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CONFIRMATION OF RADIOACTIVITY IN THYROIDS OF VARIOUS ANIMALS

July 15 to August 9, 1954

Hardin B. Jones

September, 1954

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CONFIRMATION OF RADIOACTIVITY IN THYROIDS OF VARIOUS ANIMALS

July 15 to August 9, 1954

Hardin B. Jones

Donner Laboratory of Biophysics and Medical Physics
and Radiation Laboratory, Department of Physics
University of California, Berkeley, California

September, 1954

Assuming that the observed contamination of animal thyroids has as its basis an air-borne distribution that may follow the prevailing winds, it is possible to estimate from Van Middlesworth's and Gunther's data that a primary zone of rather uniform I^{131} burden exists, encircling the northern hemisphere, approximately 1000 miles wide and 20,000 miles in its global perimeter. If there is uniform distribution, approximately 6×10^{20} liters of air at standard conditions are contained in this strip. Outside this zone of rather uniformly high concentration, transitional zones of more dilute air may be expected to exist. The total I^{131}-containing space in the atmosphere, based upon the concentration in the primary zone, may be roughly approximated as e times the volume of the primary zone (e = 2.718...); thus a volume of air equivalent to about 2×10^{21} liters may contain I^{131} at the level of contamination estimated for the above primary zone.

Most of these observations are based upon the measurement of the cow thyroid. The cow has a 30-gram thyroid and respires an estimated tidal volume of 2×10^{6} liters of air (standard conditions) per month.

Roughly, then, the degree of contamination of our atmosphere can be estimated. The cow should extract all of the I^{131} from air it breathes (considering factors of diffusion and distribution coefficients of iodine or iodide). The cow as of June 12, 1954, averaged about 0.003 μc I^{131} per gram; this is equal to about 0.1 μc per thyroid. If the cow has retained all the I^{131} to which she is exposed then she has approximately

$$\frac{2 \times 10^{6} \text{ liters air breathed per month}}{2 \times 10^{21} \text{ liters of contaminated air in the world}}$$

$$= 1 \times 10^{-15} \text{ of world sample of } I^{131} \text{ assimilated per cow.}$$

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Since the cow I^{131} burden is about 0.1 μc, the atmospheric burden as of June 12 was of the order of

$$\frac{0.1\ \mu c}{1 \times 10^{-15}} \times \frac{1}{1 \times 10^{6}\ \mu c/\text{curie}} \approx 10^{8} \text{ curies of } I^{131} .$$

This calculation can be modified to a consideration of either chronic or acute contamination of the atmosphere.

If biological turnover of labeled iodine in the thyroid is somewhat greater than the rate of contamination, the total iodine uptake may have been greater and the air burden as estimated above may therefore be proportionately larger. There is also the possibility of incomplete retention (see references), and the air contamination may be greater for this reason.

It is difficult to estimate thyroid burden earlier than June 12, 1954. This would need to be reckoned from dates on initiation of the contamination--a factor of mixing within the global air mass. It does seem to be suggestive, however, that the relative contamination (as corrected for 8-day decay rate) in animal thyroids increased in July (Gunther's measurement) as compared to June (Van Middlesworth's measurement) by nearly a factor of 5. This could represent a slow saturation of the animal thyroids from a fixed source, or increase of the airborne burden of I^{131} at the earth's surface during that time.

The quantities of I^{131} per gram of thyroid are very low, seldom exceeding the range of 0.0003 to 0.001 μc per gram of thyroid. Nevertheless this amount persisted for a considerable period before it was diminished by radioactive decay, owing to constant uptake from a larger distribution reservoir. It is likely that the exposure incurred during this period averaged in the range of 0.05 to 0.5 r per thyroid for most mammals in the northern hemisphere.

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