5. R. W. Perkins, J. M. Nielson, W. C. Roesch, R. C. McCall, *Science* **132**, 1895 (1960).
6. E. C. Anderson and W. H. Langham, *ibid.* **130**, 713 (1959).
7. H. E. Palmer, in "Research and Development Activities in the Radiological Sciences—1961," *Hanford Rept. HW-73337* (1962), p. 29.
8. We are indebted to Dr. Kasumi Kasugi of the Public Health Service for use of the hospital facilities at Kotzebue and Barrow; to Max G. Brewer, director of the Arctic Research Laboratory, for invaluable support in transporting equipment at Barrow and Anaktuvuk Pass and for the use of the laboratory facilities; and to Amos Lane for his help in contacting Eskimo subjects and for interpreting. This work was performed under a contract [AT(45-1)-1350] between the Atomic Energy Commission and the General Electric Company.

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Cesium-134 in Alaskan Eskimos and in Fallout

Abstract. *Whole-body counts of Alaskan Eskimos during the summer of 1962 showed the presence of cesium-134 as well as cesium-137. Cesium-134 was also found in reindeer and caribou meat; this finding was confirmed through coincidence counting. There was generally about 1 percent as much cesium-134 as there was cesium-137. Cesium-134 was also found on air filters collected at Richland, Washington. The appearance of cesium-134 seems to be world-wide and continuing.*

In the first report of the finding of cesium-137 in Laplanders (*1*), mention was made of a small peak at 800 kev in the scintillation-counter pulse-height spectrum. After further study, Lidén and Andersson (*2*) concluded that the peak was caused by Cs^{134}. The identification was made through coincidence counting and half-life measurement. The Cs^{134} was found both in people and in reindeer meat, in the same abundance relative to Cs^{137}. In measurements made in March 1961, about 1.6 percent as much Cs^{134} as Cs^{137} was found.

The same Cs^{134} peak was found in the spectra for some Alaskan Eskimos during the work described elsewhere in this issue. Figure 1 shows the average spectrum for the ten Eskimos with the highest body burdens of Cs^{134} found in the 1962 study. The peak is clearly visible. It is also visible in the spectra for the individual Eskimos of this group, particularly in the spectrum for the individual with the highest body burden (790 nc) of Cs^{137}, but more significant statistics are obtained by averaging the spectra.

All of the individuals in this high-body-burden group were from Anaktuvuk Pass. The average spectrum for all the people of Anaktuvuk Pass for whom counts were made showed the Cs^{134} peak, but it was not so well resolved in this spectrum as in the average spectrum for the high-body-burden group. The peak could not be clearly identified in spectra for individuals or groups from other parts of Alaska. We feel that the statistical uncertainties in the count for the low-body-burden groups and the interferences of low-level radiation from $Zr\text{-}Nb^{95}$ from external sources were large enough to conceal a peak even if there were one.

The average spectrum for 200 people for whom counts had been made with the Hanford whole-body counter at Richland, Washington, in 1961 was computed to see if any evidence for the occurrence of Cs^{134} could be found. (The period of counting had been 20 minutes instead of 5 or 10, as in the 1962 study of the Eskimos.) Again, the statistical uncertainty stemming from K^{40} and Cs^{137} contributions to the spectrum in the region where the Cs^{134} peak would occur was large enough to conceal such a peak.

Comparison of photo-peak heights for the Eskimos and correction for gamma-ray abundances and for efficiency and resolution of the counter gave a Cs^{134}/Cs^{137} activity ratio of 0.0118. Comparing the average spectrum for the Eskimos with the spectrum for Cs^{134} and Cs^{137} sources dissolved in water gave a ratio of 0.0125. The counts for the Eskimos were made in July 1962. Correction for decay of the two isotopes gives an activity ratio of 0.018 for March 1961. This value is in reasonable agreement with the ratio found in Lapland.

Counts for reindeer and caribou meat collected in Alaska in the summer of 1962 also showed the presence of Cs^{134}. Findings for the Cs^{134} content of these meat samples were verified and measured by gamma-gamma coincidence counting of the 0.605- and 0.797-Mev cascade photons, in the manner reported by Lidén and Andersson. Two sodium iodide (T1) scintillators, 23.8 cm in diameter and 9.2 cm thick, were used for counting 1.4-kg meat samples. The coincidence spectra obtained in this manner were compared with the spectrum for a standard Cs^{134} source of similar geometry. These measurements showed the Cs^{134} to be present in a concentration 0.82 percent that of the Cs^{137}.

