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## Concentrations of $^{210}\text{Po}$ and $^{210}\text{Pb}$ in Zooplankton at Pulau Redang, Terengganu, Malaysia

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**Abstract:** Zooplankton samples collected from eight stations around Pulau Redang, Terengganu, Malaysia were used to measure the concentration activities of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  using Alpha Spectrometry. Mean activity in zooplankton tissue for  $^{210}\text{Po}$  [ $364.67 \pm 21.00 \text{ Bq kg}^{-1}$  (dry wt.)] was much greater than  $^{210}\text{Pb}$  [ $93.67 \pm 6.83 \text{ Bq kg}^{-1}$  (dry wt.)] with ranging ratio of  $^{210}\text{Po}/^{210}\text{Pb}$  from 3.46 to 4.71. These fluctuations may be related to the feeding habits of zooplankton and daily biological processes occurred in water column.

**Key words:**  $^{210}\text{Po}$ ,  $^{210}\text{Pb}$ , zooplankton

### INTRODUCTION

The naturally-occurring alpha-radioactive nuclide such as  $^{210}\text{Po}$  is concentrated by most marine organisms and is the major source of the relatively high natural radiation dose to which such organisms are exposed<sup>[1]</sup>.  $^{210}\text{Po}$ , 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,  $^{210}\text{Po}$  is largely produced from the decay of  $^{210}\text{Pb}$  ( $t_{1/2} = 22.3$  years) deposited from the atmosphere. A small amount of  $^{210}\text{Po}$  in the seawater originates from the atmospheric deposition of polonium itself<sup>[2]</sup>.

The behavior of  $^{210}\text{Po}$  in the ocean differs from that of  $^{210}\text{Pb}$ , especially because of the higher affinity of  $^{210}\text{Po}$  with organic matter. In water column, polonium is usually adsorbed by plankton and forms complexes with organic matter, while lead reveals a stronger tendency to be sorbed on mineral suspended matter<sup>[3]</sup>. The activity ratio of  $^{210}\text{Po}/^{210}\text{Pb}$  for zooplankton collected in coastal water is about 10 and increases from 20 to 30 for open water organisms<sup>[3]</sup>.

This study was carried out to determine the distribution and fluctuation concentration activity of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  in zooplankton collected around Pulau Redang, Terengganu, Malaysia.

### MATERIALS AND METHODS

Zooplankton samples were collected from eight stations at Pulau Redang, Terengganu as shown in Fig. 1. Samples were collected using plankton net with a mesh

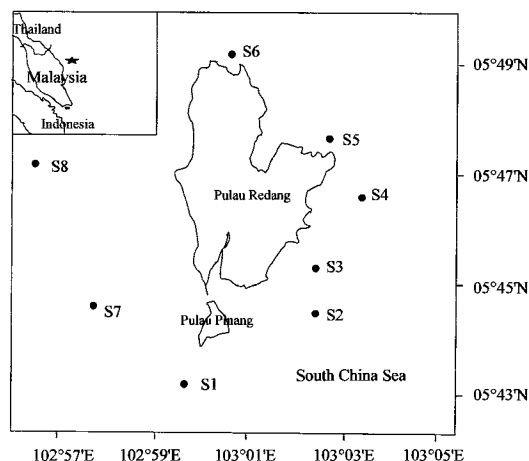


Fig. 1: Sampling stations were conducted around Pulau Redang, Malaysia

size of  $250 \mu\text{m}$  towed at the back of the boat for 15 min. All samples were stored in PVC bottles with 4% of formalin.

In the laboratory, the samples were filtered through  $0.45 \mu\text{m}$  membrane filter paper and dried in an oven until constant weight at  $60^\circ\text{C}$ . About 1-2 g samples were digested with mixing of  $\text{HNO}_3$ ,  $\text{H}_2\text{O}_2$ ,  $\text{HClO}_4$  and  $\text{HCl}$  in the glass beaker for 2 h<sup>[4]</sup>. In the addition about 1 mL of  $^{209}\text{Po}$  ( $0.267 \text{ Bq mL}^{-1}$ ) was used as tracer for calculate chemical recovery. After cooling at room temperature, the aqueous were filtered using filter paper and evaporated their liquid on the hot plate until dryness and continue re-dissolved the residue with 80 mL of 0.5 M  $\text{HCl}$ . After that, about 0.15 g of ascorbic acid was added and following

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spontaneously deposited on silver disc. The activity of  $^{210}\text{Po}$  was counting using Alpha Spectrometry, while  $^{210}\text{Pb}$  was determining after three months in growths from  $^{210}\text{Po}$ <sup>[5]</sup>.

## RESULTS AND DISCUSSIONS

**Distribution of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  in zooplankton at coastal water:** In the Table 1 the mean activity of  $^{210}\text{Po}$  recorded was  $364.67 \pm 21.00 \text{ Bq kg}^{-1}$  and ranged from  $62.33 \pm 3.17$  to  $560.33 \pm 30.83 \text{ Bq kg}^{-1}$ . The mean concentration of  $^{210}\text{Pb}$  was  $93.67 \pm 6.83 \text{ Bq kg}^{-1}$  and fall within the ranged of  $13.33 \pm 0.83$  to  $162.17 \pm 11.67 \text{ Bq kg}^{-1}$ .

