The weather and health of London / Alexander Buchan.

Royal Institution of Great Britain.

WEEKLY EVENING MEETING,

Friday, March 25, 1881.

WARREN DE LA RUE, Esq. D.C.L. F.R.S. Secretary and Vice-President,
Cor. Mem. Acad. des Sciences, France,
in the Chair.

ALEXANDER BUCHAN, Esq. M.A. F.R.S.E.
Sec. Scot. Met. Soc.

The Weather and Health of London.

To the statistician London affords materials for the prosecution of many inquiries such as could not be obtained from the statistics of any other city either in ancient or modern times. Among the more important of these inquiries are those which relate to questions suggested by the enormous aggregation of human beings over a limited area which London presents on a scale absolutely unparalleled in the world's history. It is one of these questions we bring before you this evening, viz. the influence of the climate on the health of the people of London.

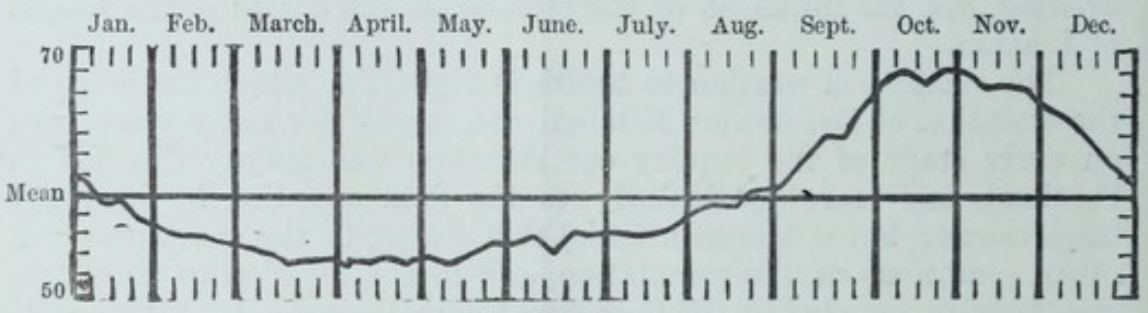
The relation of weather to health is a question which has engaged the attention of Dr. Arthur Mitchell and myself for many years. In an early stage of the inquiry our attention was mainly directed to Scotland, and more particularly to the data supplied by its eight large towns; but it was soon found that, owing to the sparseness and other conditions of the population, and to the division of time into months only, adopted by the Registrar-General for Scotland, the available data were not sufficiently exact to show the true relations of weather to the fluctuations of the death-rate through the year. In truth it was only after not a little unsuccessful labour, and what could at best be characterised as no more than partially successful work, that we resolved eight years ago to open the discussion of the whole subject by an exhaustive examination of the meteorological and vital statistics of London and London alone. More specifically our reasons for the selection of London were that it afforded data from (1) an enormous population spread over an area so limited that it might be regarded as having one uniform climate during each of the seasons of the year; (2) satisfactorily full weekly reports of weather and the deaths from the different diseases; and (3) returns extending over a sufficiently long time.

In the case of diseases such as diarrhœa and bronchitis, which seem to be directly and immediately under the influence of temperature, and such epidemics as scarlet fever and whooping-cough, the rate of

mortality from which is largely determined by season and weather, a comparatively small number of years is required to give a satisfactory approximation to their true weekly curve of mortality. But as regards the great majority of diseases, it quickly became apparent that a thirty years' average was required in the construction of curves which could be offered as true "constants" for the diseases to which they refer. The thirty years beginning with 1845 were therefore adopted. An examination of the curves shows that some of their striking features, particularly those indicating the complications of special diseases and their connections with each other, which the weekly averages disclose, would entirely disappear if monthly averages only were employed.

The curves of the more prominent and interesting of the diseases are shown on the accompanying woodcuts, the straight black line in each figure being drawn to represent the mean weekly death-rate on an average of the fifty-two weeks of the year, and the figures on the margin the percentages above or below the average. With this general average the mean death-rate of each week is compared and the difference above or below calculated in percentages, which, when *plus, are placed* above the mean line of the figure, and when *minus*, below it. Thus as regards scarlatina (Fig. 1), the mean mortality of

FIG. 1.



Scarlet Fever.

the fifty-two weeks is 49·6; on the first week of January it is 7 per cent. above the mean, from which time it continues to fall to the annual minimum, 35 per cent. below the mean in the middle of March; thence rises to the mean in the end of August; to the annual maximum, 60 per cent. above the mean, in the end of October, and thereafter steadily falls. The portion of the curve above the mean line thus shows the time of the year when, and the degree to which, the mortality from scarlatina is above its average, and the portion below the line when it is under it.

Fig. 2 shows similarly the distribution of the mortality from whooping-cough through the weeks of the year, and Fig. 3 the distribution of the mortality from small-pox. It is seen at once that the mortality curve from scarlatina is precisely the reverse of the curve of whooping-cough, the maximum death-rate period of the one

corresponding to the minimum period of the other, and *vice versâ*. It is also seen that the mortality curve for small-pox (Fig. 3) is quite distinct from the other two curves.

In order to ascertain the degree of steadiness of these curves, a curve was calculated and drawn for each of the seven epidemics of scarlatina and for each of the eight epidemics of whooping-cough during the thirty years, with the instructive result that the curve for

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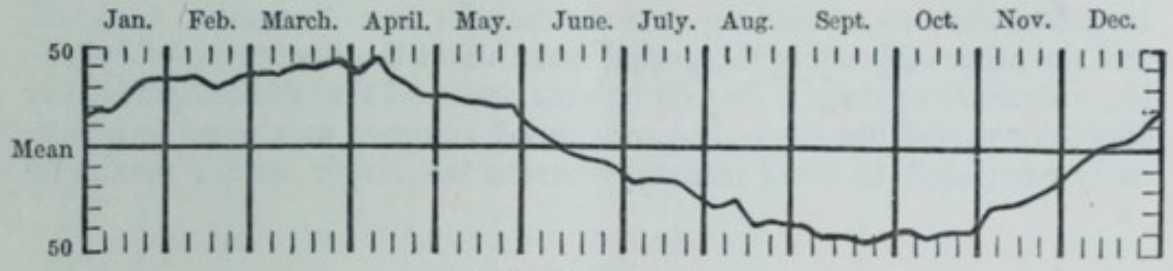
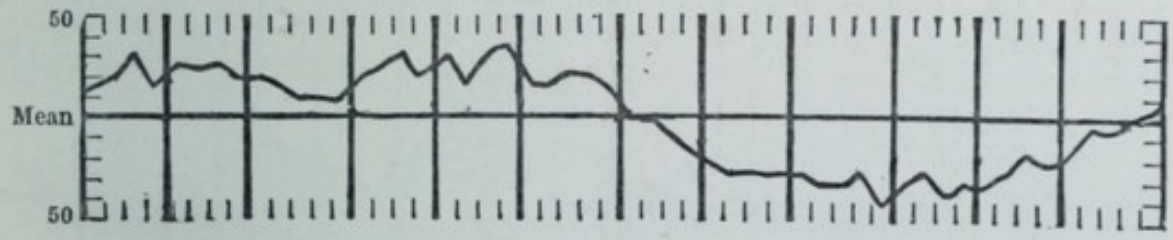


Whooping Cough.

