EFFECTS OF CHRONIC, LOW LEVEL α- OR γ-RADIATION IN ZEBRAFISH (*Brachydanio rerio*)

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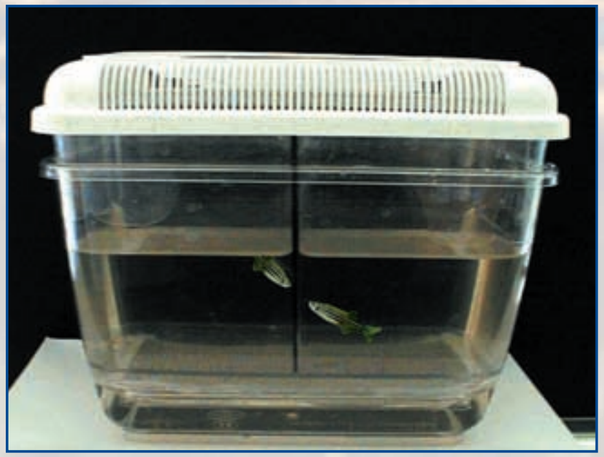
Introduction

- There is increasing support nationally and internationally for the development of standards for the protection of the environment from the effects of radioactive waste disposal. Work towards such development is already in progress in the EU-funded FASSET project and in the ICRP.
- Development of environmental protection standards will require information on environmental dosimetry and radiation dose / response relationships.
- One area where a lack of data has been clearly identified is the relative damaging effects of α- and γ-radiation. This is of particular importance as several of the radionuclides which are released under authorisation into the environment are α-emitters.
- It is well known that α-radiation is much more effective than γ-radiation, on an equal absorbed dose basis, in producing tissue damage in man and mammals but while it seems certain that the same will be true for aquatic organisms, there are no data available on this for relevant end points (eg reproductive capacity).
- This poster presents some initial results of a study in which a comparison of the effects of chronic, long term exposure to α- or γ-radiation on reproductive output is being carried out using a representative fish, the zebrafish.

Experimental Methods

Groups of zebrafish were exposed to α-radiation by being fed brine shrimp (*Artemia*) which had been spiked with ^{210}Po. Other groups were exposed to γ-radiation from external ^{137}Cs sources. The meal activities required to deliver experimental α-radiation dose rates were determined in pilot experiments and γ-radiation dosimetry was carried out using thermoluminescent dosimeters. Except for irradiation all groups of fish including unirradiated controls were treated identically.

Irradiations with α- or γ-rays started at the same time, when fish were large enough to eat the ^{210}Po - spiked brine shrimps, and continued throughout the experiment. When mature, fish were placed in pairs and allowed to breed once per week. The numbers of eggs laid, the number of unfertilised eggs and the numbers of fertilised eggs which hatched successfully were all recorded.



Experimental fish tank containing a pair of zebrafish separated by a perspex divider which is removed once a week to allow mating.

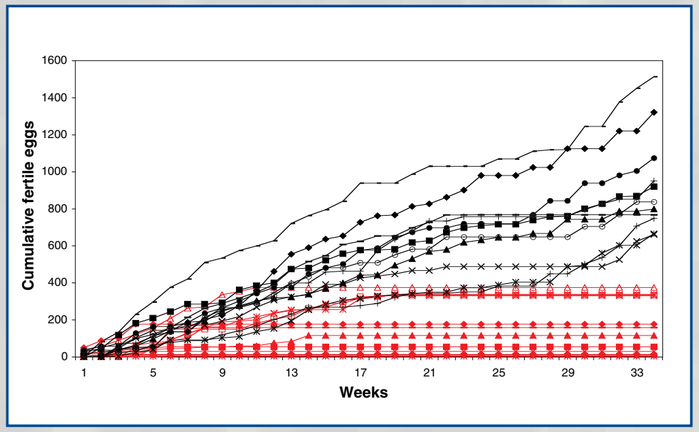
Table 1. Estimated mean dose rates to experimental zebrafish.

