small black aromatic tasting seeds like those of the cultivated cardamom. If ever planters go into Africa, the cardamom will be an important product of the soil for commerce, for there are vast tracts of forest with the climate, soil, and checkered shade which are necessary for the cultivation of the cardamon. Orchilla weed should also become a valuable article of commerce; it grows in many parts of the forest. I consider, however, that when the great forest of Central Africa is opened up to civilization, by far the most valuable article of commerce will be india-rubber, the want of which is increasingly felt in the civilized world. Now that electricity is so much used for various purposes, the demand for india-rubber grows larger and larger: the supply which is shut up in the African forest is practically unlimited. There are various trees of the fig tribe which yield this product, but by far the greatest amount is contained in the india-rubber vines[1] which abound in the forest and hang from almost every tree. In cutting our way through the forest in some places, we got covered with the milky glutinous sap, which dropped upon us from the vines we cut through.

"The natives know its value, and use it largely for smearing the inside of their buckets in order to make them hold water. They use it largely also for covering the ends of their drum-sticks. The india-rubber obtained is of a clear, yellowish colour, like glue, and is of the most elastic description.

"In the forest region I saw no water-lilies, but in Emin Pasha's Province, in the Bari country, I saw two kinds.[2] They were both about the size of an ordinary white water-lily, and the leaves and flowers floated on the surface of the water, but the stalks and formation of the leaves and flowers was finer and more slender. One was of a pink coral-like colour, not white like the Zanzibar lily, and the other of a pale bluish lavender. They were growing in small clear pools only a few miles apart in the valley of the Nile, at an altitude of about 3000 feet above the sea.

"One of the most interesting botanical discoveries I made in the forest was the discovery of a wild orange-tree. During our march through the forest I had continually come upon trees varying from 8 to 15 feet high. They had double leaves of a peculiar shape, which had a delicious smell like orange leaves; the branches were covered with long sharp thorns, and I at once pronounced them to be orange-trees. My fellow officers smiled incredulously, and exclaimed: 'Orange-trees[3] in the middle of the forest!' But I held to my opinion, and just before reaching the open country, I came upon a tree with both flowers and fruit upon it. The flowers were exactly the same as the flowers of a cultivated orange-tree. The fruit, which was green, was about the size of a marble. On cutting through it with a knife I found it had the same divisions as an ordinary orange, but each division was full of small seeds, which were very bitter and aromatic. On reaching Emin's Province I told him about it, and he regretted very much that I had not brought a specimen with me, for he was a good botanist, and wished to add it to his collection of dried plants. He told me my discovery was doubly interesting, as many years before a German had penetrated the forest on the west coast of Africa, and reported that he had found wild orange-trees. His story was discredited, and now our discovering the orange-tree in the forest pointed that his report was after all true.

"I have not space to speak much about the flowers we saw in the open country, but will say a few words about those flowers which we found at a high altitude on the slopes of Ruwenzori, or the Mountains of the Moon. Lieutenant Stairs who made the ascent of the mountains, gives the following facts in his report:—

"'The barometer stood at 21·10, thermometer 70° F. Ahead of us and rising in one even slope stood a peak, in altitude 1200 feet higher than we were. This we now started to climb, and after going up a short distance came upon three heaths. Some of these must have been 20 feet high, and as we had to cut our way foot by foot through them our progress was necessarily slow. Here and there were patches of inferior bamboos, almost every stem having holes in it made by some boring insect, and quite destroying its usefulness. Under foot was a thick spongy carpet of wet moss, and the heaths on all sides of us we noticed were covered with "Old Man's Beard" (*Usnea*). We found great numbers of blue violets which had no smell, and from this spot I brought away some specimens of plants for Emin Pasha to classify. The altitude was 8500 feet. We found blueberries and blackberries[1] at an altitude of 10,000 feet. The following[2] are the generic names of the plants collected as named by Emin Pasha:—

Clematis.	Moschosma.
Viola.	Lissochilus.
Hibiscus.	Luzula.
Impatiens.	Carex.
Tephrosia.	Anthistiria.
Glycine.	Adiantum.
Rubus.	Pellæa.
Vaccinium.	*Pteris aquilina.*
Begonia.	Asplenium.
Peucedanum.	Aspidium.
Gnaphalium.	Polypodium.
Helichrysum.	Lycopodium.
Senecio.	Selaginella.
Sonchus.	Marchantia.
Erica arborea.	Parmelia.
Landolphia.	Dracæna.
Heliotropium.	Usnea.
Lantana.	Tree Fern.'