FIG. 3.



Small-pox.

each of the separate epidemics was substantially identical with the general curve for the whole thirty years' period, each of the four prominent phases of each curve occurring all within a week of each other. As regards the small-pox curve, if the deaths during the epidemic of 1870–72, by far the most fatal of all the epidemics during the thirty years, be deducted from the general result, we obtain a curve which is substantially the same curve as that for the whole thirty years, but only less pronounced. From these results if follows, and the remark is of general application to all the curves, that the mortality curves for the different diseases arrived at in this inquiry may be regarded as true constants of these diseases for London.

The climate of London, looked at as influencing the health of the people, may be divided into six types of weather according to the season of the year. These are respectively—

Period 1.—Damp and cold, fourth week of October to third week of December.

Period 2.—Cold, fourth week of December to third week of February.

Period 3.—Dry and cold, fourth week of February to second week of April.

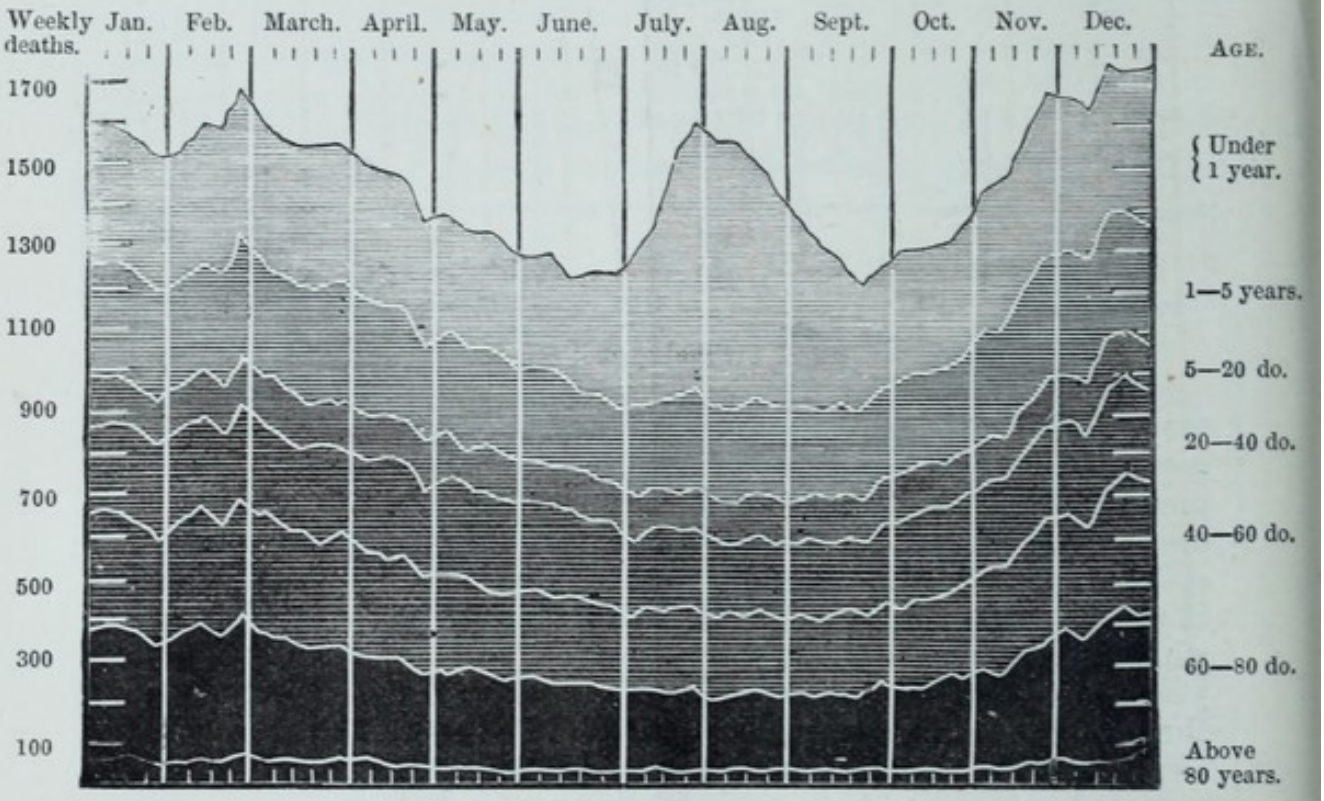
Period 4.—Dry and warm, third week of April to third week of June.

Period 5.—Heat, fourth week of June to first week of September.

Period 6.—Damp and warm, second week of September to third week of October.

The outstanding features of the death-rate in its relation to the varying types of weather through the year are shown by the top curve of Fig. 4, which represents the total mortality for all ages. This curve shows two maxima in the course of the year: the one, by far the larger of the two, extending over six months from November to April, and the other embracing the period from about the beginning of July to the autumnal equinox. It will be also observed that the comparatively short-continued but strongly-pronounced summer maximum is practically restricted to mere infants, whereas the larger winter maximum

FIG. 4.

