politan mortality with that of the Registration Area. Some of the more interesting facts which have been established by this study may be summarized.

The mortality rate for pulmonary tuberculosis of the children of wage earners is not higher than that of children of the general population. This is all the more striking when we consider that about one half of the children in the Registration Area live in rural communities. The decline in the death rate from pulmonary tuberculosis during the years 1911 to 1916 is greater in the insured than in the general population. The mortality from organic heart disease is higher in wage earners than in the population at large, especially during the working ages. This higher rate persists to old age but to a less degree. Contrary to the general belief, there has been no increase in the death rate for organic heart disease in the period 1911 to 1916. Bright's disease too is a more frequent cause of death in the insured.

Accidents rank fifth in the causes of death. How serious this problem still is, and how great the field for prevention is, is shown by a comparison of the statistics of England and Wales with those of the United States. In 1913, that is before the war, the accident mortality for England and Wales for the ages from 35 to 45 was 62.4 per 100,000. In the United States it was 139.6 per 100,000 in the Registration Area and 154.3 per 100,000 in the insured males at the same ages. Industrial policy holders suffer from a higher accident rate at the ages where the occupational factor plays a part, and where too their death works the greatest hardship to their families. There has been little reduction in the accident rates in the six years under study. During the working years the suicide rate of male workers is greater than that of the general population. It is interesting to note that the colored rate is one half of the white rate. However the homicide rate for negro males is seven and a half times as great as for the entire group of insured wage earners. In the age period 25 to 34 it ranks next to pneumonia as a cause of death of negro males.

The study of the diseases incident to pregnancy and the puerperium is of the utmost importance. The statistics are based on the age group 15 to 45, the child-bearing period. In this age period these diseases cause more deaths than any class of disease except pulmonary tuberculosis. The rates are 66.1 per 100,000 for whites, and 82.3 per 100,000 for blacks. Puerperal sepsis caused 43 per cent. of all the deaths, albuminuria and convulsions 26.4 per cent. The figures for the Registration Area are almost the same. There has been some decline in the maternal death rate in the six years under study. The decline in the insured was 10.7 per cent., which was greater than that in the general population. The authors consider this a vindication of the Metropolitan Life Insurance Company's system of visiting nurses. These figures point out a very important field for preventive medicine.

The analysis of the cancer mortality rates for the period 1911 to 1916 is instructive, for it shows how unsafe it is to generalize. The necessity of considering age groups, the sex and race, as well as the site of the cancer, before drawing inferences as to the increase or decrease of cancer mortality is well brought out. The statistics of the Metropolitan Life Insurance Company show no definite increase in cancer mortality in the six years under study.

I have mentioned but a few of the valuable facts brought out in this volume. The authors are to be congratulated on having made an important and unique contribution to the study of the incidence of disease among wage earners, a study which will be of great assistance to all who labor for the prevention of disease, be they doctors, economists or social workers.

ERNST P. BOAS

SPECIAL ARTICLES

THE INTERACTION OF GRAVITATING AND RADIANT FORCES[1]

1. *Atmospheric Temperatures.*—These relations are so interesting, not to say perplexing,

[1] Advance note from a Report to the Carnegie Institution of Washington, D. C.

that I venture to give a few typical examples of the information which I have been gathering. I may recall that the observations are made in a very large, dark, damp room, semi-subterranean, in which the temperature variations on the thermograph rarely reach 1° per day. A compensated ball m of about .6 gram, movable on a quartz fiber, is gravitationally attracted by an external kilogram, M, in the

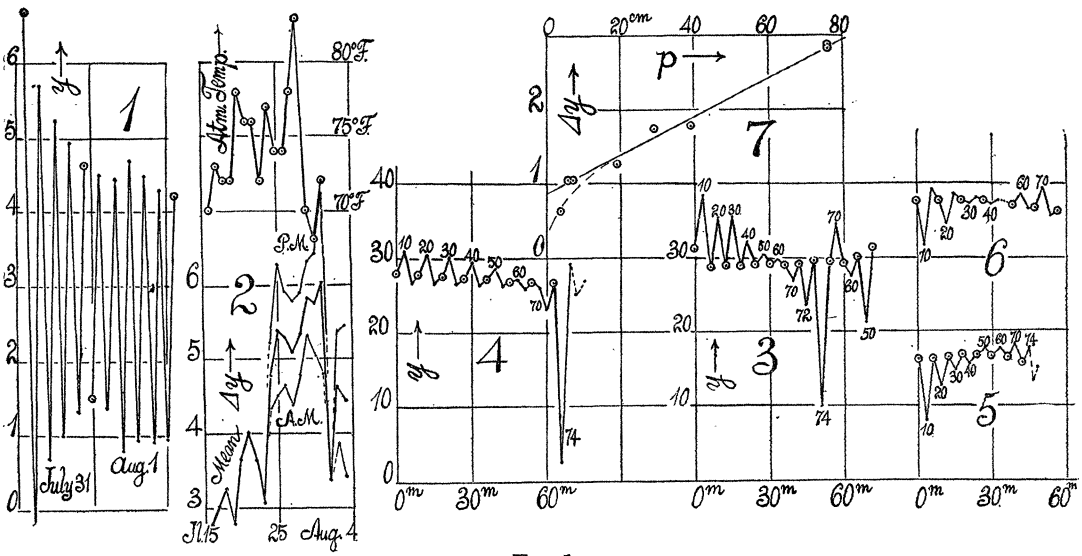

Fig. 1.

