# $^{210}$Po and $^{210}$Pb in the Zooplankton at Pulau Redang, Terengganu, Malaysia

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ABSTRACT

Concentrations of natural radionuclide such as $^{210}$Po and $^{210}$Pb were measured in the zooplankton collected from eight stations at Pulau Redang, Malaysia using the Alpha Spectrometry. The total activity of $^{210}$Po was much greater than the activity of $^{210}$Pb. The mean concentration of $^{210}$Po in the zooplankton was found to be 21.88 ± 1.26 dpm/g (dry wt.) while the mean concentration for $^{210}$Pb was about 5.62 ± 0.41dpm/g (dry wt.). The range activity ratio of $^{210}$Po/$^{210}$Pb was from 3.46 to 4.71 and factor which influenced the concentration activity of $^{210}$Po and $^{210}$Pb in the zooplankton may be related to their feeding habits.

*ABSTRAK*

*Kepekatan radionuklid tabii iaitu $^{210}$Po dan $^{210}$Pb telah diukur dengan alfa spektrometri dalam zooplankton yang dipungut dari lapan stesen di Pulau Redang, Malaysia. Aktiviti total $^{210}$Po adalah lebih tinggi berbanding dengan aktiviti $^{210}$Pb. Kepekatan purata $^{210}$Po dalam zooplankton yang diperolehi adalah 21.88 ± 1.26 dpm/g (berat kering) sementara kepekatan purata untuk $^{210}$Pb adalah 5.62 ± 0.41dpm/g (berat kering). Julat nisbah aktiviti $^{210}$Po/$^{210}$Pb ialah dari 3.46 ke 4.71. Faktor yang menyebabkan perubahan kepekatan $^{210}$Po dan $^{210}$Pb dalam zooplankton mungkin bergantung kepada tabiat pemakanan.*

**Keywords**: $^{210}$Po; $^{210}$Pb; zooplankton

# Introduction

The naturally occurring alpha-radioactive nuclide such as $^{210}$Po is concentrated in most marine organisms and is the major source of the relatively high natural radiation dose to which such organisms are exposed (Cherry et al. 1987). $^{210}$Po, a member of the uranium decay series, is an alpha-emitter which decays with a half-life of 138.4 days to stable lead. In the marine environment, $^{210}$Po is largely produced from the decay of $^{210}$Pb (T1/2 = 22.3 years) deposited from the atmosphere. A small amount of $^{210}$Po in the seawater originates from the atmospheric deposition of polonium itself (Uğur et al. 2002).

The behavior of $^{210}$Po in the ocean differs from that of $^{210}$Pb, especially because of the higher affinity of $^{210}$Po for organic matter. In the water column, plankton absorbs polonium and forms complexes with organic matter, while lead reveals a stronger tendency to be sorbed on mineral suspended matter (Skwarzec & Bojanowski 1988; Bacon et al. 1980; Fellows et al. 1981). The $^{210}$Po /$^{210}$Pb activity ratio for zooplankton collected in coastal water is about 10 and increases from 20 to 30 for open water organisms (Bacon et al. 1980). The present study was carried out to determine the distribution of $^{210}$Po and $^{210}$Pb in zooplankton collected from Pulau Redang.

# Materials and Methods

Zooplankton samples were collected from eight stations at Pulau Redang, Terengganu (Figure 1). Samples were collected using plankton net with a mesh size of 250 μm towed at the back of the boat for 15 minutes. All samples were stored in PVC bottles in 4% formalin.

