particularly at low concentrations, making them the most sensitive indicators of environmental uranium exposure (Cooley et al., 2000; Cooley and Klaverkamp, 2000; Kraemer and Evans, 2012).

Here, we present data on uranium uptake in scales of three nototheniid fishes from coastal waters around James Ross Island (Antarctic Peninsula). By comparing individual uranium concentrations with fish standard length, we also assess whether there is any evidence for bioaccumulation.

2. Material and methods

2.1. Study site

James Ross Island (S 64°6.81967′, W 57°36.44228; 2600 km^2) is situated in the north-western sector of the Weddell Sea, close to the northern tip of the Antarctic Peninsula. The Czech Johann Gregor Mendel Antarctic Research Station (S 63°48.04823′, W 57°52.98268’; Fig. 1) has been located on the island since 2006 and human presence on the island is limited to seasonal visits by a small number of researchers. Power at the station is provided by solar and wind generators, with gasoline only used for emergency generator use. The island's climate is characterised by short summers (December–February) with mean air temperatures often higher than 0 °C, at which time the pack ice usually breaks up along the coast. Coastal substrate consists almost entirely of eroding rock, pebbles, gravel and sand, with no obvious organic sediment.