Cesium-134 has also been found in fallout at Richland, Washington. Cesium

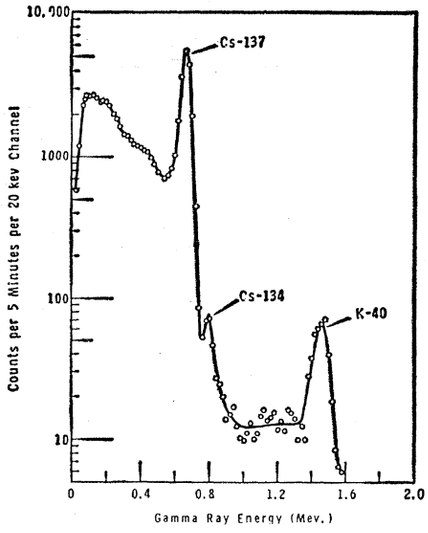

Fig. 1. Average scintillation-counter pulse-height spectrum for the ten Eskimos with the highest body burdens of Cs^{134} found in the 1962 study.

was separated chemically from an air filter which had been in service in 1960. The Cs^{134}/Cs^{137} activity ratio was less than 0.01 (the total activity was too low to permit precise measurement). An activity ratio of 0.017 was found for cesium chemically separated from an air filter that was in service from early December 1962 through February 1963. Although Cs^{134} is produced in nuclear reactors, there is no reason to suspect that the Hanford plant was the source of the Cs^{134} on these filters. The ratioactivity found on the filters is comparable with that found on other filters throughout the Pacific Northwest.

The foregoing data indicate that Cs^{134} has been and is being deposited in North America as well as in northern Sweden and Finland, and that the deposition is probably world-wide. Cesium-134 has been reported in fallout elsewhere. Particulate samples collected from air over St. Louis during March 1957 showed rates of disintegration for Cs^{134} that were from 12 to 16 percent of those for Cs^{137} (*3*). Cesium-134 was also found in a soil sample taken near ground zero after an atomic balloon shot in Nevada (*4*). No Cs^{137} was observed in this sample, so the Cs^{134} evidently resulted from neutron activation of inert Cs^{133} in the soil. It seems unlikely that the Cs^{134} in the St. Louis sample could have been produced by activation of Cs^{133} in soil.

The world-wide distribution of Cs^{134} has an important bearing on the identification of its source. The formation, from fission of uranium-235, of Cs^{134} at concentrations 1.6 percent those of Cs^{137}

would require a fission yield of Cs^{134} of 7×10^{-8} percent. This is higher by about an order of magnitude than the fission yield one would expect (*5*). Cesium-134 can be formed in nuclear reactors by neutron capture in the fission product, Cs^{133}. Lidén and Andersson cite Prawitz, who calculated that 6 months' exposure of U^{235} to a flux of 10^{13} neutrons per square centimeter per second would give a Cs^{134}/Cs^{137} ratio of 0.33 (*6*). Blomeke and Todd, however, calculate a ratio of 0.03 for these same conditions (*7*). In our study, an elementary calculation was made which was in agreement with the low value of Blomeke and Todd. Lidén and Andersson considered the possibility that the Cs^{134} found in Lapland came from the reactor accident at Windscale in England in 1957. The high reactor yield predicted by Prawitz made this possibility seem reasonable. This hypothesis no longer seems likely, however, for several reasons: (i) Prawitz's calculated yield is too high by a factor of about 10; (ii) the presence of Cs^{134} in regions remote from Lapland and the constancy of the proportion of Cs^{134} relative to Cs^{137} seem very hard to explain in terms of a particular accident; and (iii) the presence of Cs^{134} in current fallout in about the proportion in which it must have occurred in earlier fallout indicates that it is still being formed. We feel that the source of the Cs^{134} is yet to be identified. The yield of Cs^{134} from fissionable isotopes other than U^{235} has not been reported, and this yield may be high enough to account for the observed abundance. Unless there is a rather high yield from one of these fissionable materials, it would appear that the Cs^{134} must be produced from inert Cs^{133} (*8*).

