so as to allow readings to be more precise than can be made with a wider neck. To the short arm of the tube is temporarily attached a 30-cm flexible rubber tube provided near its free end with a Mohr cock or similar device for closing. Both tubes are completely filled with distilled water (by means of a small funnel or thistle-tube attached to the free end of the rubber tube) and the cock is closed. Next, the porcelain piece is filled with distilled water and the free end of the J-tube is inserted, the rubber stopper being forced firmly into place in the usual way. The whole assemblage is now reversed and held upright with the J-bend below. In this manner it is lowered into the reservoir, which is nearly filled with distilled water until the short arm of the J is below the water, then a drop or two of mercury is introduced into the open end of the rubber tube, and the cock is opened. The mercury drop falls to the glass J below and forms the valve in the same general manner as in several mountings previously described. The rubber tube is now pulled off and removed, and the J-tube is lowered farther till it nearly reaches the bottom of the reservoir. The reservoir stopper borne on the tube is firmly set into place, and the operation of installing is complete except for the subsequent filling the reservoir to the index mark in its neck. The amount of water entering the reservoir for a complete reversal of the valve[2] is not more than .05 cubic centimeters.

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SPECIAL ARTICLES

THE PHOTOCHEMISTRY OF COD LIVER OIL

WHEN Kugelmass and McQuarrie suggested recently[1] that oxidation of cod liver oil gave rise to ultra-violet radiation, the present writers were inspired to the extent of searching for other substances of biochemical or therapeutic interest which, when oxidized, might be persuaded to yield evidence of luminescence by prolonged exposure to sensitive plates. We were more disposed to this research by the encouraging reports of Steenbock[2] on the antirachitic value of radiated foodstuffs, in which he quotes the above results, presumably in support of the probability of his findings. More recently Manville[3] has quoted them in a similar connection.

We have been unfortunate in not being able to find the substances for which we sought, nor have we been able to duplicate the results reported on cod liver oil, with satisfactory controls. We are publishing our work, however, for the use of those who may incline, as we did, toward an attractive interpretation of such findings, the further investigation of which has considerably disillusioned us.

We used Cramer instantaneous iso plates, each plate cut into four quarters just before exposure, one of which was used as a control. In certain of the experiments we bathed the plates in Nujol mineral oil, to sensitize them to ultra-violet of 2,300 to 1,900 Å U[4] checking against unsensitized parts of the same plate. We have also employed preexposure of the whole plate, before cutting, placed at one half meter from a light ruby lamp behind a ground glass screen, for ten seconds. This accomplished an exposure just sufficient to cause a slight fog with normal development; the next increment of exposure, during the experiment, was then several times more effective than the same exposure of the plate without preexposure. Except for this procedure plates were handled in complete darkness until development outside the direct beam from a safe red light.

Our experiments were performed in a light-proof box in the dark room, using Vitreosil five eighth inch test tubes as containers for the test material. Between the test tube and the plate was interposed a glass screen, with a hole or slit through which it was hoped to obtain the effects of ultra-violet radiation. Our first box, of wood, was painted on the inside with asphaltum. The tubes were thrust through holes in the cover, one half inch from the plate covered by the screen. In this box we obtained wonderful images of the slits, whether any cod liver oil was put in the tubes or not. We then transferred operations to a bright copper box, fitted with holders that facilitated manipulation, each tube and its corresponding plate being in a separate compartment. The screens used at this stage consisted of two plates of glass the edges of which were separated one fourth inch, and which were fastened together with two narrow cross

[2] Harvey, E. M., "The action of the rain-correcting atmometers," *Plant World, 16*: 89–93, 1913.

[1] Kugelmass, E. N., and McQuarrie, I., SCIENCE, Vol. 60, No. 1551, Sept. 19, 1924.

[2] Nelson and Steenbock, *J. B. Chem.*, Vol. 62, p. 577, 1925.

[3] Manville, *Jour. A. M. A.*, Vol. 84, No. 19, p. 1401, 1925.

[4] Dr. Samuel Pond, of this institution, informs us that Nujol sensitized iso plates without preexposure have the same sensitivity as, or greater than, the Schumann plates, from the beginning of the gelatin absorption range (2300 Å U) to the quartz absorption range (1900 Å U). (Lyman, T., SCIENCE, July 20, 1921, p. 48.) From 2,300 to 3,500 A U the sensitivity of iso unsensitized plates is equal to or better than the Schumann. (Harrison and Hesthal, *Journ. Opt. Soc. of Am.*, 1924, Vol. 8, p. 482.) We wish to thank Dr. Pond for valuable advice throughout the photographic procedure.

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.

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"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.