"These were just a few specimens Lieutenant Stairs brought down with him. But the slopes of Ruwenzori will, when properly explored, yield numbers of unknown treasures to be added to the Botanical Encyclopædia.

"For many weeks we drank coffee which we made from the berries of the wild coffee-trees which abound on the highlands round the great lakes of Central Africa. The Arabian coffee was originally supposed to have come from Kaffa, in Abyssinia. That which we found in Karagwe, Ankori, and Uganda is equal in flavour to the finest Arabian coffee, and will, when Central Africa is opened up, be another of the chief articles of commerce.

"I. A. M. JEPHSON."

[1] Landolphia.
[2] *Nymphæa stellata* and *N. Lotus* are both plentiful in Upper Nile-land.
[3] This reads like a tree *Citrus*, and if so is an interesting discovery, as no species is hitherto known there.

[1] It would be very interesting to have these identified. The two highest-known species of Rubus are *pinnatus* and *rigidus*, at 5000–6000 feet.
[2] This list is in Stanley's book. The *Viola* is no doubt *abyssinica*, common to the mountains of Madagascar, Abyssinia, the Cameroons, and Fernando Po. There are three heaths known on the high mountains of Central Africa, viz. *Erica arborea*, *Ericinella Mannii*, and *Blaeria spicata*. There is no *Vaccinium* known before in Tropical Africa; though three or four are plentiful in Madagascar, and there is one on the Drakensberg, so that its occurrence is most probable. The ferns of Tropical Africa are nearly all species widely spread in other continents.

TOWN FOGS AND THEIR EFFECTS.[3]

UNTIL 1880 the formation of fog was looked upon as arising simply from the separation of liquid water, probably in the form of hollow vesicles, from an atmosphere saturated with aqueous vapour; but in that year Aitken showed that really the determining cause of the separating out of liquid water, and consequent formation of fog, was dust present in the air. He pointed out that a change of state, a gas passing to a liquid, or a liquid to a solid, really always occurred at what he terms a "free

[3] The paper by Dr. W. J. Russell, F.R.S., introducing the discussion on Town Fogs at the Hygienic Congress.