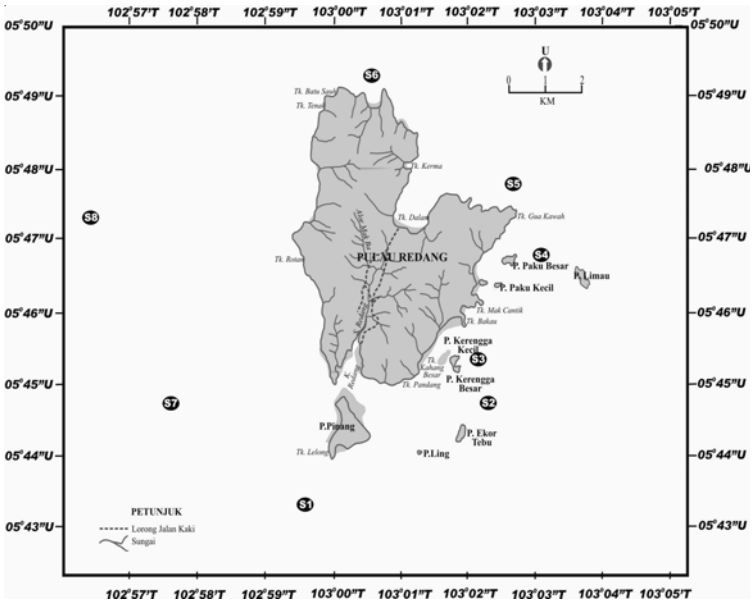


FIGURE 1: Sampling Stations at Pulau Redang

In the laboratory, the samples were filtered through a 0.45μm membrane filter paper and dried in an oven at 60°C until constant weight. About 1-2 g of the samples was digested with $HNO_3$, $H_2O_2$, $HClO_4$ and HCl for 2 hours (Yamamoto et al. 1994). About 1ml of $^{209}$Po (17.27 ± 0.6960 dpm/ml) was used as a tracer to calculate the chemical recovery. The aqueous part was filtered using a filter paper and evaporated on a hot plate until dryness. The residue was redissolved with 80 ml of 0.5M HCl. About 0.15 g of ascorbic acid was then added following spontaneous deposition on a silver disc. The activity of $^{210}$Po was counted using an alpha spectrometer, while $^{210}$Pb was determined after 3 months ingrowths from $^{210}$Po.

## Results and Discussions

The $^{210}$Po and $^{210}$Pb concentrations measured at 8 stations in Pulau Redang are given in Table 1. The concentration of $^{210}$Po ranged from 3.74 ± 0.19 dpm/g to 33.62 ± 1.85 dpm/g (dry wt) with a mean of 21.88 ± 1.26 dpm/g. Meanwhile, t he mean concentration of $^{210}$Pb was 5.62 ± 0.41 dpm/g (dry wt.) with a concentration ranged from 0.80 ± 0.05 dpm/g to 9.73 ± 0.70 dpm/g (dry wt.).

The concentration of $^{210}$Po was high at most of the stations. This is due to the feeding habits of the zooplankton where grazing zooplankton accumulate $^{210}$Po through ingestion of particulates and absorption of $^{210}$Po into their digestive organs (Skwarzec & Falkowski 1988). Besides that, zooplankton also can repackage the nuclides into feacal pellets.

Concentrations of $^{210}$Pb were 3 to 4 times lower than the concentrations of $^{210}$Po. This is because $^{210}$Pb tends to be sorbed on to mineral suspended matter (Skwarzec & Bojanowski 1988; Fellows et al. 1981). Kadko (1993) demonstrated that biological uptake may be more important than inorganic absorption for $^{210}$Po, and it is opposite for $^{210}$Pb. The $^{210}$Po/$^{210}$Pb ratio ranged from 3.46 to 4.71. This ratio was rather low compared to other studies where the 210Po/210Pb activity ratio for zooplankton collected in coastal waters is about 10 (Skwarzec & Bojanowski 1988). According to Gasco et al. (2002) if the ratio of $^{210}$Po/$^{210}$Pb differed from the unity, the $^{210}$Po/$^{210}$Pb was not in equilibrium. The higher concentrations of $^{210}$Po with respect to $^{210}$Pb could be explained by the biomagnification in zooplankton. Besides, the concentration of $^{210}$Po in zooplankton is not only from the decay of $^{210}$Pb. A selected uptake for $^{210}$Po from the environment is also occurred in zooplankton (Smith & Towler 1993; Wildgust et al. 1998).

## Conclusions

The concentrations of $^{210}$Po and $^{210}$Pb in the zooplankton from Pulau Redang were slightly different. Several factors affect these distributions, mainly the high affinity of $^{210}$Po absorbed by zooplankton as compared to $^{210}$Pb that causes the high concentrations of $^{210}$Po in the zooplankton. The data for $^{210}$Po and $^{210}$Pb in Malaysian zooplankton is less available. The assessment of $^{210}$Po and $^{210}$Pb in zooplankton is very important for determining its contribution to the background radiation as well as for estimating the