given environment. When M is on the right, or on the slightly warmer side of the region, m is deflected toward larger numbers y, of the scale. In the other case, the reading y is in smaller figures. The actual displacement of m is $x = .1455\ y$ in apparatus *I;* and $x =$ $.0214\ y$ in apparatus II. The needle carrying m (balanced by an opposite m) pointed north-south, the case being on this side of the large central laboratory pier. The basement wall is over 4 meters off on the east, and over 30 inches thick. This therefore receives solar radiation, directly or indirectly, in the morning.

Fig. 1, for instance, shows the direct reading, y of apparatus *I,* on July 31 and August 1, the mass M being passed alternately form east (larger reading) to west, at intervals of about an hour.

The readings were now averaged per semi-day (A.M. and P.M.) and also per day and an example of results is given in Fig. 2, Δy showing the double amplitude or total excursions of the aperiodic needle, resulting from the combined attraction of gravitational and radiant forces. Δy varies from much below 3 to much above 7, even in the short interval between July 15 and August 4, and in spite of the fact that the laboratory temperature is practically constant. It follows therefore that the ball M and the east wall reciprocate in their radiant exchanges, almost directly, in a way of which the room temperature gives no interpretable account.

On the top of Fig. 2 I have inserted the atmospheric temperatures kindly furnished by Meteorologist Charles S. Wood, of the Providence Station, U. S. W. B. It is obvious at a glance that the two groups of curves, those for Δy and that for external atmospheric temperature are of the same kind; but the Δy curves follow the temperature curve with a lag of one to three days. Whatever radiation falls on the outside of the east wall of the laboratory, shines in a subdued form on the ball M a few days later. In the dark room one can thus predict what occurred in the outer world several days ago—too bad it is not the other way! But these successive isotherms as they creep through the wall are not given to prophecy. Like our politicians, they have developed a tactile sense and prefer to feel their way.

If we turn again to Fig. 1, it will be noticed that the lower readings for which the ball M is *behind* the case and thus screened from the wall are quite variable, though not usually as much so as the upper readings, in which nothing intervenes between ball and wall. It is thus obvious that the ball parts with what it has absorbed with extreme reluctance. I have therefore been tempted to ask whether with the thermal radiation something else may not have passed which finds in the lead ball so tenacious a receptacle.

2. *Efflux of Air.*—Let me now pass to a different class of experiments given in Figs. 3, 4, 5, 6, in which the ordinates are again scale readings, y, but the periods between them only about 3 minutes. Apparatus *II* with an airtight case is here used and it is exhausted in steps of 10 cm. of mercury each, *very slowly,* but otherwise much after the manner of treating the fog-chamber. Fast exhaustion would throw the readings out of scale and there might be interference from air currents. For this reason pressure increments from influx are here not very trustworthy.

The effect of this efflux is to slightly cool the inside of the case. Thus the ball M, or the environment, is temporarily warmer than the needle m, or the inside. In Fig. 3 (note the small scale) the ball M is discarded and the exhaustions, 0–10, 10–20, . . . 70–72, 72–74 cm., are marked as to the large numbers on the curve. The needle in these experiments was somewhat oblique to the case, the right end being nearer the front window and the left end near the rear. A relatively warmer window if attracting throws the reading into larger numbers. Exhaustion is made when the needle is in an equilibrium position, as indicated by the little circles on the curve. Fig. 3 shows therefore, that the effect of exhaustion is actually a temporary radiant pressure increment on the *cold* side of the needle, the amount of which gradually diminishes until the exhaustion from 60 to 70 cm. (pressures 16 to 6 cm.) has been passed. After this the effect changes sign and the temporary increments now increase with great rapidity on the *warm* side of the needle. A few trials were also made for influx (74–70, 70–60 cm., etc.), in which a total reversal is in evidence, not very smooth, because of the experimental difficulties mentioned.

The ball M was then replaced and put on the far side, so that its attractions (gravity, warmth) would counteract the attraction of the plate glass window. The result of this change of environment is given in Fig. 4. The window (less in mass but nearer) first acts, as before; thereafter the ball M (further but with much more mass) produces an opposed effect. The branches are doubly inflected and the zero points (circles) lower than before, owing to gravitational attraction. Finally the changes of sign of the radiant forces occur as in Fig. 3; but at the high vacua (70–74 cm.), the window effect is absent. Here also the needle begins to show vibration.