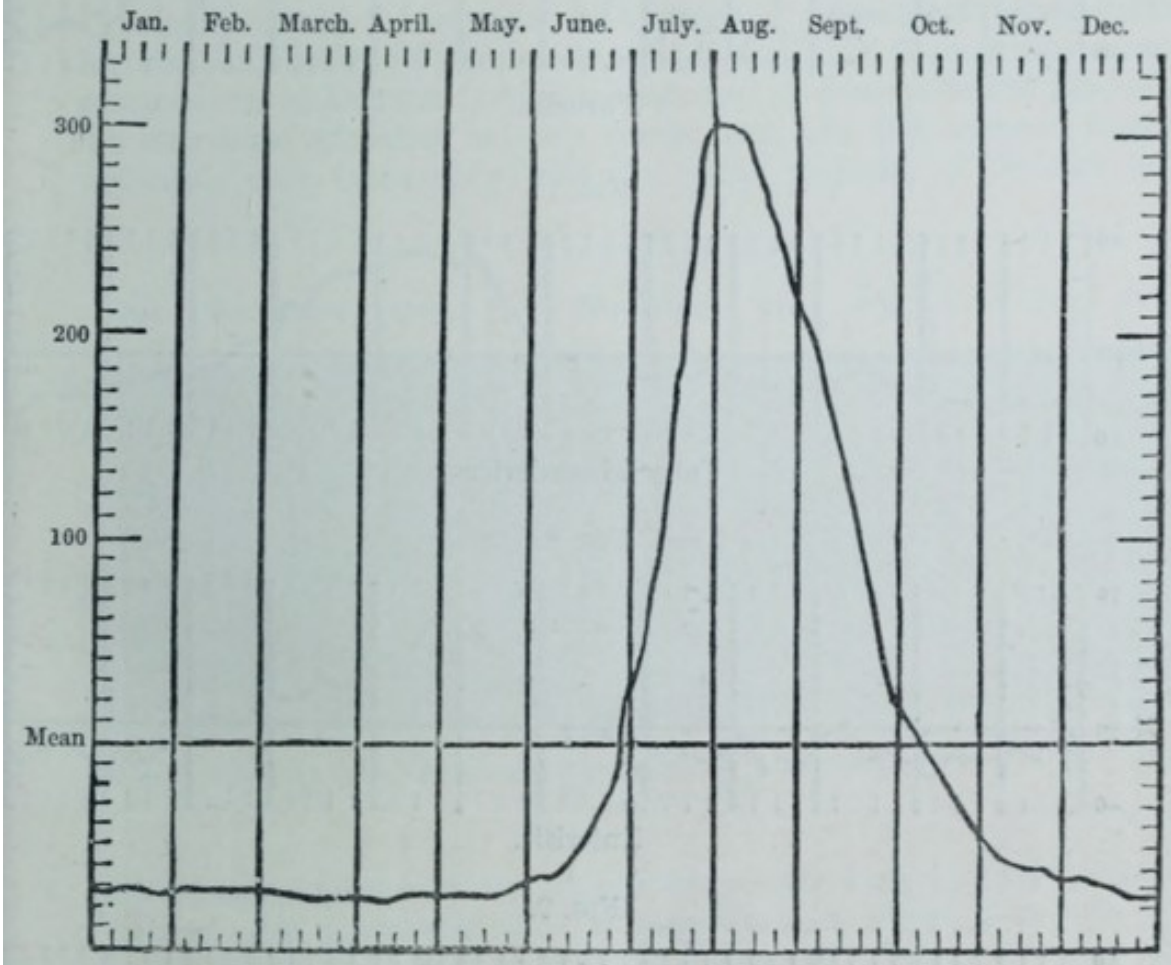


is a feature of the curves for all ages; and hence of all weather influences the cold element in the climate of London is that which is most destructive to life.

Figs. 5 to 10 are representative curves of those diseases which go to form the summer maximum when "*heat*" is the chief characteristic of the weather. The direct relation of the progress of mortality from diarrhœa to temperature is strikingly seen in the startling suddenness with which the curve shoots up during the hottest months of the year, and the suddenness, equally startling, with which it falls on the approach

of colder weather. The curves for dysentery, British cholera, and cholera are substantially the same as the curve for diarrhœa, and all show the same close obedience to temperature. It is a noteworthy circumstance that these four curves group themselves into pairs—diarrhœa and British cholera on the one side, and dysentery and Asiatic cholera on the other. The chief points of difference are that

FIG. 5.

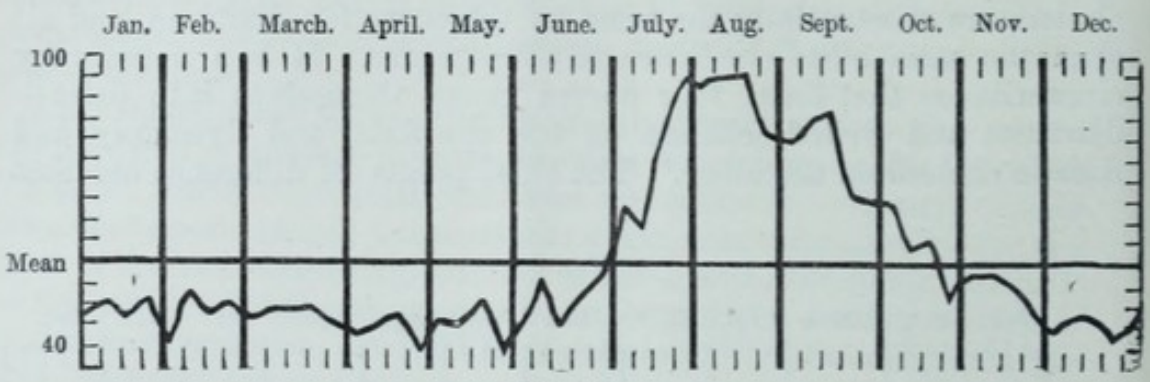


Diarrhœa.

dysentery and Asiatic cholera begin markedly to rise considerably later than the other two allied diseases, attain their maximum a month later, and fall more rapidly than they rose, the annual phases being nearly a month later than those of diarrhœa and British cholera, which diseases are less deeply seated in the system.

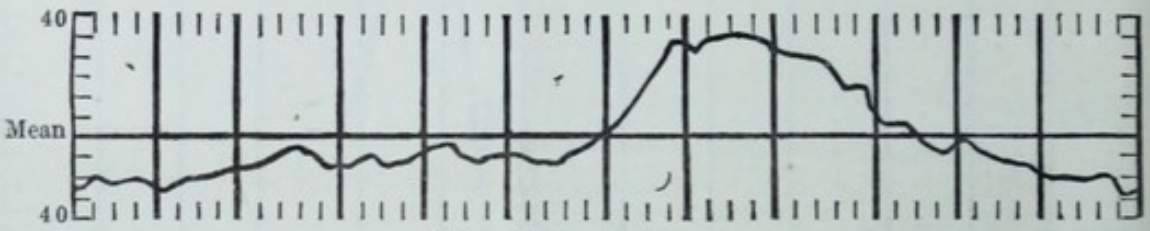
The peculiarly malignant character of summer diarrhœa among young children under five years of age may be shown by the weekly mortality from diarrhœa, rising from 20 in the middle of June, to 342 in the first week of August, 1880, when the mean temperature of July and August was about the average. In July 1876, when the temperature was 3°·6 above the average, the weekly mortality from diarrhœa among children rose to 502 on the last week of that month. On the

FIG. 6.



Thrush.

FIG. 7.

