Table 2. Alpha-radioactivity of the A_0 layer in different forest types. Units are counts per hour, per square centimeter.

Species dominant in forest	Average		
	S.W. Wis.	N.E. Wis.	S. Appa-lachians
Acer saccharum	2.63	6.77	8.35
Tilia americana	3.30		
Quercus sp.	3.28		
Carya sp.	3.42		8.46
Pinus sp.		5.11	
Fagus grandifolia		6.61	8.75
Tsuga canadensis		9.14	9.87
Abies sp.		6.70	20.70

square meter. The retention of the alpha-emitting substances in the mor humus may be related to the specific nature of its chelating humic acids (*5*). Further work on this relationship is in progress.

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17 October 1955

Acute Myeloid Leukemia Following Prolonged Iodine-131 Therapy for Metastatic Thyroid Carcinoma

There is considerable current interest in the role of radiation in producing leukemia. Reports to date of both human and animal studies (*1, 2*) have been concerned with the results of external radiation. We are reporting here the occurrence of leukemia subsequent to prolonged irradiation exclusively by an internally administered radioisotope (*3*).

Two instances of acute leukemia have developed in the Montefiore Hospital series (*4, 5*) of sixteen patients with metastatic thyroid carcinoma who have been treated intensively with radioiodine. The radioiodine administered to this group of patients, commencing in 1943, ranged from 195 mc to 2290 mc over a 6-month to 9-year interval. A detailed clinical report of these two cases is in preparation.

The first patient (J.F.) to develop leukemia received 13 therapeutic doses of I^{131} from 1947 to 1951, totalling 1455 mc. He was 58 years old when therapy started. Employing the methods and data reported previously (*6*), we estimate that he received a cumulative blood radiation dose of about 600 rad (Fig. 1). The amount of generalized body radiation received is, usually, about half the blood radiation dose (*6*). The patient died in 1951 with a clinical picture of acute myeloid leukemia. Post-mortem studies revealed, among other findings, myeloid leukemia involving bone marrow, spleen, liver, and lymph nodes, as well as anaplastic carcinoma of the thyroid metastasizing to cervical lymph nodes, skull, spine and lungs.

The second patient (B.L.) received a total of 1730 mc of I^{131} from 1948 to 1953, which we grossly estimate delivered 550 rad to the blood. She was 61 years old when therapy was initiated. As indicated in Fig. 2, this patient received 20 therapeutic doses of radioiodine, the first two of which were administered at Mt. Sinai Hospital, New York. Although that hospital reported that the white blood count was 6500, the patient had recurrent leucopenia after she came under our observation. The leucopenia, associated with a persistent severe anemia, became more marked in her last 3 years. In June 1953, her differential count began to show abnormal forms and high "lymphocyte" counts. In September 1954, the white blood count began to rise rapidly, with a high proportion of myeloblasts, and the patient was readmitted to the hospital because of persistent bleeding. She died 5 weeks later, exhibiting the clinical and hematological features of acute myeloid leukemia. The autopsy findings included acute myeloid leukemia with infiltrates in bone marrow, spleen, liver, lungs, kidneys, and pancreas, and metastatic thyroid adenocarcinoma in the skull.

A causal relationship between radioiodine therapy and leukemia is not definitely established by these results. However, the occurrence of these two cases in a series of 16 patients tends strongly to validate the correlation. Moreover, the experimental production of leukemia in animals by radiation (*7*), the frequent occurrence of leukemia among radiologists as compared with other physicians (*8*), and the high incidence of myeloid leukemia among the survivors of the Hiroshima and Nagasaki atomic explosions (*1*) are all consistent with the existence of a relationship between the radiation received during massive radioiodine therapy and the subsequent development of leukemia. Furthermore, two case histories have been published (*9*) in which development of acute leukemia has been reported subsequent to external radiation followed by I^{131} therapy for thyroid carcinoma.

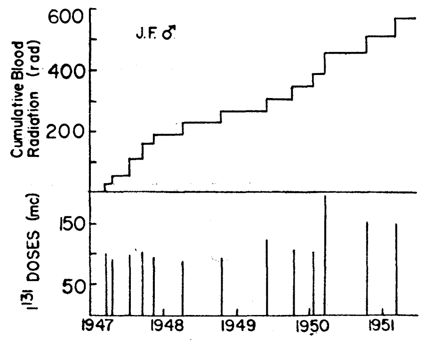

Fig. 1. Patient J.F. The cumulative blood radiation and the therapeutic doses of I^{131} administered are plotted as a function of time.

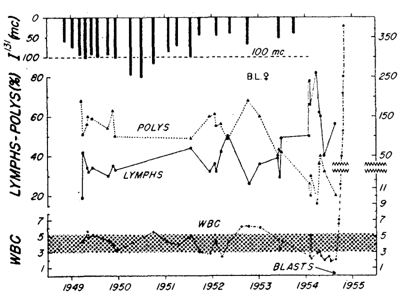

Fig. 2. Patient B.L. Variation of the white blood cell count, lymphocytes, and polycytes with time. The bars at the top indicate the occurrence and magnitude of the radioiodine doses administered to the patient.

It is noteworthy that the type of leukemia developed by both patients reported here was acute. This is consistent with the recent report of Moloney (*10*) that, of 92 cases of leukemia occurring among survivors of atomic bombing, 52 were acute or subacute and only 40 were chronic. Moloney's observations, as well as the relatively small number of cases of chronic leukemia among radiologists, as compiled by March (*8*), seem incompatible with the view that leukemia following irradiation is generally chronic (*2*). The delay in the onset of leukemia, which occurred 4 and 5 years, respectively, after initiation of radioiodine therapy, is consonant with Moloney's observations (*10*) that in survivors of atomic bombing the disease has had a latent period of 2 to 9 years, appearing most frequently 4 to 6 years after exposure.

