# PHYLOGENETIC CONSISTENCIES IN RADIONUCLIDE AND METAL ACCUMULATION BY TELEOST AND CHONDRICHTHYAN FISHES OF THE MEDITERRANEAN

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## Abstract

There is a need to explain why different organisms contrast greatly in their capacities to accumulate trace element contaminants. Such understanding will enhance predictive ecological risk assessment for these contaminants and permit better evaluation of the 'reference organism' approach to radiation protection [1,2,3]. More fundamental biological explanations of these differences in bioaccumulation between different organisms are yet to be achieved. Experimental investigations have shown consistencies within teleost and chondrichthyan fish in their patterns of bioaccumulation of multiple trace elements. Such patterns are indicating phylogenetically-based predispositions for elevated boaccumulation and internal exposures among these contaminants.

*Keywords: Teleostei, Bio-Accumulation, Elasmobranchii, Metals, Radionuclides*

To test the hypothesis of taxon-based bioaccumulation patterns we had previously conducted a 14 day uptake/ 29 day loss experiment of uptake from seawater that compared the whole-body uptake and loss kinetics of seven radiotracers in a teleost (turbot- *Psetta maxima*) and chondrichthyan (lesser dogfish- *Scyliorhinus canicula*) . This experiment showed appreciable differences ($P \leqslant 0.01$) between the two species in their rates of accumulation for multiple elements (eg. Am-241, Zn-65 and Cs-137) [4], which were great enough to warrant further assesment of the hypothesis, as described below. A set of nine radiotracers in seawater were used for an experimental exposure that compared their whole body: water concentration factors at 14 days in each of three teleosts and three chondrichthyans. Radiotracers included the anthropogenic radionuclides $^{54}$Mn, $^{60}$Co, $^{65}$Zn, $^{134}$Cs and $^{241}$Am that are typically released into coastal waters from nuclear power stations, and that could be expected to increase in the future due to enhanced nuclear power programs that are planned. Radiotracers of Cd, Ag and Se were also included as they are contaminants that are commonly elevated in coastal waters due to effluents from land-based sources. Teleost fish species were turbot *Psetta maxima*, Order Pleuronectiformes, Family Psettodidae, sea bream *Sparus aurata*, Order Perciformes, Family Sparidae and sea bass *Dicentrarchus labrax*, Order Perciformes, Family Serranidae. The chondrichthyans were dogfish *S. canicula*, Order Carcharhiniformes, Family Scyliorhinidae, undulate ray *Raja undulata*, Order Rajiformes, Family Rajidae and spotted torpedo *Torpedo marmorata* Order Torpediniformes, Family Torpedinidae. Discriminant function analysis was used to determine an equation to best separate between dogfish and turbot on the basis of their CFs among 7-9 radiotracers. This function could then be used to objectively classify individuals of the other chondrichthyan and teleost species used in this experiment, as being closer to the *a priori* chondrichthyan or teleost 'bioaccumulation model'. Hierarchical classificatory, multi-dimensional scaling (MDS) and similarity (ANOSIM & SIMPER) analyses were also used to further assess the hypothesis of different bioaccumulation characteristics for species of teleosts and chondrichthyans. These analyses also identified those trace elements that were most different between them in their bioaccumulatory capacities. Discriminant function analysis on whole body: water concentration factors (CFs) for 7-9 radiotracers separated dogfish and turbot in the two independent experiments. Associated classification functions grouped the teleosts, seabream and most seabass with turbot and the chondrichthyans, undulate ray and spotted torpedo with dogfish, thus supporting our initial hypothesis of taxon-based boacumulation patterns. Hierarchical classificatory, multi-dimensional scaling and similarity analyses also separated all three teleosts from all chondrichthyans that were more diverse amongst themselves compared to teleosts. Dogfish were the most distant from teleosts, followed by the undulate ray and then torpedo. Among the several multivariate statistical techniques that were used to compare between taxa there were trace elements that were repeatedly more prominent in determining the separations between teleosts and chondrichthyans, based on their CFs, viz. Cs-134 was consistently elevated in teleosts and Zn-65 was elevated in chondrichthyans. Chondrichthyans were also higher in Cr-51, Co-60, Ag-110m and Am-241, whereas teleosts were higher in Mn-54. Our results suggest that chondrichthyans may be more susceptible to contamination from exposures in seawater for a greater range of trace elements, compared to teleosts.

## References

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