

from 32 subjects resident in the following three general areas of the Yukon and Northwest Territories: Area No. 1, the town of Yellowknife; Area No. 2, rural inland districts in the Mackenzie River and Southern Yukon region; and Area No. 3, the northwest shores of Hudson Bay. The subjects can also be classified in the following three groups on the basis of dietary habit: (i) reindeer or caribou meat consumed several times a week, (ii) either reindeer or caribou meat consumed about once a week or a diet described generally as "high protein," and (iii) diet not described as "high protein" or not including reindeer or caribou meat (that is, "normal"). No dietary record was obtained for the English series of ten samples and, because the samples were collected unselectively and in the sequence in which they were delivered in a general hospital, they can be presumed to be representative of the area where they were obtained.

Determinations of the concentration of  $Po^{210}$  in these samples were carried out by a method previously described (1), and results are given in Table 1. Values for the Canadian "normal diet" samples are comparable to those for the English series, while the value for the caribou-reindeer eaters are generally higher than the "normal" mean value by factors of up to 80. This is about the same range of variation found in earlier measurements on samples of Eskimo bones (where, however, no information on diet was available) (1). The results (Table 1) also indicate a dependence of  $Po^{210}$  concentration on residence locality, as such, among subjects within a given diet classification. However, this may simply reflect the inadequacy of the information available to us concerning detailed dietary habits of subjects in the areas concerned. The values of the activity ratio of  $Pb^{210}/Po^{210}$  (shown in parentheses) that have been measured for some of the samples show, in every case, that  $Po^{210}$  is in excess of equilibrium with  $Pb^{210}$ .

Estimation of the  $Po^{210}$  concentrations in other body organs of the Canadian residents can be made by comparison of the English placenta series with a previous set of measurements of  $Po^{210}$  in autopsy samples from accident cases occurring in the same area as that from which the placenta samples were drawn (1). This comparison is made in Table 2. Unfortunately bone was not included in this series of measurements; a value

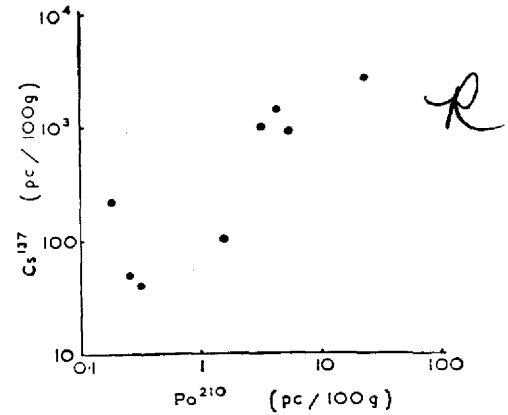


Fig. 1. Relationship between  $Po^{210}$  and  $Cs^{137}$  concentrations measured in human placentas.

for bone has been derived from the concentration ratio, bone/liver, found in another set of measurements of autopsy material, which was carried out on tissue from hospitalized subjects with terminal illness (2).

The ratios given in the third column of Table 2 should provide a means for estimating the  $Po^{210}$  concentration in the corresponding tissues of the subjects of Table 1, and in particular the "meat eaters." In this connection it is useful to bear in mind that a  $Po^{210}$  concentration of 1 pc/100 g, uniformly distributed, gives rise to a tissue dose rate of about 1 mrad/yr.

### Polonium-210 Content of Human Tissues in Relation to Dietary Habit

**Abstract.** Concentrations of polonium-210, a natural fallout nuclide, in human placentas collected in northern Canada ranged up to 27.8 picocuries per 100 grams, or 80 times the average United Kingdom value. High levels are related to the inclusion of reindeer or caribou meat in the diet, and a correlation exists between the concentrations of polonium-210 and cesium-137 in the placentas.

Attempts to follow up the suggestion (1) that there may be relatively high levels of  $Po^{210}$  in tissues of people dependent for food on meat of animals, such as reindeer and caribou, that graze on lichens have hitherto been prevented by difficulties in obtaining suitable samples of tissue. I now report on measurements made on a series of human placentas obtained from residents of northern Canada, as compared with a series from London, United Kingdom. The Canadian series was obtained

Table 1. Polonium-210 concentration, in picocuries per 100 g (wet wt.) in human placenta. Activity ratios,  $Pb^{210}/Po^{210}$ , are shown in parentheses.

Yellowknife, N.W.T.	Inland, rural	Hudson Bay coast	London, U.K.
<i>Much reindeer and caribou</i>			
2.41 (0.25)	1.54	4.3	
	5.28 (0.16)	5.4	
		9.3	
		12.2	
		14.1	
		22.8	
2.41	3.41	11.4 ± 6.2	
<i>Some reindeer and caribou, or "high protein"</i>			
0.35	0.09	3.2	
	1.07 (0.64)	5.4	
	1.48 (0.75)	9.6	
	3.09 (0.27)	10.8	
		11.5	
		12.2	
		27.8	
0.35	1.44	11.5 ± 7.3	
<i>"Normal" (no reindeer or caribou)</i>			
0.08			0.14
0.18			0.23
0.19			0.26
0.24			0.27
0.30			0.28
0.31			0.29
0.36			0.37
0.40			0.39
0.45			0.50
0.58			0.52
0.92			
0.36 ± 0.22			0.33 ± 0.11

Table 2. Comparative concentrations of  $\text{Po}^{210}$  in tissue of United Kingdom residents.

Tissue	$\text{Po}^{210}$ concn. (pc/100 g)	Concn. ratio tissue/placenta
Placenta	0.33	
Liver	1.69	5.1
Kidney	1.72	5.2
Lung	0.54	1.6
Testis	0.39	1.2
Bone	2.9	8.8

In order to investigate the possibility of a correlation between natural  $\text{Po}^{210}$  and artificial  $\text{Cs}^{137}$  levels in human tissues,  $\gamma$ -spectrometric measurements have been made of the  $\text{Cs}^{137}$  contents of some of the placentas in the Canadian series. The results (Fig. 1) yield a correlation coefficient of 0.93, significant at the 0.1-percent level, for placental concentrations of the two nuclides and thus provide new evidence for an origin and route of uptake of the polonium isotope that are similar to those of  $\text{Cs}^{137}$ . The explanation of this finding seems to lie in the natural

atmospheric content of  $\text{Rn}^{222}$ , whose decay results ultimately in production of  $\text{Po}^{210}$  ( $\text{Cs}^{137}$  is also produced in the atmosphere by radioactivity decay of a rare gas, the fission product  $\text{Xe}^{137}$ ), and in the predominant importance of a food chain involving animals dependent for grazing on large areas of slow-growing vegetation that is known to accumulate both nuclides effectively, following their deposition from the atmosphere.

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#### References and Notes

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2. ———, R. V. Osborne, W. V. Mayneord, in *The Natural Radiation Environment*, J. A. S. Adams and W. M. Lowder, Eds. (Univ. of Chicago Press, Chicago, 1964), p. 395.
3. I thank the staffs of the various Canadian hospitals and St. Helier Hospital, Carshalton, for providing the samples of placenta, and P. M. Bird of the Canadian Department of National Health and Welfare for organizing the supply of specimens from Canada. The  $\text{Cs}^{137}$  measurements were made by R. Elrick in our department.

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