TABLE 1: $^{210}$Po and $^{210}$Pb Concentrations in Pulau Redang Zooplankton

| Stations | Location | $^{210}$Po, dpm/g (dry wt.) | $^{210}$Pb, dpm/g (dry wt.) | $^{210}$Po/210 Pb |
|---|---|---|---|---|
| S1 | 05° 43' 35N | 32.12 ± 1.55 | | 3.67 |
| | 102° 59' 41E | | 8.76 ± 0.47 | |
| S2 | 05° 44' 44N | 33.62 ± 1.85 | | 3.46 |
| | 103° 02' 19E | | 9.73 ± 0.70 | |
| S3 | 05° 45' 21N | 22.29 ± 1.14 | | 3.57 |
| | 103° 02' 18E | | 6.25 ± 0.38 | |
| S4 | 05° 46' 54N | 9.19 ± 0.47 | | 3.58 |
| | 103° 03' 06E | | 2.56 ± 0.15 | |
| S5 | 05° 47' 54N | 20.27 ± 1.16 | | 4.01 |
| | 103° 02' 54E | | 5.05 ± 0.33 | |
| S6 | 05° 49' 22N | 29.22 ± 2.06 | | 4.71 |
| | 103° 00' 31E | | 6.20 ± 0.69 | |
| S7 | 05° 44' 44N | 3.74 ± 0.19 | | 4.69 |
| | 102° 57' 42E | | 0.80 ± 0.05 | |
| S8 | 05° 47' 28N | 24.60 ± 1.65 | | 4.37 |
| | 102° 56' 04E | | 5.62 ± 0.47 | |
| | Mean | 21.88 ± 1.26 | 5.62 ± 0.41 | 4.01 |
| | Range | 3.74 – 33.62 | 0.80 – 9.73 | 3.46 – 4.71 |

intake levels of these radionuclides by marine organisms. Therefore, more detailed studies should be undertaken to investigate the role of transport $^{210}$Po and $^{210}$Pb transport within the marine environment within the food chain.

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## References

Bacon, M. P., Brewer, P. G., Spencer, D. W., Murray, I. W., Goddard, I. 1980. Lead-210, polonium-210, manganese and iron in the Cariaco Trench. *Deep-Sea Research*, **27A**: 119-135.

Cherry, M. I., Cherry, R. D., Heyraud, M. 1987. Polonium-210 and lead-210 in Antarctic marine biota and sea water. *Marine Biology*, **96**: 441-449.

Fellows, D. A., Karl, D. M., Knauer, G. A. 1981. Large particle fluxes and the vertical transport of living carbon in the upper 1 500m of northeast Pacific Ocean. *Deep-Sea Research*, **28**: 921-936.

Gascó, C. Antón, M. P., Delfanti, R., González, A. M., Meral, J., Papucci, C. 2002. Variation of the activity concentrations and fluxes of natural ($^{210}$Po, $^{210}$Pb) and anthropogenic (239, $^{240}$Pu, $^{137}$Cs) radionuclides in the Strait of Gibraltar (Spain). *Journal of Environmental Radioactivity*, **62**: 241-262.

Kadko, D. 1993. Excess $^{210}$Po and nutrient cycling within the California coastal transition zone. *Journal of Geophysical Research*, **98**: 857-864.

Skwarzec, B & Falkowski, L. 1988. Accumulation of $^{210}$Po in Baltic Invertebrates. *Journal of Environmental Radioactivity*, **8**: 99-109.

Skwarzec, B. & Bojanowski, R. 1988. $^{210}$Po content in sea water and its accumulation in southern Baltic plankton. *Marine Biology*, **97**: 301-307.

Smith, J. D. & Towler, P. H. 1993. Polonium-210 in cartilaginous fishes (Chondrichthyes) from South-eastern Australian waters. *J. Mar. Freshwater Res.*, **44**: 727-733.

Uğur, A., Yener, G., Başsari, A. 2002. Trace metals and $^{210}$Po ($^{210}$Pb) concentrations in mussels (*Mytilus galloprovincialis*) consumed at western Anatolia. Applied Radiation and Isotopes, **57**: 565-571.

Wildgust, M. A., McDonald, P. & White, K. N. 1998. Temporal changes of $^{210}$Po in temperate coastal waters. *Sci. Total Environ.*, **214**: 1-10.

Yamamoto, M., Abe, T., Kuwabara, J., Komura, K., Ueno, K., Takizawa, Y. 1994. Polonium-210 and lead-210 in marine organisms: intake levels for Japanese. *Journal of Radioanalytical and Nuclear Chemistry*, **178**: 81-90.