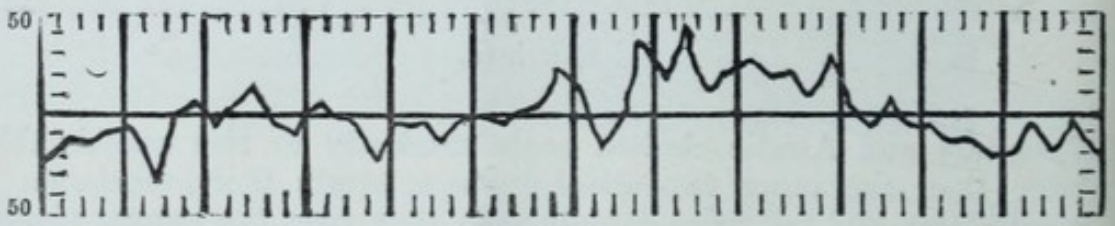


Tabes Mesenterica.

FIG. 8.

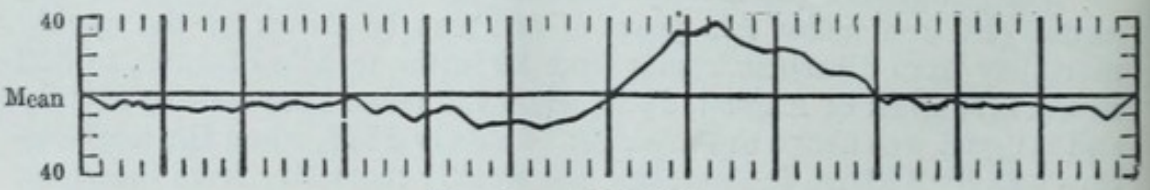
Enteritis.

FIG. 9.



Jaundice.

FIG. 10.

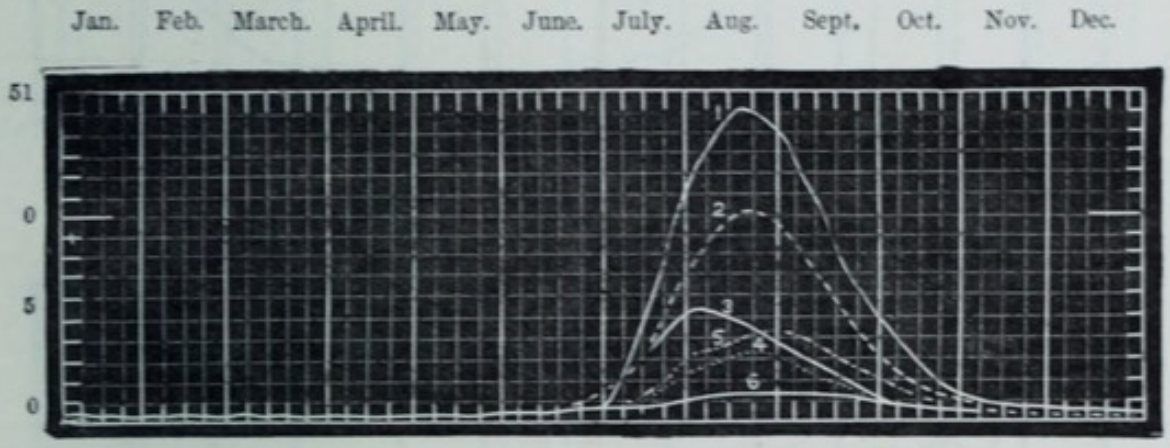


Atrophy and Debility.

other hand, during the cold summer of 1860, the diarrhœa mortality for all ages did not in any week exceed 90.

Of the British large towns the lowest mortality from summer diarrhœa is that of Aberdeen, which has the lowest summer temperature. The diarrhœa mortality of each town is found from year to year to rise proportionally with the increase of temperature, but the rate of increase differs widely in different towns, thus pointing to other causes than mere weather, or the relative temperatures and humidities of these towns, as determining the mortality. Fig. 11 shows the weekly death-rate from diarrhœa for six of the largest British towns, viz. Leicester, curve 1; Liverpool, 2; London, 3; Bristol, 4; Portsmouth, 5; and Edinburgh, 6; from which it is seen that though the summer temperature of London is higher than that of Liverpool and Leicester, its diarrhœa mortality is very much less. In this respect London contrasts very favourably with the great majority of British large

FIG. 11.



Weekly Deaths from Diarrhœa calculated on the Annual Mortality per 1000 of the population.

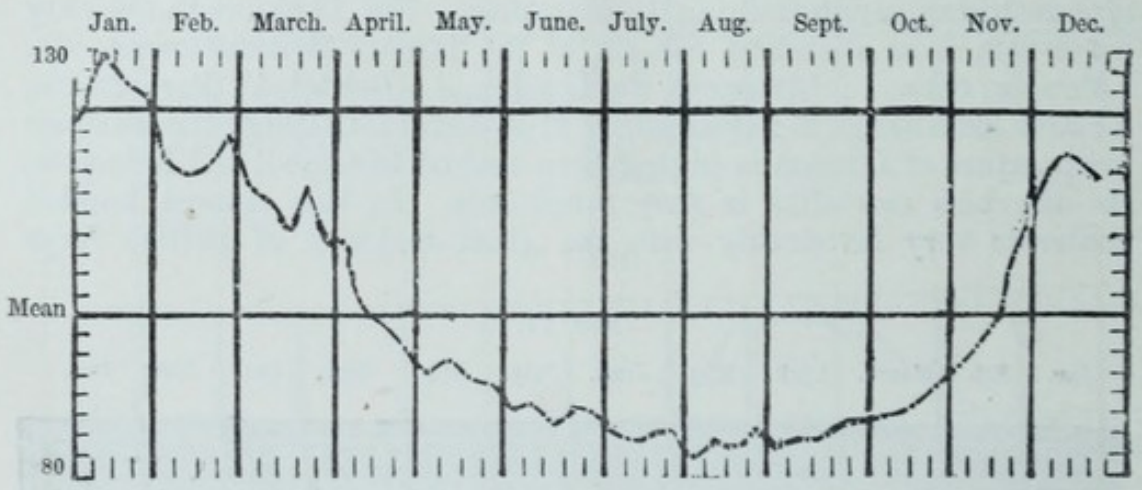
towns, showing its sanitary conditions generally are at least fairly satisfactory; but inasmuch as it is somewhat in excess of a few of the towns whose summer temperature is scarcely lower, London offers problems in this field to the sanitary reformer for his solution.

