BIOACCUMULATION OF HEAVY METALS AND RADIONUCLIDES IN THE JELLYFISH *CASSIOPEA ANDROMEDA* AND *AURELIA AURITA* (CNIDARIA, SCYPHOZOA)

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Abstract

Experimental radiotracer studies show that both benthic (*Cassiopea andromeda*) and pelagic (*Aurelia aurita*) jellyfish readily accumulate heavy metals (Co, Zn, Ag and Cd) and radionuclides (^{137}Cs, ^{241}Am) from water and food and retain them for long periods of time with biological half-lives (Tb1/2) ranging from a few days to several weeks. Zinc and Ag were accumulated to the greatest degree (CF ~ $4x10^2$) with the benthic species showing a greater affinity for the metals than the pelagic form. Light-dark uptake experiments suggest that endosymbiotic zooxanthellae in *C. andromeda* may account for the enhanced uptake and retention capability noted in this species.

Keywords : radionuclides, bioaccumulation, Cnidaria, metals, medusae

Introduction

Jellyfish are prey for numerous invertebrate and vertebrate species and as such play a central role in the trophic organization of many marine foodchains. Furthermore, they are known to prey abundantly and selectively upon certain zooplankton species including fish larvae (1), and thereby may exert a major impact on the structure and dynamics of mesozooplankton communities as well as fish stocks (1, 2). Their impact on the environment is particularly important during summer blooms, when jellyfish may occur in very dense aggregations containing millions of individuals (3). Despite the well-known ecological importance of jellyfish, data are extremely sparse on the accumulation of metals in coelenterates (4) although their abundance, trophic position, and planktonic behaviour suggest they can affect the fluxes and fate of these contaminants in marine waters. Therefore, our objective in this study was to investigate the biokinetics of heavy metal and radionuclide transfer in jellyfish in order to assess their role in the marine fluxes of these contaminants.

Material and methods

Two jellyfish species, the benthic *Cassiopea andromeda* and the pelagic *Aurelia aurita*, were acclimated to laboratory conditions (open circuit aquaria; water renewal 10% per hour; salinity 38‰, T=18±1°C ; fed daily with *Artemia salina* nauplii) for approximately 8 weeks prior to experimentation. Both species were then experimentally exposed to radiotracers of four heavy metals (^{57}Co, ^{65}Zn, ^{110m}Ag, ^{109}Cd) and two long-lived artificial radionuclides (^{134}Cs, ^{241}Am) directly from water or through their food (viz. *Artemia* nauplii previously exposed to the tracers for 48h). Using gamma spectrometric techniques (5), uptake and excretion of the radioisotopes were followed in whole animals for 1-3 months to determine concentration factors (CF), assimilation efficiencies (AE), and retention (Tb_) of the contaminants. Tissue distribution of the isotopes was also determined by dissection. In addition, the possible influence of the symbiotic zooxanthellae on contaminant bioaccumulation in *C. andromeda* was examined by performing uptake experiments under light and dark conditions.

Results & discussion

With either exposure mode (sea water or food), ^{110m}Ag and ^{65}Zn were the metals accumulated to the greatest degree by both jellyfish species (Table 1). Furthermore, in all cases both radionuclides, ^{134}Cs and ^{241}Am, were always taken up much less efficiently and lost more rapidly than the heavy metals. Except in case of zinc which was taken up with similar efficiency by the two species, *C. andromeda* accumulated all other isotopes much more efficiently than *A. aurita* (Table 1).

Dissection of *C. andromeda* showed that the vesicles, situated along the arms and containing the endosymbiotic zooxanthellae, always displayed the highest CF for the metals tested. The CFs in vesicles ranged from 110 ± 8 (^{57}Co) to 1080 ± 230 (^{110m}Ag), and were 2 to 17 times higher that those calculated in the other body compartments (viz. umbrella, tentacles, gut and mesoglea). This suggests that autotrophic metabolism of the photosynthetic zooxanthellae is actively involved in metal uptake by this jellyfish. Indeed, all the metals were more readily concentrated by jellyfish under light conditions (Table 1). In contrast, no significant difference was observed in uptake of the radionuclides under light and dark conditions.

Elimination of metals and radionuclides previously accumulated via seawater was also species dependent. Retention capacity for metals in *A. aurita* was quite weak in that all the accumulated isotopes were rapidly excreted with biological half-lives (Tb1/2) ranging from only 3 to 6 days, whereas *C. andromeda* retained metals much more efficiently with Tb1/2 ranging from 25 to 60 days. Accordingly, zooxanthellae may also be involved in the processes of metal release.

The feeding experiments demonstrated that, except for ^{134}Cs and ^{241}Am, both jellyfish species readily accumulated and assimilated these metals from their prey. Furthermore, heavy metal assimilation efficiency (AE) and resultant retention ($T_{b1/2}$) were always higher in *C. andromeda* (AE, 65 to 94%; $T_{b1/2}$, 28 to 65 days) than in *A. aurita* (AE, 37 to 57%; $T_{b1/2}$, 20 to 29 days).

Table 1. Whole-body concentration factors calculated in jellyfish exposed to radioisotopes for 14 days in sea water.

Isotope	*A. aurita*	*C. andromeda* (in light)	*C. andromeda* (in dark)
^{57}Co	6.0 ± 0.5	82 ± 3.9	64 ± 2.2
^{65}Zn	317 ± 37	412 ± 39	281 ± 23
^{110m}Ag	28 ± 3.2	455 ± 25	305 ± 10
^{109}Cd	20 ± 3.3	224 ± 16	148 ± 11
^{134}Cs	1.6 ± 0.2	3.6 ± 0.4	4.1 ± 0.5
^{241}Am	1.2 ± 0.2	12 ± 1.3	10 ± 0.6

Conclusions

These radiotracer studies have shown that jellyfish take up heavy metals and retain them in their tissues quite efficiently, in particular Zn and Ag. Both sea water and food are important pathways for metal accumulation in their tissues. Metal assimilation from food was particularly elevated in *C. andromeda*. High metal assimilation from ingested prey coupled with a strong retention in jellyfish tissues indicates that over the long term, dietary intake might be the predominant source of metal contamination in this benthic medusa. Jellyfish, which are key representatives of the gelatinous plankton community, constitute an important biomass in the oceans. Given they are also efficient metal bioaccumulators, jellyfish likely play an important role in biological transfer and recycling of heavy metal contaminants in the marine environment.

References

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