Experimental Group	α-radiation dose rate (μGy / h)	γ-radiation dose rate (μGy / h)
1	8	300
2	26	1000
3	184	7400
4	736	-

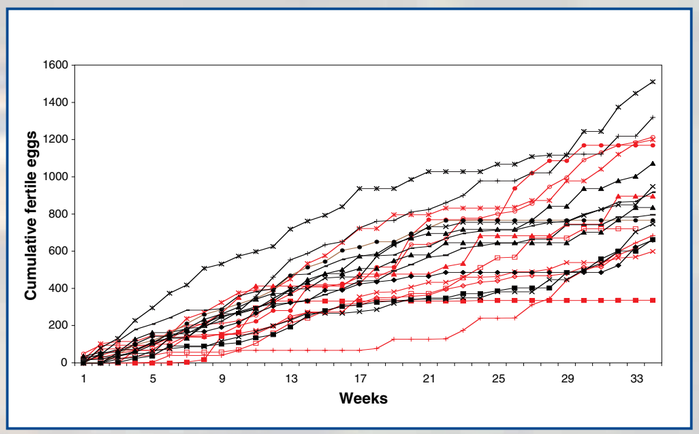
Results

Detailed statistical analysis has yet to be carried out but examination of graphs showing the cumulative number of fertile eggs reveals the major features of the results. Among γ-irradiated zebrafish the highest dose rate used (7400μGy/h) caused all pairs of fish to cease egg production within 14 weeks of starting to mate (Graph 1). In the other γ-dose rate groups (300 and 1000μGy/h) egg production was similar to that in controls (Graph 2).

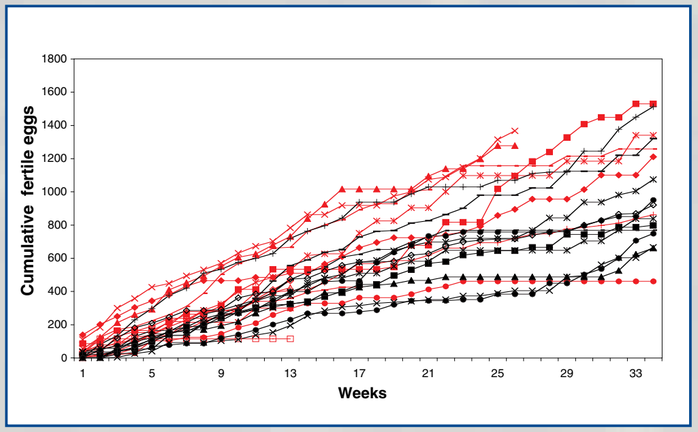
Among α-irradiated zebrafish none of the experimental groups (8, 26 or 184μGy/h) showed any clear differences in egg production from controls (Graph 3). A higher dose rate group (736μGy/h) was therefore added but as yet it has shown no difference from controls (Graph 4).



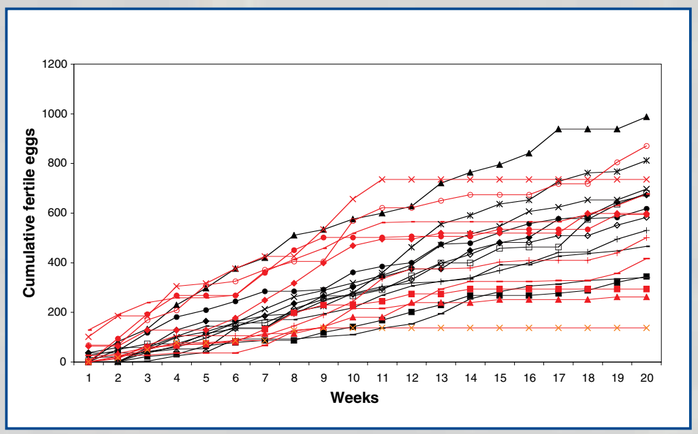
Graph 1: Gamma Radiation Group 3 (7400μGy/h - red) and Controls (black)



Graph 2: Gamma Radiation Group 2 (1000μGy/h - red) and Controls (black)



Graph 3: Alpha Radiation Group 3 (184 μGy/h - red) and Controls (black)



Graph 4: Alpha-Radiation Group 4 (736μGy/h - red) and Controls (black)

Discussion and Conclusions

Compared to the γ-radiation dose rate which produced a clear effect on reproductive output (7400μGy/h, Graph 1), the α-radiation dose rates used (see Table 1) were between approximately 10x (7400 / 736) and 1000x (7400/8) lower. None of the α-radiation dose rates used produced a clear effect on reproductive output, therefore for this endpoint it is concluded that α-radiation delivered as a continuous exposure is less than 10 times more effective than γ-radiation.

In the literature α-radiation has been shown to be between 5 and several hundred times more damaging than γ-radiation for a range of endpoints in mammals, with a clustering around ~40 times. The present work suggests that in continuously irradiated fish the relative effect is less than 10, towards the lower end of this range. More detailed statistical analysis of the results and histological analysis of experimental fish may reveal other endpoints where a more precise comparison of these radiations can be made.

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