Figs. 6 to 10 give the curves for thrush, tabes mesenterica, enteritis, jaundice, and atrophy and debility, all of which have their maximum fatality during the hottest period of the year, and all of these, it will be noted, are bowel complaints. Indeed with the apparent exception or one or two nervous diseases, all those diseases which indicate an increase in their death-rate during the summer months are bowel complaints.

An examination of the curve for the whole mortality (Fig. 4) shows that the great preponderance of deaths in London takes place during the coldest months of the year. Of the diseases to which this excessive mortality is due the first place must be assigned to

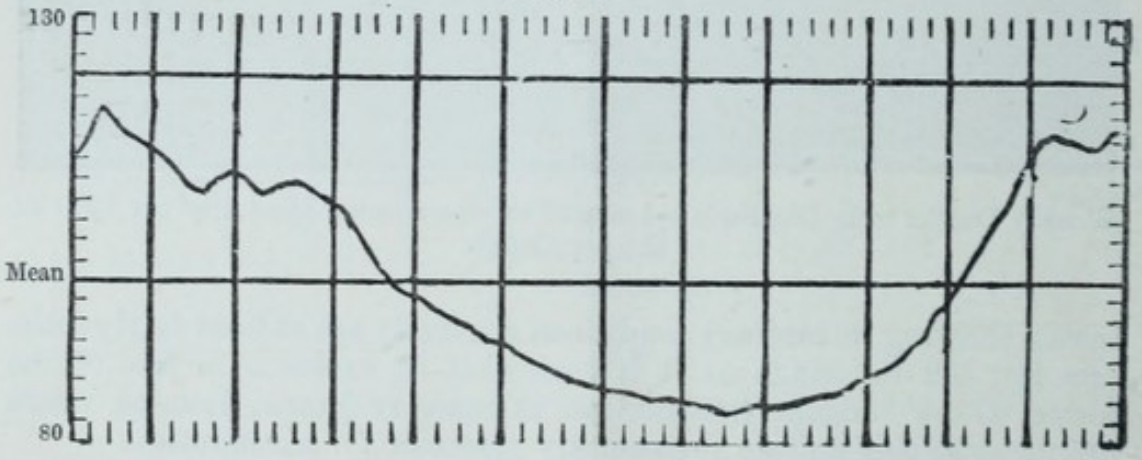
diseases of the respiratory organs, the more marked of which are given in Figs. 12 to 15. About one in eight of all deaths that occur is caused by bronchitis, and one in sixteen by pneumonia; so that nearly one-fifth of the deaths is occasioned by these two diseases of the respiratory organs. Our researches appear to warrant the conclusion that the greatest fatality from these diseases occurs when the temperature is

FIG. 12.



Asthma.

FIG. 13.



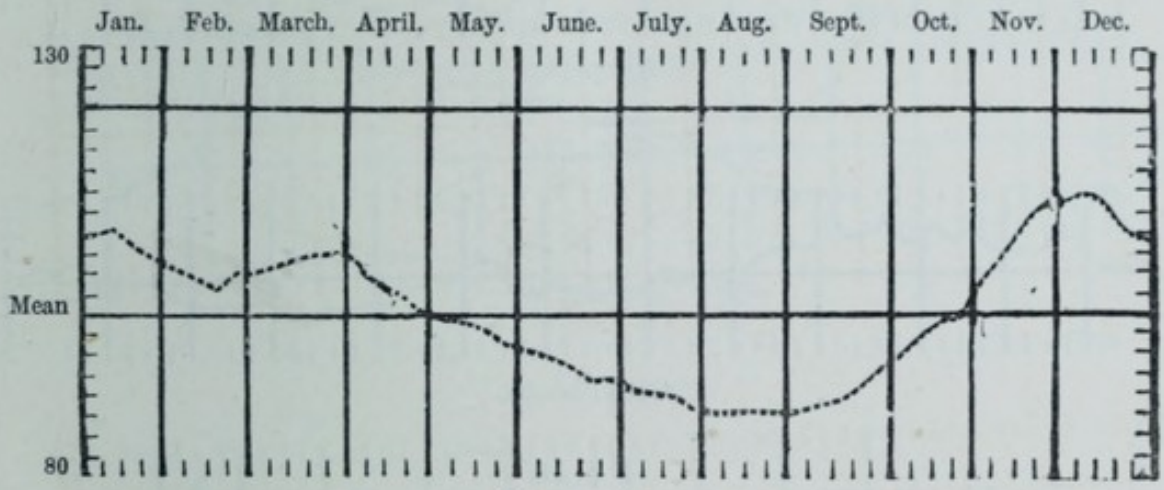
Bronchitis.

between 32° and 40°. In New York, where the mean winter temperature is 10°·0 lower than in London, the mortality from bronchitis and pneumonia is greatly less; and on the other hand, in Melbourne, where the winter temperature is about 10°·0 higher than that of London, the mortality from diseases of the respiratory organs forms but a small fraction of the whole deaths.

These four curves of the mortality from diseases of the respiratory organs are substantially the same, each having its maximum in the cold months, and its minimum in the warm months. Asthma shows,

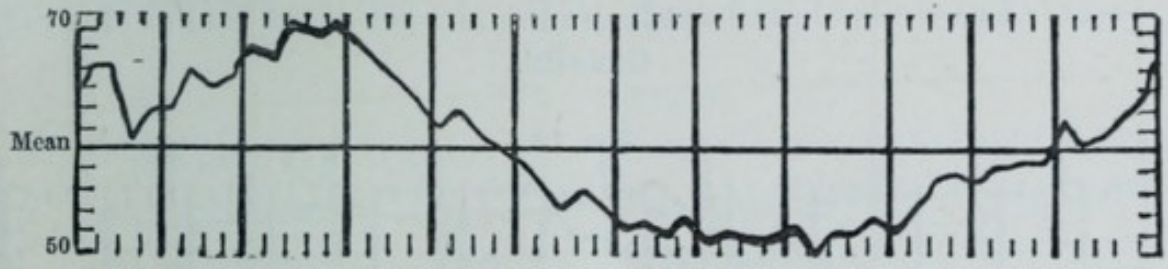
in the amplitude of its annual rage, the greatest sensitiveness to weather, and pneumonia the least. They all show, though in different degrees, a double-ridged maximum: the one ridge being in the middle of January, when the temperature falls to the annual minimum, and the other in March, when the combined qualities of cold and dryness are at the annual maximum. Asthma and bronchitis are decidedly at the maximum when the weather is coldest, whereas laryngitis has its maximum in March, when the weather is coldest and driest, the last disease thus forming the link connecting the more strictly throat diseases with diseases of the nervous system.

FIG. 14.



Pneumonia.

FIG. 15.



