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BOVINE THYROID I^{131} IN THE ABSENCE OF ATMOSPHERIC NUCLEAR WEAPONS TESTS

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Bovine Thyroid I^{131} in the Absence of Atmospheric Nuclear Weapons Tests [1.]

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The approximately three year period from late 1958 to late 1961 during which no high yield nuclear weapons tests took place in the atmosphere afforded an opportunity to study the deposition of fall-out in the absence of its continuing formation. For short half-life nuclides, no assays of samples taken before the advent of controlled nuclear fission are possible. The period without weapons tests has offered the only opportunity to study these nuclides in the absence of fallout contamination. The presence of short half-life nuclides in the biosphere is not in itself proof of spontaneous formation since sources of fission products other than nuclear weapons tests exist.

The accumulation of air borne iodine-131 in the thyroid glands of domestic ruminants has been studied under several circumstances. Van Middlesworth (1954, 1956) and Blincoe and Bohman (1962) have reported I-131 accumulation subsequent to atmospheric nuclear weapons tests. Van Middlesworth (1958) and Robertson and Falconer (1959) reported I-131 accumulation following a nuclear reactor accident. The presence of I-131 in bovine thyroids in the absence of known releases of I-131 to the atmosphere has been reported (Blincoe, 1960).

The purpose of this study was to ascertain the concentration of iodine-131 in cattle thyroids in the absence of atmospheric nuclear weapons tests.

Methods

For this study thyroid glands were removed from cattle being slaughtered by a commercial meat packing plant. The only selection practiced was that glands were not taken from very young animals. The greater rate of iodine metabolism (Blincoe, 1958) and different diet of calves would negate comparison with data on

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Table 1

Comparison of Counting Systems

System	N	T	Units
Average Background	2.80	2.07	counts/min.
Average total background counts collected per day	496	384	counts
Standard Deviation of Counting the average background	0.13	0.10	counts/min.
Average Unknown	3.09	2.32	counts/min.
Average total unknown counts collected per sample	216	162	counts
Standard deviation of counting the average unknown	0.21	0.18	counts/min.
Counter Efficiency	5.0	2.8	Percent

more mature cattle. Individual histories were not available on most animals. It is estimated that at least 90% of the animals slaughtered spent the 60 days prior to slaughter within 100 miles of Reno and in the rain shadow of the Sierra Nevada mountain range.

Iodine-131 was determined on 4.0 ± 0.1 gram (fresh weight) samples of thyroid tissue. In so far as possible both lobes of a gland were sampled from at least two locations and no tissue from the isthmus was used. The gland tissue was dissected free of extraneous tissues. The samples were placed in new plastic test tubes and the I-131 measured using a well type scintillation counter, pulse-height analyzer and scaler. The 0.364 MEV gamma ray of I-131 was counted with the pulse height analyzer set to accept only gamma ray energies between 0.359 and 0.369 MEV (10 KV band width). All samples were counted on two measurement systems of different manufacture and the results averaged. Samples were counted for one hour with thirty minute background counts being made between samples. All background data collected on a given day were averaged. Standardization was accomplished by counting capsules containing known activities of purified I-131. All data were decay corrected to 10 AM PST on the day of slaughter. The results of measurements on four to six glands collected at the same time were averaged.

Data for the comparison of the two counting systems used (table 1) and for calculation of the precision of measurement were compiled by random selection of no more than two data collected on any one day. Only data collected during the period without testing and only data from Reno samples were used for these calculations.

Table 2

Yearly Mean Values of Bovine Thyroid I^{131} in Reno

Year	pC/g
1959	1.0
1960	1.9
1962 (To 9/1/62)	0.8

Results and Discussion

Pertinent characteristics of the two measurement systems used and the average counting data for unknown samples are given in table 1. The two counting systems used were quite comparable in signal-to-noise ratio. The average count rate for an unknown sample was approximately one to two standard deviations of measurement above the average background. The net count rate for the samples was so small (0.2 to 0.3 counts per minute) as to render any given datum only semi-quantitative. The standard deviation of measurement (precision) as determined by comparing measurements on the same sample from both measurement systems was 0.67 pc (picocuries or micromicrocuries) per gram (Youden, 1951). The precision of either counting assembly along was 0.48 pc per gram as determined by replicated counts. The average I-131 concentrations in bovine thyroid glands (table 2) was one to two standard deviations of measurement above zero. In a previous paper (Blincoe, 1960) it was demonstrated that this small count rate was indeed iodine-131 since it was of the correct gamma ray energy, decayed with a half-life comparable with the half-life of I-131, and was peculiar to the thyroid gland.

During 1959 and 1961 the concentration of I-131 in bovine thyroids was very constant at an average value of about one picocurie (pc) per gram of fresh tissue (fig. 1, table 2). In 1960 the concentration was erratic. The mean concentration for the year was 1.9 pc per gram and the average concentrations for a single day ranged from 0.2 to 4.9 pc per gram.