The concentration activities of  $^{210}\text{Po}$  were slightly more than  $100 \text{ Bq kg}^{-1}$  at all the stations and contradict with cockles (less than  $100 \text{ Bq kg}^{-1}$ ) reported by Tee *et al*<sup>[5]</sup>. This was due to the feeding habits of zooplankton, where the grazing zooplankton having a capability for concentrate  $^{210}\text{Po}$  than  $^{210}\text{Pb}$  from the particulate during the ingestion process and absorb into digestive organs<sup>[6]</sup>. Besides that, zooplankton also can repackage the nuclides into fecal pellets<sup>[11]</sup>. Concentrations of both nuclides found in zooplankton were slightly higher if compare with cockle<sup>[5]</sup> and this will suggested most of nuclides especially  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  deposited into the sea as rain or aerosol was use by first producer as zooplankton and deposit onto seabed as settling particles was use by second producer as benthos (i.e., cockles).

Meanwhile for  $^{210}\text{Pb}$ , their concentrations were slightly three to four times lower than the concentrations of  $^{210}\text{Po}$ . This is due to the fact that  $^{210}\text{Pb}$  reveals a stronger tendency to be sorbed on mineral suspended matter<sup>[7]</sup> but during this study a slightly good statistical correlation between  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  was plotted

Table 1: Concentration activities of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  in zooplankton obtained during this study

Stations	Location	$^{210}\text{Po}$ , Bq kg <sup>-1</sup> (dry wt.)	$^{210}\text{Pb}$ , Bq kg <sup>-1</sup> (dry wt.)	$^{210}\text{Po}/^{210}\text{Pb}$
S1	05°43'35"N 102°59'41"E	535.33±25.83	146.00±7.83	3.67
S2	05°44'44"N 103°02'19"E	560.33±30.83	162.17±11.67	3.46
S3	05°45'21"N 103°02'18"E	371.50±19.00	104.17±6.33	3.57
S4	05°46'54"N 103°03'06"E	153.17±7.830	42.67±2.50	3.58
S5	05°47'54"N 103°02'54"E	337.83±19.33	84.17±5.50	4.01
S6	05°49'22"N 103°00'31"E	487.00±34.33	103.33±11.50	4.71
S7	05°44'44"N 102°57'42"E	62.33±3.170	13.33±0.83	4.69
S8	05°47'28"N 102°56'04"E	410.00±27.50	93.67±7.83	4.37
Mean		364.67±21.00	93.67±6.83	4.01

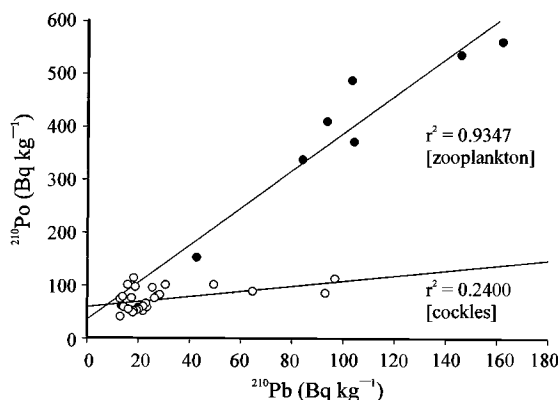


Fig. 2: Distribution activities of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  in the zooplankton and cockles

( $r^2 = 0.9347$ ) in zooplankton tissues and not appear for cockles (Fig. 2). This situation occurs especially for coastal zooplankton because coastal water having direct or indirect input from the land and directly accumulates in the zooplankton body during daily biological processes. But previous measurement of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  in pelagic seawater showed that biological uptake maybe also important than inorganic absorption for  $^{210}\text{Po}$  scavenging<sup>[8]</sup>, while the opposite is appear for  $^{210}\text{Pb}$  as reported by Bacon *et al.*<sup>[9]</sup>.

Activity ratio of  $^{210}\text{Po}/^{210}\text{Pb}$  obtained in zooplankton tissue at sampling stations was ranging from 3.46 to 4.71 (Table 1). This was rather low if compare to other studies where the  $^{210}\text{Po}/^{210}\text{Pb}$  activity ratio for zooplankton collected in coastal water is about  $10^3$ <sup>[3]</sup>. According to Gasco *et al.*<sup>[10]</sup> if the ratio of  $^{210}\text{Po}/^{210}\text{Pb}$  was different from the unity which is 1, the  $^{210}\text{Po}/^{210}\text{Pb}$  ratio was not in equilibrium. The higher concentrations of  $^{210}\text{Po}$  with respect to  $^{210}\text{Pb}$  could be explained by its biomagnifications in zooplankton. Besides, the concentration of  $^{210}\text{Po}$  in zooplankton was not overall from the decay of  $^{210}\text{Pb}$ . A selected uptake for  $^{210}\text{Po}$  from the environmental habitat also occurred in zooplankton<sup>[11,12]</sup>. As mentioned above, a largely ratio between  $^{210}\text{Po}$  with  $^{210}\text{Pb}$  also indicating most of the aerosol deposit onto the sea of Malaysian waters containing much source of natural polonium caused by green or biogenic burning (i.e., forest burning) and slightly high statistical correlation between  $^{210}\text{Po}$  with  $^{210}\text{Pb}$  found in zooplankton (Fig. 2).

## CONCLUSIONS

The concentrations of  $^{210}\text{Po}$  and  $^{210}\text{Pb}$  in zooplankton from Pulau Redang were differing significantly with ratio

more than unity caused by biogenic input. Good statistical correlation also obtained between studied nuclides in zooplankton.

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