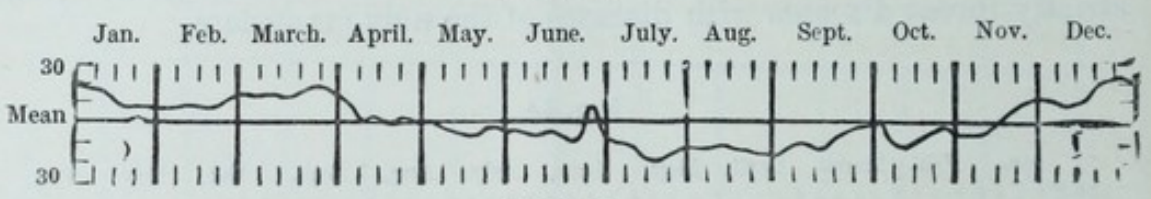
Laryngitis.

But an element of weather other than mere temperature plays an important part in bringing about the high death-rate from these diseases. That deleterious atmospheric influence is fog; and in cases where the fog is dense and persistent the mortality from diseases of the respiratory organs becomes truly appalling, as happened in London in 1880, when the mortality was nearly doubled. An examination of the fogs of London shows that they do not commence till the autumnal equinox; and it is at this epoch that asthma (Fig. 12), which is by far the most sensitive of all diseases to fog, starts from its annual minimum; and in the end of November and beginning

of December, when fogs become most frequent, the curves for asthma and bronchitis shoot up with startling suddenness.

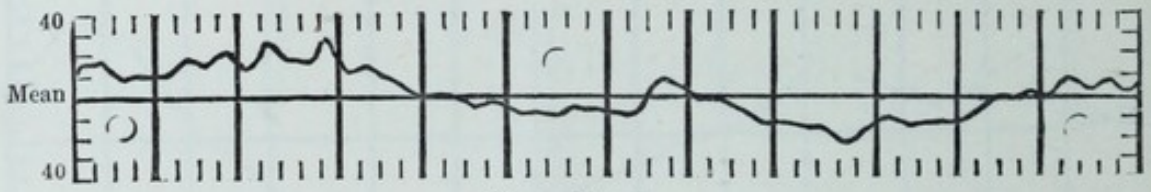
Figs. 16, 17, and 18 represent the curves for three of the nervous diseases, viz. apoplexy, convulsions, and cephalitis. Apoplexy will be observed to show a double-ridged maximum quite analogous to that of the diseases of the respiratory organs; whereas in the case of convulsions, the maximum may be regarded as quite single, and

Fig. 16.



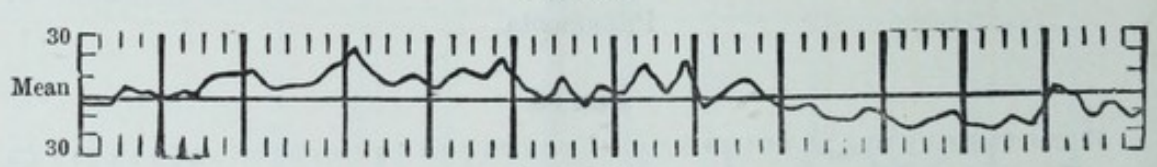
Apoplexy.

Fig. 17.



Convulsions.

Fig. 18.



Cephalitis.

Fig. 19.

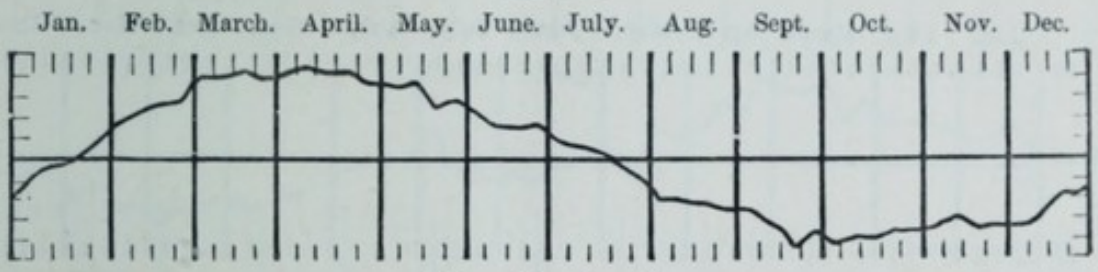
Suicides.

occurring in spring, this being the season when nervous diseases generally are most fatal. On the other hand, the curve for cephalitis stands alone among nervous diseases as having its annual maximum considerably later and as keeping above the mean till at least the end of July, thus covering that portion of the year when the climate is driest and hottest, as well as driest and coldest. The intimate

relations observed between the curve for suicides (Fig. 19) and that for cephalitis is very striking.

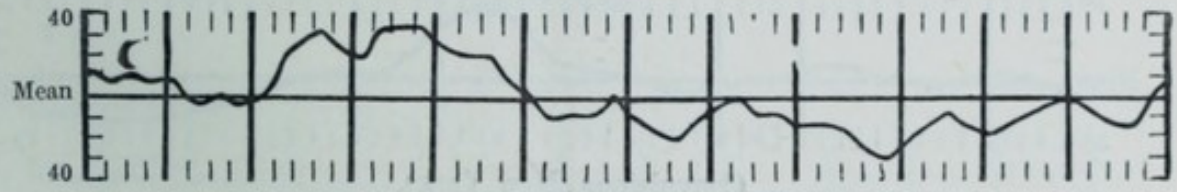
The maximum mortality for whooping-cough, Fig. 20, gout, Fig. 21, and phthisis, Fig. 22, occur in the same season as that for the nervous diseases. The maximum mortality from whooping-cough occurs in the spring months, and the curve suggests that this is more a disease of the nervous system than of the respiratory organs, a view which, singularly enough, was maintained by the elder Dr. Begbie, one of the most distinguished of our Edinburgh physicians, upwards of thirty years ago. The relations of gout to diseases of the nervous

FIG. 20.



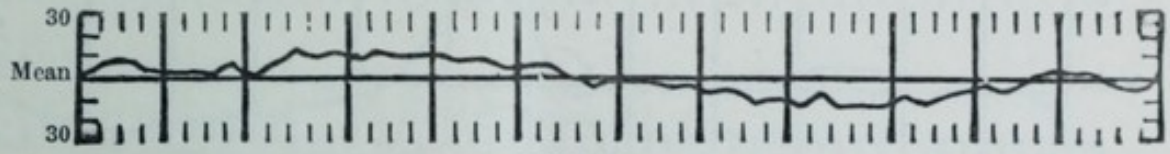
Whooping Cough.

FIG. 21.



Gout.

FIG. 22.