surface"; that as long as a molecule of liquid water is surrounded by like molecules, and the same with gaseous water, we do not know at what temperature, or whether at any temperature, they would change their state; but if in contact with a solid then at the surface, where they meet, the change will occur; if the solid be ice it may become liquid or the liquid may become solid, and the same kind of action occurs when the liquid is in contact with its own vapour; in fact, that what we call the freezing and boiling-points of a body are the temperatures at which these changes take place at such free surfaces. The dust always present in the atmosphere offers this free surface to the gaseous water, and thus induces its condensation. This specific action of dust varies very considerably, first with regard to its composition, and second with regard to the size and abundance of the particles present. Sulphur burnt in the air is a most active fog-producer, so is salt. Many hygroscopic bodies form nuclei having so great an affinity for water that they can cause its condensation from an unsaturated atmosphere. At the same time non-hygroscopic bodies, such as magnesia and many others, are powerful fog-producers; no doubt their activity may in part be attributed to their being good radiators of heat, and thus becoming cooled, induce condensation. Mr. Aitken also shows that the products of combustion, even when the combustion is perfect, are powerful fog-producers, a fact which has important bearing on the production of town fogs. One other point in these experiments I cannot omit mentioning, it is the exceedingly minute amount of matter capable of inducing fog. In his first series of experiments Mr. Aitken showed that $\frac{1}{100}$ of a grain of iron wire, however often it was heated, evolved on each heating sufficient dust to cause a visible fog, and afterwards, with still more delicate apparatus, that $\frac{1}{1000}$ of a grain of either iron or copper, when treated in the same way, gave a similar result, and from these last experiments he infers that even $\frac{1}{100000}$ grain of either wire, if only slightly heated, would yield sufficient nuclei to cause a visible amount of fog. It is of much importance and interest, seeing how small a quantity of dust is required to produce fog, to know that even this small amount may be filtered out of the air by passing it through cotton wool, and thus an air be obtained in which a fog cannot be produced. Mr. Aitken's description of such an atmosphere is at first most alluring, for he says, if there was no dust in the air there would be no fogs, no mists, and probably no rain; but he goes on to state that when the atmosphere became burdened with supersaturated vapour, it would convert everything on the surface of the earth into a condenser; every blade of grass and every branch of a tree would drip with moisture deposited by the passing air; our dresses would become wet and dripping, and umbrellas useless; but our miseries would not end here, for the inside of our houses would become wet, the walls and every object in the room would run down with moisture. I think, if we picture to ourselves this state of things, we may be thankful that there is dust and fog. Dust in its finer forms is invisible to us; but as its delicate particles become loaded with moisture, it becomes a fine mist, dense if the number of particles are many; if, however, the dust-particles are fewer, and the amount of aqueous vapour the same, each particle will have a larger amount of condensed moisture to carry, and it will give rise to a more coarse-grained fog; the moisture, or some of it, will be more feebly attached to its nuclei, producing then what is known as a wet fog, whereas at least a most important fact in the production of a dry fog is the strong affinity between the nuclei and the condensed vapour. As most of you are no doubt aware, Mr. Aitken has invented a most ingenious method for counting the number of dust-particles in air, and has obtained most interesting and valuable results. I can only mention here that some of these results deal with the clearness of air in relation to the number of dust-particles present, and other results show how little effect rain has in diminishing the amount of the finer dust in air. Evidently towns will supply dust of all kinds, and therefore offer every inducement for fogs to form there, and that at least some of the particles will be capable of causing the condensation of moisture even from an atmosphere which is not saturated with aqueous vapour. This condensation of moisture is a very complete process for removing all kinds of impurities from the air. Floating particles are free surfaces, and become weighted by the moisture they condense and tend to sink, and even the gaseous impurities in the air will be dissolved and carried down by the moisture present.

Experiment confirms this, for it has been proved how correctly the impurities of an air can be ascertained by determining the composition of dew, even if it be artificially and locally formed. It is of importance to note that even the purely gaseous emanations from our towns cannot pass away when a fog exists, as is shown by the accumulation of carbonic acid which takes place during a fog. Taking 4 volumes in 10,000 volumes as the normal amount of carbonic acid in London air, some years ago I found that it increased in the case of a dense fog to as much as 14·1 volumes, and often to double the normal amount, which must represent a very serious accumulation of the general impurities in the air.

A fog in this way becomes a useful indicator of the relative purity of the atmosphere in which it forms. If pure aqueous vapour be condensed it gives a white mist—a country fog, a sea fog—and a white light seen through it is not converted into a red light; but in town fogs the whiteness of pure mist disappears and becomes dark, in some cases almost black in colour, the change being produced by the foreign matters floating in the air, and by far the most abundant colouring matters of our town fogs are the products generated by the imperfect combustion of coal; but in addition to these bodies, many others must obviously find their way into the air over a town. Especially will there be dust from the universal grinding and pounding going on in street traffic and many mechanical operations, from the general disintegration of substances and the decomposition of perishable materials—all will add something to the air, and it will become an integral part of the fog. However, although it is often said that a town fog is so dense that it may be cut with a knife, still it is difficult to condense so much of it that it can be subjected to a searching chemical analysis. In 1885, by washing foggy air, I was able to determine the amount of sulphates and chlorides present, and as indicators of organic matter the quantity of carbon and nitrogen in the fog. The results showed strikingly how largely the amounts of organic matter and ammonia salts in the air varied with the weather; no case of dense fog occurred when the experiments were being made; but the mean of several experiments clearly showed that in foggy weather the amount of organic matter was double as much as existed in the air in merely dull weather, and that the amount of sulphates and chlorides increased under like conditions, but not to the same extent. Fog may, however, be made to give its own account of its constituents, for we have only to collect and analyze the deposit which it leaves to learn what its more stable constituents are, and we have to thank the air-analysis committee of the Manchester Field Naturalists' Society for the most complete analysis of such a deposit which has yet been made. The deposit analysed occurred during the last fortnight in February of this year (1891), and was obtained from the previously-washed glass roofs of the plant-houses at Kew, and Messrs. Veitch's orchid-houses at Chelsea. At Kew 20 square yards of roof yielded 30 grammes of deposit. At Chelsea the same area gave 40 grammes, which represents 22 lbs. to the acre or 6 tons to the square mile, and the composition of these deposits is as follows:—