During late December 1959 and the first 47 days of 1960 a regular increase in bovine thyroid I-131 concentration was observed (fig. 1). During this period snow fell in Reno on almost a daily basis. After the 47th day of 1960 precipitation stopped and the thyroid I-131 concentration decreased with a half-period of six days to its previous level. The rate of return to normal was the same as observed subsequent to nuclear

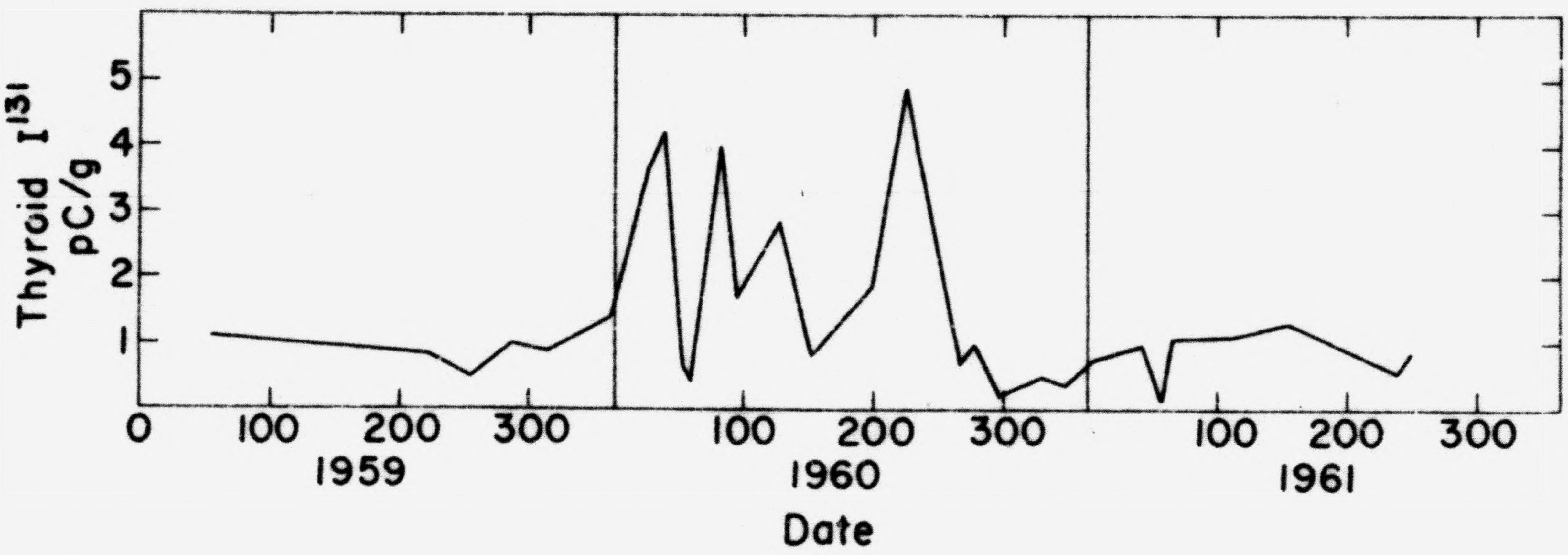

Figure 1. BOVINE THYROID I-131 CONCENTRATION IN RENO, NEVADA.
Each point represents the average of four to six samples.

weapons tests (Robertson and Falconer, 1959, Blincoe and Bohman, 1962). This increase was felt to be due to washing out of the atmosphere by precipitation. It has been demonstrated in several mammalian species that iodine-131 is absorbed only through the gastro-intestinal tract (Robertson and Falconer, 1959; French, 1959) although calculations have been made assuming a pulmonary absorption (Jones, 1954). Bovine thyroid I-131 would thus reflect deposited, rather than air borne fallout and should parallel precipitation.

On February 13, 1960, (day 44) a 60 to 80 kiloton nuclear device was detonated near Latitude 27° N, Longitude 0° (Sahara Desert). A rise in fallout was reported in early March along the 80th meridian in Ecuadore (2° S), the Canal Zone (9° N) and in Puerto Rico (18° N) but not further north (Patterson and Lockhart, 1960). No increase in bovine thyroid I-131 was observed in Reno (39° N) between February 13 and March 10. Thus the fallout from this test went considerably south of the western United States during its first pass around the world. A rise in bovine thyroid I-131 was noted on March 22, 27 days after the test (fig. 1). The data of Patterson and Lockhart (1960) indicated the debris was moving about 20° per day in the tropics. Using this figure, the rise of I-131 in Reno 27 days after the test indicated the debris entered the Reno area on its second trip around the world. A much smaller yield detonation at the same location on April 1, 1960, and the dispersal of the fallout debris from the earlier test are felt to be responsible for the instability of the bovine thyroid I-131 concentrations during the late spring and early summer of 1960. On December 27, 1960, and April 25, 1961, two further atmospheric tests were conducted in the Sahara desert. The fallout from these tests did not result in any increase in the bovine thyroid I-131 concentration in Reno.

The increase observed (fig. 1) in one set of samples on August 11, 1960 (day 224) corresponds to no publicly announced release of fission products. All glands sampled on this date were uniformly high in I-131 concentration.

Possible sources for the I-131 observed in thyroid glands of cattle include unannounced testing of nuclear weapons, natural production of I-131, and disposal of reactor produced I-131. The constancy of the 1959 and 1961 data would tend to rule out unannounced testing as a possible source. The possible natural production of I-131 would account for the consistency of the 1959 and 1961 data. Carbon-14 and hydrogen-3 are known to be produced in the upper atmosphere by cosmic ray interactions. If I-131 were similarly produced one would expect an increase in thyroid I-131 in the spring due to increased mixing of air across the tropopause. Examination of the 1961 data (fig. 1) reveals no increase of I-131 during the first third of the year. This, as well as the lack of potential starting materials for I-131 production in the upper atmosphere, would tend to rule out upper atmospheric formation of this nuclide. The disposal of reactor produced I-131 appears to represent the most probable source of the constant low level of I-131 observed in bovine thyroid glands.

Summary

Cattle in Reno, Nevada, exhibit a constant very low concentration of I-131 in their thyroid glands in the absence of known releases of I-131 to the atmosphere. This concentration is about one picocurie per gram of fresh thyroid tissue. This I-131 appears to originate below the tropopause.

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