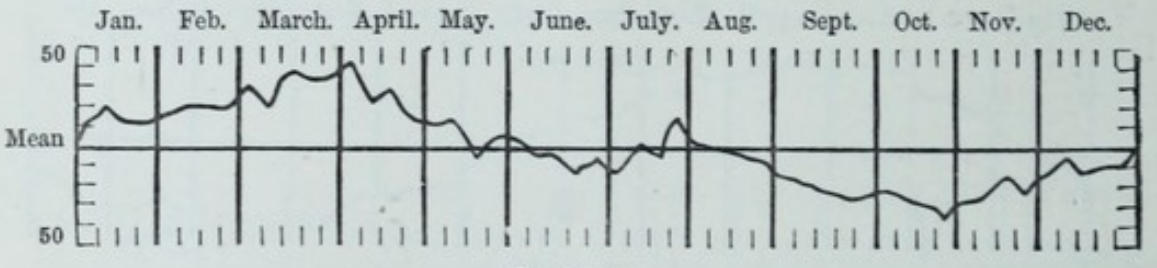
Phthisis.

system are too obvious to call for remark. Phthisis is one of the two most fatal scourges of our British climate, one out of every eight deaths which occur being caused by consumption. Its mortality-curve, Fig. 22, shows unmistakably its intimate relations to nervous diseases, thus affixing greater significance to its known complications with hereditary insanity, scrofula, and some other mental diseases.

Reference has been made to the influence of the heat of summer on certain nervous diseases. That influence acts fatally, both indirectly through the bowels in the case of the young, and directly on the nervous centres. The curve for convulsions, Fig. 17, is

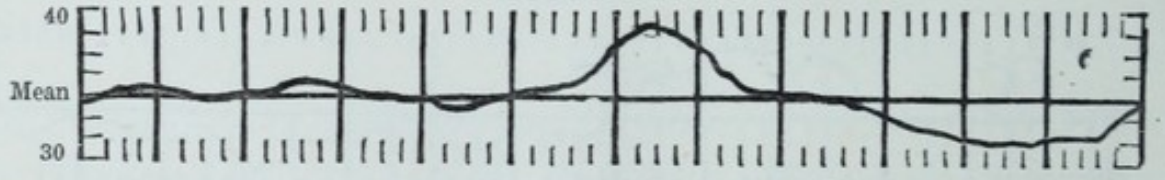
identical with that for teething, Fig. 23, and it may be added that the curve for hydrocephalus is simply a reproduction of the same curves. Now these curves show a small, but distinct, and, as revealed by each year's figures, a constantly recurring secondary maximum in summer, which in the case of London is almost wholly due to the bowel complications of these diseases. The curve (Fig. 24) for convulsions for New York, where the summer temperature is 10°·0 hotter than in London, shows this feature of the curve enormously magnified, so much so, indeed, that instead of being, as in London, an insignificant secondary maximum, it stands out as the prominent feature of the

FIG. 23.



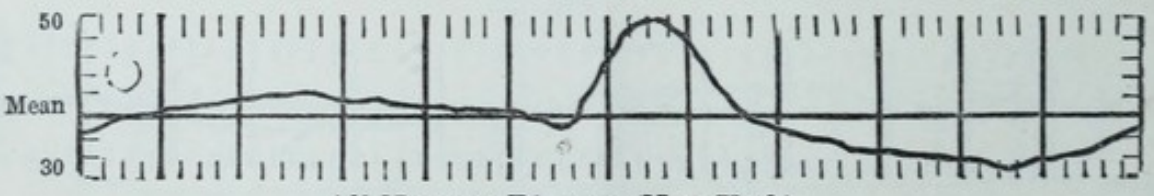
Teething.

FIG. 24.



Convulsions (New York).

FIG. 25.

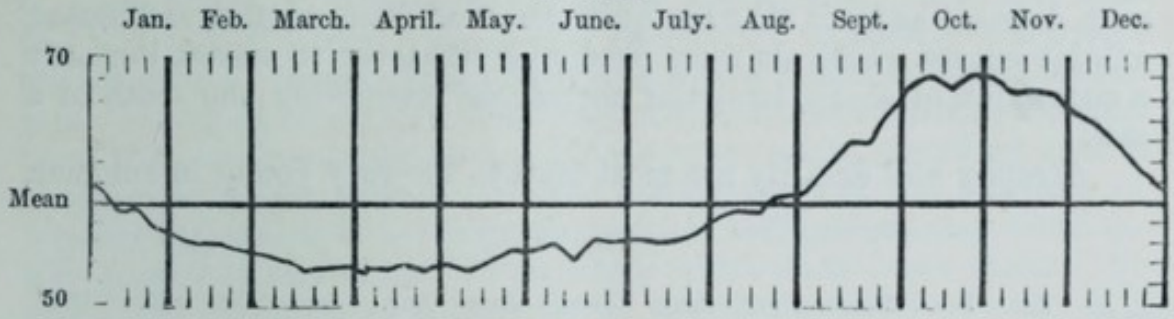


All Nervous Diseases (New York).

curve. Whilst this result is doubtless largely due to complications with bowel complaints, it is, as an examination of the statistics shows, in no small degree caused by the direct influence of the great summer heat of New York on the nervous centres. This is impressively shown by the mortality curve for the whole of the nervous diseases (Fig. 25), which is even more pronounced in this particular than the curve for convulsions alone (Fig. 24). Keeping this fact in view, the peaks showing an increased fatality in London from cephalitis (Fig. 18) and suicides (Fig. 19) during July and August acquire, in the eyes of the physician, a more impressive significance.

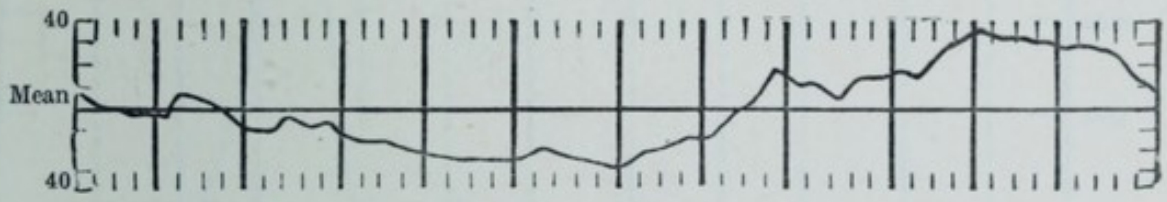
The curve for the whole mortality (Fig. 4) shows September and October to be two of the healthiest months of the year. The three curves, scarlet fever (Fig. 26), typhoid (Fig. 27), and diphtheria (Fig. 28), are the most striking exceptions to this, these curves all

FIG. 26.