	Chelsea. Per cent.	Kew. Per cent.
Carbon	39·0	42·5
Hydrocarbons	12·3	4·8
Organic bases (pyridines, &c.)	2·0	
Sulphuric acid (SO_3)... ...	4·3	4·0
Hydrochloric acid (HCl) ...	1·4	0·8
Ammonia	1·4	1·1
Metallic iron and magnetic oxide of iron...	2·6	41·5
Mineral matter (chiefly silica and ferric oxide)	31·2	
Water, not determined (say difference)	5·8	5·3
	100·0	100·0

These analyses give, I believe, for the first time, a definite account of the composition of fog-deposit. Soot and dust are by far its principal constituents, rendered sticky and coherent by hydrocarbons, but I should like to give you the striking description which Prof. Thiselton Dyer has sent me of this deposit, collected at Kew. He says: "It was like a brown paint, it would not wash off with water, and could only be scraped off with a knife. It thickly coated all the leaves of the evergreens, and upon what have not yet been shed it still remains." In the above analysis it is curious to note the large amount of metallic iron and magnetic oxide of iron.

The details with regard to these very interesting analyses we shall hear from a member of the Manchester Committee, and I will only ask you to note how large a proportion of these deposits arises from the imperfect combustion of coal. We also learn from the Manchester Committee some interesting facts with regard to fog-deposits which occurred last winter in their city. This deposit which was collected from Aucuba leaves contained as much as 6 to 9 per cent. of sulphuric acid, and 5 to 7 per cent. of hydrochloric acid, mostly, of course, in a state of combination, but the deposit was, they say, "actually acid to the taste." Also, that three days' fog deposited per square mile of surface, in by no means the worst part of Manchester, 1½ cwt. of sulphuric acid, and even as far out of the city as the Owens College, on the same area, over 1 cwt. of acid and 13 cwt. of blacks.

There is still one other point characteristic of town fogs to be noted: it is their persistency in an atmosphere considerably above the dew point. A country fog under such circumstances directly passes away; a town fog apparently does not do so. There seem to me to be two reasons for this: one is that the moisture is protected, and its evaporation to a large extent hindered, by the presence of oily matter; and secondly, when the moisture has really gone, the soot and dust remain, and produce a haze.

The great distance to which fogs will travel is also remarkable, for they have on many occasions been traced to a distance of at least 25 to 35 miles from London, and I believe I might say to 50 miles.

I have so far discussed the production and composition of town fogs, and before considering their effects, would say a word on the question of whether in London they are increasing in frequency and density. A complete and accurate record of fogs in London is not kept; several stations are required, and a correct method of registering the density and distinguishing the difference between haze and fog is necessary; but fortunately there is a fair approximation to this complete registration of London fogs published by the Meteorological Office in their daily reports. The observations are made every morning at Brixton, and every afternoon at Victoria Street, and from a paper by Mr. Brodie, on "Some Remarkable Features in the Winter of 1890–91," published in the Journal of the Royal Meteorological Society, I learn that the number of fogs thus registered which have occurred each winter since 1870 is as follows, winter being represented by the months December, January, and February. I have divided these 20 years into four groups of 5 years each:—

Between 1870 and 1875, 93 fogs occurred.
" 1875 and 1880, 119 " "
" 1880 and 1885, 131 " "
" 1885 and 1890, 156 " "

It appears, then, that during the last twenty years there has been a steady increase in the number of winter fogs. I am not aware of any data to prove whether the density of these fogs has increased, but it is probable that the increase of number of fogs largely depends upon an increase of atmospheric impurity, and the conversion of haze and mist into obvious fog; and as the great colouring matter of fogs arises from the combustion of coal, I have drawn up the following table from information which has been kindly furnished to me by Mr. G. Livesey and Mr. J. B. Scott, of the Coal Exchange. It gives the amount of coal really consumed annually in London; it does not include the coal used by the different gas companies. For the first five years, the amount given in the table is rather too high, as the quantity used by the suburban gas companies could not be ascertained and deducted. The quantities apply to what is known as the London district—an area, on an average, of 15 miles round London. The table shows an absolute increase, during the last fifteen years, of 2,000,000 tons of coal—that is, half as much again is now burnt as was burnt in 1875.

