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A Spectrometric Method for the Study of Radon Partition in Radium-Burdened Animals[1]

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THE RADIUM burden of living mammals is usually obtained by measuring both the gamma-ray activity of the Ra(B + C) retained in the body and the time rate at which radon is lost in the breath. Whereas the first can be done consistently with satisfactory accuracy (1), relevance of the latter measurement is predicted on the assumption that, at the time of sampling, the rate of radon exhalation equals the rate of radon release from the radium deposits in the body. Since the radon exhalation rate of a single subject may vary over short periods of time (2), experimental results are beset by annoying uncertainties, which can be minimized at best by repeated sampling in the case of man and can be effectively eliminated only by periodic sacrifice and Ra assay when dealing with laboratory animals.

The method to be discussed here consists in comparing with a scintillation spectrometer the relative intensities of the Ra^{226} and RaB gamma rays emitted by an animal to those of suitably prepared standards, and in evaluating by these means the fraction of radon retained. It should be realized at the outset that whereas RaB emits gamma rays of 240, 295 and 350 kev in numbers comparable to its rate of disintegration, Ra^{226} emits instead a 50 per cent internally converted gamma ray of 186 kev in only approximately 6 per cent of its disintegrations. Despite this small probability of emission, the gamma ray in question is easily detected by scintillation spectrometers in Ra sources where radon is present in amounts lower than 50 per cent equilibrium, as is true of radium-burdened mammals. Some idea of the possibilities involved can be gathered by inspection of Figures 1 and 2, which show some preliminary results obtained under conditions described in the legends.

APPARATUS

Either NaI(Tl) or CsI(Tl) cylindrical crystals, 1.5 inches in diameter, sealed in aluminum containers (3), were used as scintillators. They were coupled optically to a 6292 Dumont photomultiplier tube connected in turn to the inputs of two single-channel analyzers. One of these was adjusted to cover a 35-kev-wide band of the spectrum centered over the 186-kev photopeak of Ra^{226}, and the other to record pulses over a 200-kev band astride those emitted by RaB. Correct adjustment of the channels was effected by motorized scanning of the spectrum of a Ra source in air with the instruments feeding a count rate meter and strip chart recorder. The simultaneous reading of the two bands curtailed the necessary recording time and eliminated errors arising from uncontrollable motions of the animal.

Before proceeding further, it is well to recall that the interaction of monoergic photons with a scintillator leads to the production of light pulses by photoelectrons and Compton-recoil electrons released in the crystal. This phenomenon leads to characteristics in scintillation spectra that have been adequately described in the literature (4). It will suffice to state here that the pulses recorded in the Ra^{226} band are due not only to 186-kev photoelectrons but also to Compton-recoil electrons released by Ra(B + C) gamma rays. The extent to which these are present is readily seen by comparing the spectra of Ra and Rn in air in Figure 1.

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