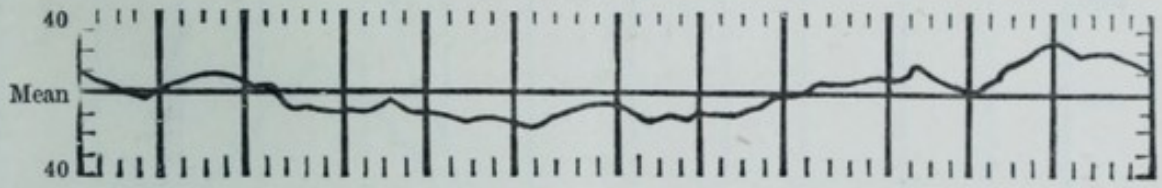
Scarlet Fever.

FIG. 27.



Typhoid Fever.

FIG. 28.



Diphtheria.

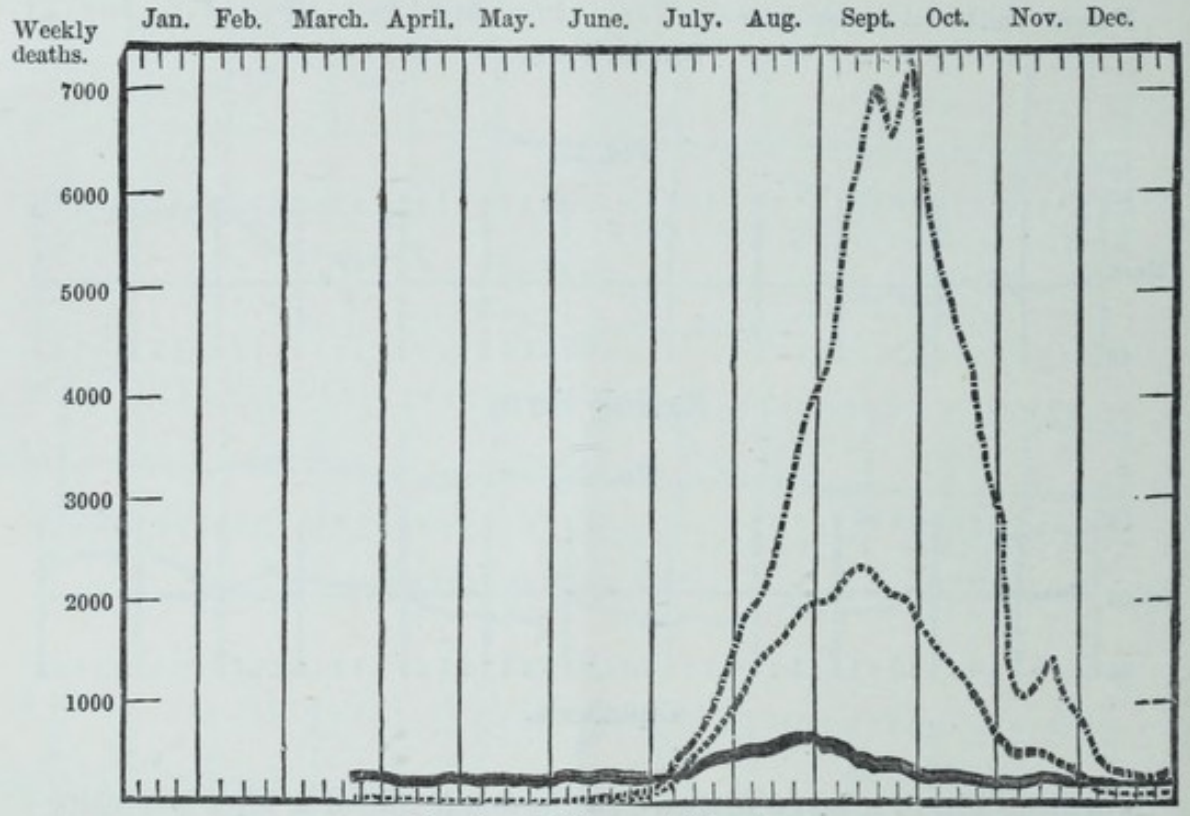
indicating either a large increase in the death-rate or a high mortality during these months. While closely related to each other, each of these three diseases has a distinct individuality of its own as regards the times of occurrence of the annual maxima and minima, and the varying amplitudes of their range from the mean line. It is a singular circumstance that diphtheria shows closer relations in its death-rate with typhoid than with scarlet fever.

Several other diseases suggest close alliances with each other through their seasonal death-rates. Thus the curve for mortification is substantially that of nervous diseases, and the curves for erysipelas and puerperal fever are in all essential respects the same, a fact of singular suggestiveness to the family practitioner. The curve for old age runs exactly parallel to that of paralysis, the old man's disease. The curves for skin diseases, rheumatism, dropsy, pericarditis, Bright's

disease, and kidney disease exhibit most striking, and in many cases the closest alliances with each other. Lastly, while bowel complaints attain their greatest mortality when temperature is highest, diseases of the respiratory organs when it is lowest, nervous diseases during the dry weather of spring and early summer, and skin diseases and certain fevers during the raw weather of autumn and early winter, such diseases as ileus, that are quite removed from weather influences, exhibit curves which show no obedience whatever to season, but only a succession of sharp, irregular serratures resembling the teeth of a saw.

Atrophy and debility are most fatal to the very young in summer,

Fig. 29.



The Great Plague of London.

but to the aged in winter; in the former case the complication being with bowel complaints, and in the latter with diseases of the respiratory organs. The annals of influenza show that a special character is given to this epidemic according to the season of the year in which it occurs. Thus when it occurs in spring the head and nervous system are most affected, but the bowels when the epidemic prevails in summer and autumn.

Fig. 29 shows by the doubly-dotted line, or highest curve, the weekly mortality of London during the Great Plague of 1665, the lower dotted curve the mean weekly mortality of the last six plagues, and the solid curve the mean weekly mortality from all other diseases

during the continuance of the last six plagues. The manner in which the plague, as a death-producer, obeyed the weather is striking, and full of interest. It did so exactly in the way in which we have seen bowel complaints to be influenced by weather. The curve of mortality for the plague bears no resemblance whatever to that for typhus, or indeed to any disease except bowel complaints. The fact that the progress of deaths from plague in relation to weather resembles so closely the corresponding progress of deaths from bowel complaints, raises the question whether there may not be a closer alliance between them than has been suspected. If we are correct in regarding such a question as a fair outcome of this investigation of the relations of weather and health, it is evident that such investigations may occasionally point to a seat of morbid processes which have been cloaked by prominent phenomena, apparently of a primary, but in reality of a secondary character.

[A. B.]

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