strips of glass, stuck on with balsam. Again we got beautiful images of the slits, especially behind the glass cross-pieces, from radiation which we finally traced to the balsam. We therefore bored one half inch holes through glass plates two by two and one half inches and slipped these behind spring clips, inserting the plates between the screens and the side of the box. This apparatus was put in a second bright tin box (light proof), the whole wrapped in black oil cloth, and kept in the dark room in a drawer, with the door locked, all the lights being unscrewed from the sockets. Images of the holes through the screens appeared as before, equally dense from the blank tubes and the test solutions, but the necessary exposure with this apparatus was longer. Oil kept in the dark for two weeks gave the same results as that kept in diffuse light on the laboratory shelf, and exposure for one half hour to bright sunlight had no effect as compared with unradiated oil. Two different samples of oil were used, one very old sample (judged by its odor) and a fresh sample purchased at the hospital pharmacy. Both gave similar results. Nujol sensitized plates showed no greater density than unsensitized. The oil was not tested on animals for antirachitic properties.

We therefore assign all our results to black body radiation of a wave length that may penetrate quartz but not glass. Further evidence to this conclusion was obtained by conducting the experiments in a warm dark room at 40° C., where the results were much more pronounced. If the reactants were such as to raise the temperature still further (*e.g.*, neutralization of strong acid by KOH), splendid images resulted after one or two hours.

Our last experiment, No. 52 (a repetition of No. 51) was conducted as follows. Four similar quartz tubes were inserted in their holders. One was left empty, one filled with cod liver oil, one with 6 cc oil and 2 cc 40 per cent. KOH, and the fourth with the same amounts of KOH and oil but with oxygen slowly bubbling through. A plate was preexposed, cut and the quarters inserted behind glass screens with holes bored through them and left at room temperature under conditions described above for 73 hours, the plates being spaced one fourth inch from the sides of the tubes. The four sections of the plate were developed coincidentally in the same tray, and all showed equal density of background and equal density of round image. The slightly greater density that one of us thought he could see in the control we assign, if it existed, to the circumstance that the cod liver oil in the other tubes may have shielded the plates from radiation from the opposite walls of their compartments.

Previous reports have appeared on the nature of black body radiation that is transmitted by quartz but absorbed by glass, capable of affecting a photographic plate.[5]

In conclusion, though we have not perhaps demonstrated the absence of ultra-violet radiation from cod liver oil, all our positive findings of differential effects we have been able to trace to faulty procedure. Our results differ from those of Kugelmass and McQuarrie in that (1) we have been unable to confirm their positive findings, and (2) we have demonstrated the effectiveness of black body radiation in simulating such results, with poorly controlled technique.

E. S. WEST,
G. H. BISHOP

MEDICAL SCHOOL
WASHINGTON UNIVERSITY

"RUSSELL EFFECT," NOT ULTRAVIOLET LIGHT, RESPONSIBLE FOR CHANGES PRODUCED IN THE PHOTOGRAPHIC PLATE BY ANTIRACHITIC SUBSTANCES[1]

IN a previous preliminary communication[2] the conclusion was drawn that ultraviolet light is emitted by cod liver oil and certain other substances curative of rickets when they are oxidized in alkaline media. The first method employed in the qualitative experiments reported was that of exposing a sensitive photographic plate to the substance to be tested for a period of twenty-four to forty-eight hours at a distance of a few inches and with a transparent quartz screen interposed to exclude the effects of reducing vapors. The quartz was sealed over a small aperture in the bottom of the lead plate-holder by means of two layers of adhesive tape. The photographic plate was placed in its holder with the film side down in apposition with the quartz window. This preparation was then placed directly over a beaker partially filled with the substance to be tested. The latter was alkalinized with sodium hydroxide and oxidized by a stream of oxygen or by the addition of hydrogen peroxide. All experiments were carried out completely in the dark room.

The conclusion that ultraviolet light was emitted

[5] Coblentz, W. W., Reports of the Carnegie Institution of Washington. Publ. No. 65, Part III, p. 21, 1906. Publ. No. 97, Part VII, p. 140, 1908. Quartz is shown to transmit 90 per cent. of the energy in the infra red affecting the photographic plate; furthermore, quartz itself emits at room temperature infra-red radiation in this region, with an emission maximum just within the range of photographic sensitivity.

[1] From the Department of Pediatrics, Yale University, New Haven.

[2] I. N. Kugelmass and I. McQuarrie, SCIENCE, Sept. 19, 1924.

was based upon the following facts. Visible light was never observed. When developed, most of the plates showed the presence of shadows corresponding in position and outline to the quartz window of the plate-holder. When the dry plate was exposed with the film side away from the substance, no shadowing was produced. Neither was there any fogging of the control plates. It was believed, therefore, that invisible ultraviolet light capable of passing through quartz but not through glass was given off.

