#### Transfer factors in marine biota:

Further evaluation of the phylogenetic bioaccumulation hypothesis Fish taxa: distributions in body components Life cycle radioecology Amphioxus the hyper-accumulator: longer-term experiment

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### Phylogenetic bioaccumulation hypothesis.....

- The working hypothesis:
  - a) Evolutionary divergent organisms have different patterns of bioaccumulation of trace elements
  - b) The greater the period of divergence the greater the differences

Hypothesis tested by short-term experimental bioaccumulation from seawater of multiple radiotracers (whole body + body component CFs);
 <sup>54</sup>Mn, <sup>60</sup>Co, <sup>65</sup>Zn, <sup>109</sup>Cd, <sup>110m</sup>Ag, <sup>75</sup>Se, <sup>134</sup>Cs, <sup>241</sup>Am, <sup>51</sup>Cr

#### • Outcomes

- Differences demonstrated can subsequently be interpreted in terms of differences in physiology and anatomy
- Can identify 'at risk' taxa, relative to reference organisms



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## Most primitive ray-finned fish- the African bichir

Mitogenomic-based phylogenetic relationships of fishes (Inoue et al., 2003)





Order: Polypteriformes Family: Polypteridae Genus: *Polypterus* 



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## MDS analysis.....







# Comparisons of tissue distributions of among bony and cartilagenous fishes.....

#### • The picture based on whole body CFs



• point of separation between all chondrichthyans and teleosts

• the majority of individual fishes group in species-specific clusters lower in the dendrogram

• the three teleost species are less diverse among themselves than the chondrichthyans



# Comparisons of tissue distributions of among bony and cartilagenous fishes.....



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# Comparisons of tissue distributions of among bony and cartilagenous fishes.....





#### Maternal transfer to eggs .....the 4<sup>th</sup> exposure pathway



#### Experimental design





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#### Maternal transfer to eggs ..... Maternal to embryo <sup>65</sup>Zn <sup>60</sup>Co transfer factors; 150 5.0 · Total activity in eggs Total activity in eggs 4.0 ٠ y = 0.0003x R<sup>2</sup> = 0.6484 y = 0.0007x. 100 • 3.0 $R^2 = 0.7261$ 2.0 50 1.0 0.0 0 5000 10000 100000 50000 Total activity ingested by mother Total activity ingested by mother <sup>65</sup>Zn 60Co 300 100 Pattern of post-feeding 250 reductions in maternal 200 150 100 % retained 50 transfer to egg 100 50 0 0 0 50 100 150 200 50 150 200 0 100 days days



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## Maternal transfer to eggs .....



#### Feeding phase



# <sup>65</sup>Zn







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# Full term patterns of accumulation in a dogfish egg for 8 trace elements - *Total egg: water CFs*

•Change of slope when apertures in case are opened

•Continual increases with period of exposure to labelled seawater for Ag, Zn, Co, Am.







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# Full term accumulation patterns in the dogfish embryo and its egg case; *water to tissue CFs*



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# Transfer to hatched pup from water exposure pathway.....

	Water: Dogfish pup CFs
Mn-54	0.4
Co-60	0.8
Zn-65	15.1
Se-75	1.7
Ag- 110m	64
Cd-109	0.3
Cs-134	0.1
Am-241	1.8







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## Amphioxus the hyper-accumulator

• A previous experiment indicated high capacity to accumulate all 8 radiotracers from seawater, compared to bony and cartilagenous fish







## Amphioxus the hyper-accumulator





Days

10

0



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20

30

## Amphioxus the hyper-accumulator







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### Experimental programme for 2010/2011.....

• Marine reference organisms;



• Fish;

African lungfish-class Sarcopterygii





 Phylum Hemichordata and Subphylum Urochordata





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#### Conclusions.....

- Results are still generally consistent with the working hypothesis of phylogenetically-based bioaccumulation patterns in marine fishes, freshwater fishes, cephalochordata and sponges, based on whole body: water CFs, *viz*.;
  - Different between species and higher taxonomic categories
  - Differences tend to be greater with longer period of evolutionary divergence
- What physiological/ anatomical differences are driving the contrasts in bioaccumulation patterns?
  - Data for CFs in six dissected body compartments show strong contrasts between bony and cartilagenous fishes; radiological implications
  - Still to interpret in terms of well established differences between teleosts and chondrichthyans in physiology and anatomy
- Comprehensive life history radioecology

   done for humans, so worth considering for other selected biota
- Amphioxus
- Bioaccumulation capacity is confirmed and indicated to be greater than initially indicated



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