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The Antirachitic Effect of December Sunlight: Seasonal Variation.

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It was first shown by Huldschinsky[1] that rays from the mercury vapor quartz lamp produced a definite antirachitic effect on rachitic infants. Hess and Unger[2] demonstrated that the sun's rays also prevented infantile rickets. This beneficial effect of the sun was confirmed with carefully controlled animal experiments by Powers, Park, Shipley, McCollum and Simmonds.[3] Hess and Weinstock[4] found that the rays which exerted this curative effect were shorter than 313 millimicrons. This means that the effective solar rays range only from 313 to 290 millimicrons in length, and constitute a very small percentage of the total solar radiation. As these very short rays are readily absorbed by smoke, dust and moisture in the atmosphere, the ultraviolet content of the sun's rays is markedly reduced in the winter months, when the sun is low in the sky, and the rays consequently have to pass through a greater distance of our atmosphere.[5, 6] It is, therefore, reasonable to expect that the antirachitic effect of sunlight will be correspondingly reduced. This raises the question as to whether this reduction may not be so great as to practically eliminate any beneficial effect during the winter months.

The results here reported are some of those obtained in an experiment being conducted by this Department with the cooperation of the Department of Physics, and the Department of Physiological Hygiene of the University of Toronto, in an attempt to determine the variations in the ultraviolet content of the antirachitic effect of the sun's rays throughout the year. The experiment was commenced in September, 1926. Each week a series of young rats are placed on a rickets-producing diet and exposed daily to the direct rays of the sun. The rats are killed after the desired period, roentgenograms of the bones made, the inorganic phosphorus content of the whole blood estimated, and the percentage of ash in the bone determined. Daily measurements of the ultraviolet content of sunlight are also made. Some of the results obtained during the month of December with the animal portion of the experiment are of sufficient interest to justify publication now.

The rats used were albinos, all obtained from the same stock.

TABLE I.
Effect on rats of exposure to December sunlight.

Treatment	Inorganic Blood Phosphorus mg. per 100 cc.			Per cent ash in bone		Roentgen Ray Evidence of Rickets	
Rats started Nov. 29, 1926. Initial Blood P. = 7.5 mg. per 100 cc. Initial ash in bone, 40.0 per cent.	After 1 wk.	After 3 wks.	After 4 wks.	After 3 wks.	After 4 wks.	After 3 wks.	After 4 wks.
Normal diet—inside cage	—	—	7.0	—	—	—	none
Rachitic diet—inside cage	—	—	1.5	—	—	—	marked
Rachitic diet—outside ¼ hour daily	—	—	1.8	—	—	—	marked
Rachitic diet—outside 2 hours daily	—	—	2.6	—	—	—	slight
Rats started Dec. 6, 1926. Initial Blood P. = 7.3 mg. per 100 cc. Initial ash in bone, 40.0 per cent.							
Normal diet—outside 2 hours daily	5.6	7.1	6.5	52.8	56.7	none	none
Rachitic diet—inside cage	3.0	3.0	1.2	31.8	30.3	marked	marked
Rachitic diet—outside 1 hour daily	—	3.0	1.7	34.0	35.9	moderate	marked
Rachitic diet—outside 2 hours daily	5.0	3.9	2.9	39.6	43.7	moderate	slight to moderate

They were 25 to 27 days old and weighed about 40 grams. They were placed on McCollum's diet 3143 (wheat 33 per cent, corn 33 per cent, wheat gluten 15 per cent, gelatine 15 per cent, calcium chloride 3 per cent and sodium chloride 1 per cent). The rats exposed to sunlight were placed on the roof of the hospital at 11 o'clock each day and taken in, after exposure varying from 15 minutes to 2 hours. Although the rats were exposed up to 2 hours daily they did not receive 2 hours of sunshine each day. The records of the Dominion Meteorological Department, which is situated within half a mile of the hospital, show that the average daily sunshine from 11 to 1 o'clock during the month of December was only 0.6 of an hour (36 minutes). Control rats were kept inside in an ordinary well lighted room on the same diet. Further control rats were placed on a normal diet, some being exposed to sunlight 2 hours daily, and others being kept inside. After varying periods up to 4 weeks, 2 rats from each cage were killed by bleeding from the carotid artery, under light ether anesthesia. Roentgenograms were taken of the rats.* The inorganic phosphate content of the blood was estimated by the method of Tisdall,[7] and the ash content of the bone by the procedure outlined by Betke, Steenbock and Nelson.[8]

The inorganic whole blood phosphorus and the per cent ash in the bones are recorded in Table I. In the same table is also given the degree of rickets as observed from the roentgenograms. Although the roentgenograms of the rats exposed to the available sunlight for a period of ¼ to 1 hour showed marked rickets, a definite deposition of lime salts could be seen at the ends of the shafts of the long bones, which deposition was not present in the rats kept inside in the same diet.

Conclusion: The sun's rays in December in the latitude of the City of Toronto produce a definite antirachitic effect on rats fed on a rickets producing diet.

Our thanks are due to the Department of Health of the Province of Ontario for a grant in aid of the expense of this investigation and to the Honorable Dr. Forbes Godfrey, Minister of Health, for his interest in this work and the authorization of the grant from his department. This is a complete report.

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The Antirachitic Effect of December Skylight and of December Sunlight Through Vitaglass.

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In the preceding publication,[1] results were reported which indicate that December sunlight in the latitude of the City of Toronto possesses a definite antirachitic effect. Although the rats were exposed for 2 hours daily, they received only a daily average of 36 minutes of sunshine, due to the cloudy weather. It has been noted by Dorno[2] and Hill[3] that skylight contains ultraviolet rays, as well as direct sunlight. This raises the question as to how much of our antirachitic effect was due to the 36 minutes exposure to sunshine, and how much to the remaining 84 minutes exposure to skylight. Accordingly rats on McCollum's rickets producing diet No. 3143[1] were placed outdoors for 2 hours daily from 11 a. m. to 1 p. m., exposed to skylight, but protected from direct sunlight. After varying periods ranging from 1 week to 4 weeks, 2 rats at a time were killed, roentgenograms taken of the bones, the blood phosphorus determined, and the per cent ash in the bones estimated. The results which are given in Table I, indicate that December skylight possesses a definite antirachitic effect, which effect is almost as marked as that obtained by exposure to the available sunlight.

A clear glass which the manufacturer claims will transmit the shortest ultraviolet rays of sunlight (290 millimicrons) can now be obtained under the trade name of "Vitaglass". We found that rays as short as 262 millimicrons, the source being an iron arc in air, will pass through this glass. To get some idea of its value from the clinical standpoint, we constructed from vitaglass, a glass box to fit over and around one of the cages. Another glass box made with ordinary glass which transmitted rays only as short as 320 millimi-