The body radiation dose received during I^{131} therapy for hyperthyroidism is at most a few percent of that received by patients who are treated for thyroid carcinoma, and it is considerably smaller than the apparent minimum leukemogenic dose, which Moloney (*10*) found to be about that required to produce severe radiation complaints. Acute systemic radiation effects are not encountered in the course of I^{131} therapy for hyperthyroidism. It is, therefore, unlikely that the incidence of leukemia in patients treated for hyperthyroidism with radioiodine will prove to be significantly higher than the occurrence of leukemia in the general population.

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24 October 1955

Palynological Study of Pleistocene Deposits on Banks Island, Northwest Territories, Canada

In connection with palynological studies made on a variety of Pleistocene deposits in Canada, I have examined several samples from Banks Island, District of Franklin, for plant microfossils.

The locality from which the samples were collected is in the general vicinity of Cape Kellett along the western shore of the Banks Island, approximate lat. 72°N, long. 120°W. According to Pleistocene geologists, this area was not glaciated during the Pleistocene time. However, deposits associated with glaciations cover this part of the island and form a shore cliff more than 100 ft high at the sampling locality. The fine plant debris occurs as lenses and streaks in the stratified gravels and silts.

The samples were collected from these beds of plant debris. The results obtained from palynological studies of two of the samples (No. 4 and No. 17) are given in Tables 1 and 2. In addition to the pollens listed in Table 1, fossil remains of fungus, fragments of bark and woody tissue, stomata of coniferous trees, and spores of mosses were also identified in sample No. 4. In sample No. 17 (Table 2) were further identified the spores of *Sphagnum* and stomata, fungus remains, and fragments of brown mosses. Among the nonarboreal pollens were identified pollen grains of Ericaceae, Caryophyllaceae, Cyperaceae, Gramineae, Polemoniaceae, and two pollen grains of *Ephedra* sp.

The palynological study suggests that, at the time when the beds from which the samples were collected were deposited, considerably more favorable climatic conditions than those now prevailing must have been present on Banks Island to account for the assemblage of pollen grains, spores, and other plant fossils present in these deposits. The total assemblage and relative numbers of pollen grains further suggest local forest coverage. The present timber line lies about 200 mi southwest of Banks Island.

The presence of pollen grains of *Ulmus, Tilia,* and *Carya* as well as *Tsuga heterophylla* made me think of the possibility that some of these pollen grains may have been transported by wind from a distant locality several hundred miles away. Even if that is true, these trees must have had a much wider distribution in earlier Pleistocene time than they do now. The lithological character of the material (gravel and silty sand) suggests rather rapid sedimentation, in which case the very low number of grains of tree pollen that would be transported by wind from a distant locality would not enter strongly into the assemblage of pollen grains and spores. This is also shown by the fact that the number of pollen grains and spores per unit volume of material is high. The high frequency cannot be described as primarily the result of a slow accumulation of pollen grains and spores transported from a distant locality by wind. The possibility of contamination seems unlikely, for several other samples that were analyzed at the same time did not yield any pollen grains at all. In addition, particular care was exercised to avoid contamination during analysis.

Of special interest is the discovery of pollen grains of *Ephedra* sp. in this material (Fig. 1). For identification, the fossil pollen grains were compared with modern reference material and descriptions of *Ephedra* pollen in palynological texts and with photographs and descriptions of modern and fossil *Ephedra* pollen given by Andersen (*1*).

The present distribution of *Ephedra* is limited to the southern parts of the Rocky Mountains (*2*). However, pollen grains of *Ephedra* have recently been found in the early postglacial sediments in the Great Lakes region by me and by Andersen (*1*). As also pointed out by Andersen (*2*, p. 19) *Ephedra* is not specific in its thermal requirements and is able to exist in edaphically favorable localities with strong isolation. In spite of that, the presence of *Ephedra* on Banks Island must involve considerable migration of the plant. It seems more likely that the species previously had a much wider distribution and that the successive Pleistocene glaciations eliminated it within the reach of the ice sheets.

As a conclusion, I suggest, on basis of palynological studies, that the long, warm interglacial periods such as Sangamon, Yarmouth, and Aftonian are probably represented by accumulation of organic deposits in the Far North and that further studies may disclose a much fuller sequence of Pleistocene deposits in the northern regions, outside the maximum extent of the Pleistocene ice sheets, than has been expected so far.

Table 1. Analysis of sample No. 4. This sample was collected from a bed of plant debris that was approximately 30 ft above sea level and 6 mi north of Cape Kellett.

Plant	Pollen grains identified (No.)
Picea	28
Pinus	43
Betula	32
Alnus	Abundant (local over-representation)
Tsuga heterophylla (?)	10
Ulmus	2
Tilia	2
Carya	1
Nonarboreal pollen, unidentified	17
Ericaceae	2
Polypodiaceae	1

Table 2. Analysis of sample No. 17. This sample was collected from a lens of plant debris that was approximately 20 ft above sea level and 7 miles east of Cape Kellett.

Plant	Pollen grains identified (No.)
Picea	6
Pinus	11
Betula	17
Alnus	16
Tsuga heterophylla	1
Tsuga mertensiana	1
Carya	3
Ulmus	1
Salix	1
Compare *Fagus*	1
Nonarboreal pollen, unidentified	32