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References and Notes

1. K. Lidén, *Acta Radiol.* **56**, 237 (1961).
2. K. Lidén and I. O. Andersson, *Nature* **195**, 1040 (1962).
3. G. S. Bien and D. C. Mart, Jr., in "Interim Progress Report," *U.S. At. Energy Comm. Publ. AECU 4164*, H. E. Suess, Ed. (1958).
4. H. L. Krieger and D. Groche, *Science* **131**, 40 (1960).
5. A. P. Baerg, R. M. Bartholomew, R. H. Betts, *Can. J. Chem.* **38**, 2147 (1960).
6. J. Prawitz, *Acta Chem. Scand.* **13**, 163 (1959).
7. J. O. Blomeke and M. F. Todd, "Uranium-235 Fission-Product Production as a Function of Thermal Neutron Flux, Irradiation Time, and Decay Time," *Oak Ridge National Laboratory Publ. 2127* (1957).
8. This work was performed under a contract [AT(45-1)-1350] between the Atomic Energy Commission and the General Electric Company.

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Blood Groups in Anthropoid Apes and Baboons

Abstract. *Tests on chimpanzees, orangutans, gibbons, baboons, and a gorilla, with blood grouping reagents prepared for human red cells, have disclosed patterns of reactions characteristic of each primate species. Determinations have been made of A-B-O groups and subgroups, M-N types, Rh-Hr types, secretor status, and Lewis types. Immunization experiments with ape and monkey blood are in progress.*

Biochemical evolution implies that closely related species will possess similar serological properties. In fact, it has been found that reagents prepared for blood grouping in man can be used for studies on apes and monkeys, and, conversely, reagents prepared with blood from rhesus monkeys led to the discovery of the Rh-Hr blood group system of man (*1*). Analogous cross-reacting isoantigenic systems have been revealed by recent studies in serum of primates, including man (*2*).

Recent increased interest in nonhuman primates as experimental animals has led to the creation of a number of primate research centers throughout the country, and one of the prime base-line investigations concerns studies on the blood groups of these animals. Such investigations dovetail with our own long-term interest in individual differences in human blood cells and serum, in particular, those revealed by immunological cross-reactions among primate species, including man. The present report summarizes observations on a series of chimpanzees, orangutans, gibbons, and baboons, as well as one gorilla, made with a battery of reagents prepared for grouping human blood.

Because of the presence of nonspecific heteroagglutinins in anti-**A** and anti-**B** reagents (*3*) intended for grouping human blood, such reagents had to be first absorbed with group-O chimpanzee red cells, before they could be used for testing nonhuman primate blood. With this technique, there was no difficulty in testing the blood cells from chimpanzees, orangutans, and gibbons. The results were then confirmed by reverse grouping of the ape sera against human red cells of group O, A_1, A_2, and B. In the case of the baboons, the red cells were not agglutinated by the reagents used, so the blood groups were inferred from the results of inhibition tests on the saliva as well as tests on the sera for agglutinins (*4*). Table 1 summarizes the findings of the present study, and compares them with those reported in the literature.

As can be seen from Table 1, only the blood groups A and O occur among chimpanzees. Among the combined total of 183 chimpanzees, there are 11.48 percent of group O and 88.52 percent of group A, yielding the gene frequencies, $I^O = 33.9$ percent and $I^A = 66.1$ percent. Among orangutans and gibbons, groups A, B, and AB, but not group O, have been encountered. The gorilla blood gave atypical reactions in that the cells were only weakly agglutinated by anti-**B** reagents and not affected by anti-**A** reagents. Since the serum contained only anti-**A**, the gorilla is classified as group B-like. Similar findings had been obtained on another gorilla by Wiener *et al.* (*5*). A gorilla studied in 1928 by Landsteiner (*6*) could not be classified, but study of the protocols indicates that this gorilla was also B-like. Table 1 does not include the findings on seven gorillas by Candela *et al.* (*7*), which were based only on tests on the urine by the inhibition technique. Interestingly, five lowland gorillas (*Gorilla gorilla*) tested in this way proved to be group B, while two mountain gorillas (*Gorilla berengei*) were group A. The baboons exhibited groups A, B, and AB; none were group O. As has been pointed out, the classification of baboons was based primarily on tests on the saliva rather than blood.

Thus, as far as the A-B-O blood groups are concerned, among the apes, gorillas are the most different from man, and most similar to monkeys, since the A-B-O groups of gorillas are more readily determined from their secretions than from their blood.

Tests for the subgroups of A were done with anti-A_1 reagents of human origin, as well as reagents prepared from seeds of *Dolichos biflorus*. Depending on the strength of the reagent, chimpanzee group-A cells uniformly gave negative or weak reactions, indicating a closer relationship to human subgroup A_2 than to A_1; thus, chimpanzees are best classified as low grade $A_{1,2}$. On the other hand, gibbon blood of group A was strongly agglutinated by anti-A_1 reagents; group AB gibbon blood was less strongly clumped. This indicates that such gibbons belong to subgroups A_1 and A_1B, respectively.