COULD ^{234}TH PARTITIONING IN SEAWATER BE KRILL-DRIVEN?

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Abstract
^{234}Th is considered a useful tracer of oceanic biogeochemical processes occurring over timescales of days to weeks. Traditionally, ^{234}Th -based particle export mathematical models have not taken into consideration the biological compartment, as typical zooplankton biomass values are not likely to result in significant biologically-mediated interactions with such models. However, recent experimental results for the Mediterranean krill *Meganyctiphanes norvegica* suggest that, if rapid ^{234}Th uptake by krill is not considered in the modeling, the occurrence of a synchronized molting event within a high-biomass krill school may result in an overestimation of ^{234}Th based particle flux by as much as one order of magnitude.
Keywords : Crustacea, Models, Particle Flux, Radionuclides.

Introduction
^{234}Th is a naturally-occurring radionuclide constantly produced in seawater by its soluble parent ^{238}U. Due to its high particle reactivity and relatively short half-life ($t_{1/2}$ = 24.1 days), ^{234}Th is commonly used as a proxy to estimate POC export from the upper oceanic water column [1]. This export is usually assessed by quantifying total ^{234}Th deficits with respect to its conservative parent nuclide ^{238}U in seawater (*ibid.*). Recent findings for three species of Antarctic crustaceans have suggested that under certain conditions krill-associated ^{234}Th would generate a several-fold positive export bias in depth-integrated ^{234}Th profiles [2]. Thus, we have tested this hypothesis by conducting analogous experiments using specimens of *Meganyctiphanes norvegica* krill collected in the NW Mediterranean.

Material and Methods
Live *Meganyctiphanes norvegica* from the NW Mediterranean were transported to the IAEA-MEL premises (Monaco), where they were acclimated for two weeks to laboratory conditions simulating their original temperature and light conditions (14°C; 37 p.s.u; darkness).
Specimens were individually placed in a 500 ml container containing 400 ml of natural filtered seawater spiked with ^{234}Th. The seawater was changed and the radionuclide spike was renewed daily. During seawater renewal operations, animals were fed shortly on a mixture of uncontaminated phytoplankton and freshly hatched brine shrimp larvae.
At different times, each individual was γ-counted (high-resolution γ-spectrometry system) alive to determine the radionuclide uptake kinetics. At the end of the 7.5-d exposure period, the individuals were placed for 10 d in new containers with clean filtered seawater that was renewed daily. Individuals were then γ-counted daily to determine radionuclide loss kinetics.

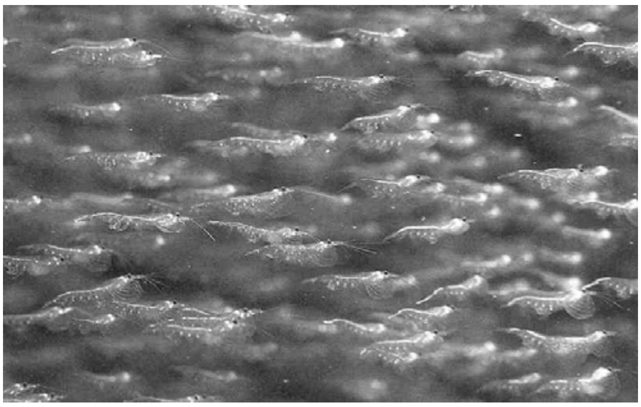

Fig. 1. *Euphausia superba* - Krill [3]

Results and Discussion
Krill rapidly took up ^{234}Th, reaching a steady-state concentration factor of about 200 in less than one week, and strongly retained the accumulated radionuclide until molting occurred. At 14 °C krill molt on average every 8 days [4], and during the experiment 9 molting events were observed which indicated that ca. 50% of whole-body ^{234}Th activity was associated with the exoskeleton.
Immediately following molting a corresponding amount of ^{234}Th was rapidly adsorbed on the newly formed cuticle. These results, coupled with published values of krill densities as high as 100 g l^{-1} [5] (Fig. 1) which commonly occur in the Southern Ocean suggest that ^{234}Th bioaccumulation could result in up to >90 % of total water-column ^{234}Th being associated with krill (Fig. 2). Hence, the occurrence of a synchronized molting event [4] within a high-biomass krill school could cause the ^{234}Th distribution in the water column to be almost entirely a result of radionuclide uptake by these organisms and consequently bias the results of traditional ^{234}Th based models by more than one order of magnitude.

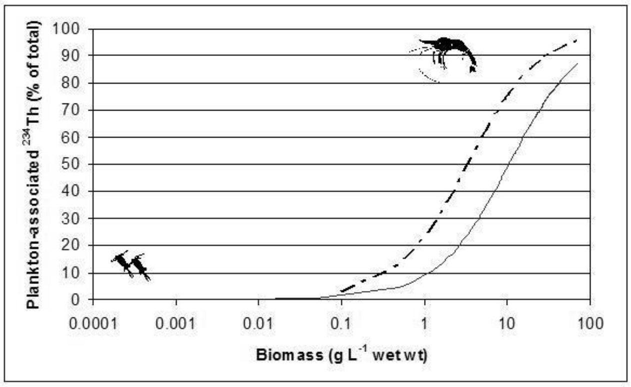

Fig. 2. CF-based computation representing the fraction (%) of total ^{234}Th in the water column associated with different biomasses of crustacean zooplankton (g l^{-1} wet wt), based on mean CF derived from experiments on Antarctic isopods and amphipods (fine dashed line [2]) or on Mediterranean krill (heavy solid line; present study).

References
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