

and their infectivity and pathogenicity for man are unknown. Because of the uncertainties about these particles, caution is warranted when working with lymphoma cell cultures.

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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 Po²¹⁰ 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

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 Po²¹⁰ 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 Po²¹⁰ 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 Pb²¹⁰/Po²¹⁰ (shown in parentheses) that have been measured for some of the samples show, in every case, that Po²¹⁰ is in excess of equilibrium with Pb²¹⁰.

Estimation of the Po²¹⁰ 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 Po²¹⁰ 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

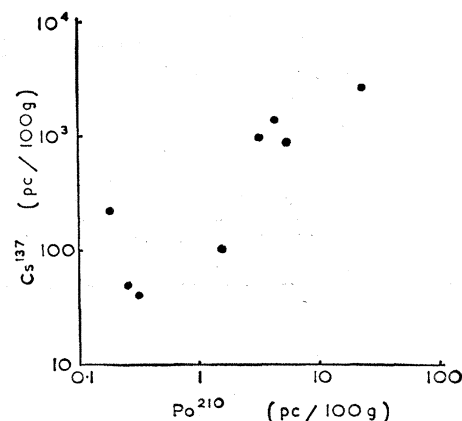


Fig. 1. Relationship between Po²¹⁰ and Cs¹³⁷ concentrations measured in human placentas.

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 Po²¹⁰ 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 Po²¹⁰ concentration of 1 pc/100 g, uniformly distributed, gives rise to a tissue dose rate of about 1 mrad/yr.

Table 1. Polonium-210 concentration, in picocuries per 100 g (wet wt.) in human placenta. Activity ratios, Pb²¹⁰/Po²¹⁰, 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 Po^{210} in tissue of United Kingdom residents.

Tissue	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 Po^{210} and artificial Cs^{137} levels in human tissues, γ -spectrometric measurements have been made of the 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 Cs^{137} . The explanation of this finding seems to lie in the natural

atmospheric content of Rn^{222} , whose decay results ultimately in production of Po^{210} (Cs^{137} is also produced in the atmosphere by radioactivity decay of a rare gas, the fission product 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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Polymorphism in Some Nearctic Halictine Bees

Abstract. Average difference in size between queens and workers of four social Halictinae common to southern Ontario ranges from 6 percent in *Augochlorella striata* (Prov.) to 15 percent in *Evylaeus cinctipes* (Prov.). Spring larvae receive provisions averaging 33.9 milligrams and become small workers; summer larvae consume on average 61.7 milligrams and develop into large queens and males.

Living organisms, unlike manufactures from modern assembly lines, show extensive visible variation. Such variation is often caused by environmental factors acting on a genotype, differences between sexes, or recurrent mutations in a population (1). Frequency curves for single characteristics (such as height or weight) are usually unimodal, and the variation is then said to be continuous; when a curve has two or more modes, the variation is said to be discontinuous. Such a situation is subject to normal evolutionary pressures and may lead to either polymorphism or speciation (1). For many years only visible morphological polymorphism was known, but "cryptic" polymorphisms of a physiological or biochemical nature have recently been discovered (2). Polymorphism in Hymenoptera, in contrast to termites, is confined to the female sex, in which there is often a very discontinuous variation, as in the caste system of honeybees and ants.

Halictine bees, which show remark-

able variety in structure and behavior, exhibit also a wide spectrum of polymorphism in species having the best-developed social behavior (3). The two female castes, queen and worker, often differ greatly in size but always lack the anatomical modifications characteristic of the castes of complex insect societies. Other halictine species, although they may have an incipient level of social behavior, show less difference in size between queen and worker (3). *Evylaeus marginatus* (Brullé) is unique in forming perennial instead of the usual annual societies, yet having castes that differ little in size despite their different behavior (4).

Biometric analyses of halictine castes in southern Ontario show a progressive discontinuity in the degree of variation in the four species studied, from *Augochlorella striata* to *Evylaeus cinctipes* (Fig. 1). The nature of the life cycle influences the degree of polymorphism (3). The two species with the greatest caste discontinuity (average difference in size between the castes is 10 per-

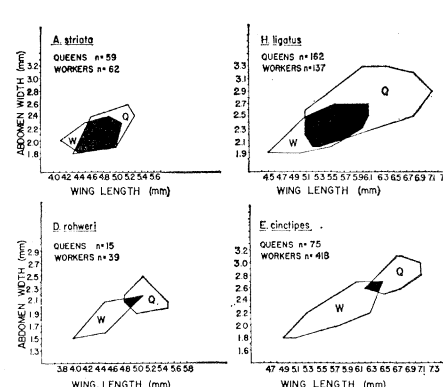


Fig. 1. Size polymorphism of female castes in *Augochlorella striata* (Prov.), *Halictus ligatus* Say, *Dialictus rohweri* (Ellis), and *Evylaeus cinctipes* (Prov.). Wing length and abdominal width are the two parameters used. Caste discontinuity is indicated by decrease in the overlap of measurements (black areas).

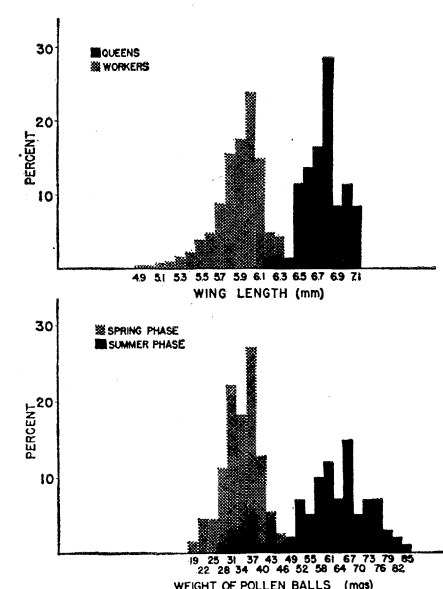


Fig. 2. Caste determination in *Evylaeus cinctipes* (Prov.). Bimodality in both histograms is similar, indicating direct relation between the weight of provisions and the size of bees that developed from them. (Top) N, 418 and 75, respectively. (Bottom) N, 65 and 98; $\bar{x}$, 33.9 and 61.9 mg, respectively.

cent in *Dialictus rohweri* and 15 percent in *E. cinctipes*) produce only one summer brood, whereas continuous production of progressively larger workers throughout the summer reduces the initial difference in size in the castes of *A. striata* and, especially, *H. ligatus*, and also explains the remarkable range in size of females of the latter two species (5).

Although all newly emerged females of the summer brood remain in their natal nests and function as nonreproductive workers, differences in the level