The attempt was now made to hang the needle symmetrically to the case, or to the environment, in the absence of the ball M, by twisting the torsion head slightly. Fig. 5 shows that the apparatus is over-corrected. The plenum radiant forces are negative, the vacuum force positive, the change of sign occurs in lower exhaustions (higher pressures) than before, and the radiometer forces are relatively less important.

In the case of Fig. 6 the ball M is restored in a position to counteract the radiant force of Fig 5. Hence Fig. 6 is a reversal of Fig. 4, just as Fig. 5 is of Fig. 3, with the differences just stated.

3. *Influx.*—In conclusion I will adduce an example of a third group of experiments, made in the manner stated in relation to Figs. 1 and 2. In the new experiments the case was exhausted to different pressures, p (cms. of mercury), but left with a slight leak of about

10 cm. per hour at the highest vacua. Hence the air within is permanently slightly *hotter* than the outside, because of the influx. Fig. 7 shows the total excursions or double amplitudes of the mass m, when the ball M is passed from one side to the other of m, in half hour periods. The graph is a little rough because the Δy for the plenum would not be quite constant and the influx can not be perfectly controlled in flow; but the evidence is none the less definite. Conceding that the region between M and m is *cold* relatively to the other side of m, there is always a radiant pressure excess on the cold side of m, increasing nearly at the same rate as the air pressure p decreases. In the high vacua the effect seems even to be accentuated so that gravitational attraction is all but wiped out.

Nothing of the inversion so clearly brought out by Figs. 3 to 6 appears in Fig. 7. In place of it the plenum radiant pressure on the cold side increases steadily, even into vanishing air pressure, p, so far as observed

If one computes the work done by the influx of but 10 cm. per hour, so nearly isothermal, as $Rm\tau \log (p'/p)$ in the usual notation (τ being absolute temperature), it is about the same for all the points of Fig. 7. The case therefore would always be heated alike, within. On the other hand the temperature increment $\Delta\theta$ of the inside air, in the *absence* of all radiation, may by an easy integration be found to be $\Delta\theta = (R\tau/Jk) \log (p'/p)$ and this increases as $\log (p'/p)$, about seven times between the plenum and the high exhaustions;[1] but it is hard to discern how temperature, as such, not considered as an index of the available heat, has anything to do with it, unless there is some other kind of radiation associated with temperature. True, when temperature differences decrease indefinitely, the times of cooling must increase indefinitely; and the meaning of infinity here depends on the delicacy of the instrumentation. But the results thus far do not show whether the temperature effect is absolute or relative and I have not therefore been able to get the mastery of the suspicion that observation of the type of Figs. 1 and 2, made under better conditions, daily, for a period of years, would be worth while.

[1] The temperature increments of the inside air, barring radiation, are 14° at $p = 40$ and about 100° at $p = 7$ cm. What is effective, is the residue, after one half hour's radiation, or more, of this thin air. It seems incredible that such infinitessimals can leave so striking a record as figure 7. In fact, most of the straightforward explanations which I have given for the sake of a cohesive argument, if examined critically, are far from satisfactory.

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THE PHILADELPHIA MEETING OF THE AMERICAN CHEMICAL SOCIETY

THE fifty-eighth meeting of the American Chemical Society was held in Philadelphia, Pa., from September 2 to 6, 1919, inclusive, the general meeting beginning on the morning of Wednesday, September 3, at the Bellevue-Stratford Hotel.

Local arrangements had been under the charge of the committee headed by George D. Rosengarten and members and guests were bountifully entertained. One thousand six hundred and eighty-seven members and guests registered for the meeting. A considerable additional number of members of the society came from the surrounding cities and towns for special parts of the program but did not register. Fully 2,000 were in attendance.

An interesting innovation of the Philadelphia Section consisted in the daily publication of the *Catalyst*, which is the official bulletin of the Philadelphia and Delaware Sections. This daily paper contained news items, lists of members and guests, the daily programs, reports of various meetings and other entertaining matter.

The general meeting opened with an address of welcome by Honorable Joseph S. McLaughlin, of the city of Pennsylvania, to which President Nichols responded. A large audience completely filling the Ball Room of the Bellevue-Stratford Hotel, listened to the address by Honorable Newton D. Baker, Secretary of War, on "Chemistry in Warfare," and to an address on "Chemistry and the Navy," by Rear Admiral Ralph Earle, chief, Bureau of Ordnance, U. S. Navy. These addresses will be found in the October number of the *Journal of Industrial and Engineering Chemistry*, together with additional details of the Philadelphia meeting.