Since the preliminary communication we have been forced to alter our original interpretation of the phenomenon observed. Attempts to obtain quantitative data with a more elaborate technique and with more rigid control of all the factors concerned gave such discordant results that the original methods were reexamined. After further investigation we have been forced to the conclusion that the great majority of our results can best be interpreted on the ground that they were produced by reducing vapors and not by the emission of light. The experiments failed to furnish evidence of a light emanation from oxidized substances curative of rickets. Since, in addition, we have been unable to detect the emanation of light under these conditions with the most sensitive photoelectric cell, we believe the phenomenon too difficult to isolate at present; it is probably of the nature of the so-called Russell effect.

In 1898 W. J. Russell[3] discovered that a large number of substances of most diverse character rendered a photographic plate developable. This phenomenon has since been referred to as the "Russell effect," "photechic effect," "Moser rays," "Metallic radiations," etc.—all pseudo-photographic effects.

A survey of the literature reveals that the phenomenon has been extensively observed and has been characterized by a number of properties. For example, it has been stated that the photographic plate is affected through thin sheets of gelatin, gutta percha, celluloid, collodion, tracing paper, photographic paper and porous substances but not through glass, quartz, mica and aluminum;[4] the emanation is not propagated in a rectilinear manner and can be swept along a bent tube by a current of air;[5] the effect can not be produced on a photographic plate in a current of carbon dioxide, dry air, hydrogen or in a vacuum;[6] the shadows formed are not bounded by straight lines but curve around a screen;[7] the property can be transferred from an active to an inactive body by contact; the emanation does not affect an electrical field;[8] the phenomenon occurs only in the presence of moist air and increased humidity accelerates it;[9] the effect is accentuated by previous exposure to sunlight, a moment's exposure producing activity for weeks, intense at first but gradually becoming feebler;[10] the property is lost by exposure of the substance in complete darkness; it may be restored by exposure to light and oxygen;[11] it is destroyed by heat;[12] the activity of the metals is in the order of the E.M.F. series and is promoted by cleaning the surface or merely scratching it;[13] the property common to all substances capable of fogging a photographic plate is their oxygen-absorbing capacity.[14]

The relation of the phenomenon to physiology was first studied by V. Schlaepfer,[15] who interpreted his experimental data on the basis of light emission. He found that lecithin, blood and certain organs of rabbits, when oxidized, fogged a photographic plate, the intensity of the shadow being related to the previous exposure of the animal or material to sunlight.

The active agency in this phenomenon appears to be a material substance rather than a radiation and chemical studies indicate that it is hydrogen peroxide, an intermediate product in organic oxidations.[4] All the phenomena exhibited by the active bodies can be reproduced by the solution and vapor of hydrogen peroxide itself. Russell found that a developable impression was produced on a dry plate by exposure for eighteen hours to the vapor of a solution containing only one part of hydrogen peroxide in a million parts of water,[16] thereby duplicating the action of light on a photographic plate.

The reverse reaction, wherein bubbles of oxygen were observed upon exposure of the oxidized substances to the mercury vapor quartz lamp, has not been confirmed.

I. N. KUGELMASS
I. MCQUARRIE
YALE UNIVERSITY

[3] W. J. Russell, Proc. Roy. Soc., London, 63, 102 (1898).

[4] W. J. Russell, *loc. cit.;* Proc. Roy. Soc., London, 80, 376 (1918).

[5] W. J. Russell, Eder's Jahrbuch 9 (1899).

[6] W. J. Russell, Proc. Roy. Soc., London, 64, 409 (1899).

[7] W. J. Russell, *Phot. J.*, 345 (1908).

[8] G. W. A. Kahlbaum, *Chem. Centralblatt,* 1905, 323.

[9] J. Blass and P. Czermak, *Physik. Z.*, 5, 36 (1904).

[10] G. LeBon, Comp. rendu. Acad. Sci., 174 (1899).

[11] E. Legrady, *Z. wiss. photog.*, 60, 1908.

[12] W. J. Russell, Proc. Roy. Soc., London, 64, 409 (1899); Luppo-Cramer, Phot. Korr., 1902, 563.

[13] *Ibid.*

[14] Kugelmass and I. McQuarrie, *loc. cit.*

[15] V. Schlaepfer, Pfluger's Archiv. f. Physiol., 561 (1905).

[16] W. J. Russell, *loc. cit.;* O. Dony, *Chem. Centralblatt,* 1908, 569.