Coal consumed in London (that used by Gas Companies deducted).

Year.	Tons.	Year.	Tons.
1875	4,882,233	1883	5,872,310
1876	4,988,280	1884	5,669,281
1877	4,143,909	1885	6,026,063
1878	4,973,147	1886	6,096,732
1879	5,833,891	1887	6,231,956
1880	5,334,823	1888	6,463,498
1881	5,598,281	1889	6,390,850
1882	5,343,974		

Supposing only 1 per cent. of sulphur in this last yearly amount is converted into sulphuric acid (H_2SO_4) and passes into the air; this would give 195,720 tons of this acid.

The five years' averages of winter fogs, we have seen, give a steady increase, but obviously the number each winter will vary much with the atmospheric conditions: for instance, last winter was remarkably favourable for the development of fog; for, again taking the last twenty years, the average number of days of fog during the winter is 25, but last winter the actual number was 50.

The general atmospheric conditions which induce fogs are a still and moist air and a high barometer—a state of the air most usual under anticyclonic conditions. The immediate determining cause, however, of a fog is usually a sudden and considerable fall of temperature. Mr. Brodie also points out that last winter was a time of calms; the percentage of such days on the average for the last twenty years is 9·7, but last winter the number was 22. Emphatically, he says, it was an anticyclonic winter.

A form of fog, well termed a "high fog," now frequently occurs in London. The lights in a street during this form of fog are often as visible as on clear nights, but above hangs a fog so dense that the darkness of night may prevail during the day. This particular form of fog appears to have become much more frequent of late years, and, in fact, it is doubtful whether in former times it ever occurred. The immediate cause of this new form of fog is difficult to explain.

London has always been the head-quarters of town fogs, but now all the large towns appear to be emulating it in this respect, and this is what we must expect; an increase of population means an increase of combustion of coal, and that implies a pouring into the atmosphere of more and more carbon, hydrocarbons, and sulphuric acid. In dry and windy weather all these bodies may be scattered so as not to produce appreciable effects; but let the air be still, and even approach a state of aqueous saturation—then, we have seen, every particle of dust and dirt becomes a centre for moisture to deposit on, and we shall have a fog imprisoning all impurities and offering them to us for inhalation. To burn coal so that only products of complete combustion shall escape is a problem of much difficulty, and is comparatively rarely done. Certainly the domestic fireplace does not do it, but, on the contrary, is the principal cause of the dark colour of our fogs. Many manufacturers, however, liberally contribute to produce the same effect.

I turn now from the constitution and production of fog to note some of the effects it produces. First, with regard to health, details on this point I leave to those who are more able to describe them than I am, but I have a few words to say with regard to the effect of London fogs on the death-rate in general. There are many people who feel so strongly the unpleasantness of fog that it induces them to magnify its results, and make extraordinary statements with regard to the mortality it produces. It has even by some been likened in deadliness to the Great Plague of London, and to other great epidemics. To ascertain how far such views were correct, I studied the Registrar-General's reports for the times of fogs; but, as I found it difficult to interpret the figures, I have expressed them by the curves upon these somewhat lengthy diagrams (Figs. 1, 2, and 3). I have selected times of fog, viz. the winters of 1879–80, 1889–90, and 1890–91, and have represented graphically the temperature, the amount of fog, and the death-rate for each day.

The results are, I think, worthy of careful study. The first thing we learn from these diagrams is that by far the greater number of fogs occur when there is a great fall of temperature; and clearly this is closely followed after a few days by a great increase in the death-rate; but how much of this increase is to be attributed to the fog and how much to the fall in temperature may be difficult to determine; but we have evidence that when fogs occur without fall of temperature they do not appear to be followed by any remarkable increase of death-rate; for, on December 15, 1889, there was a dense fog, and the temperature was even above the average: under these conditions the death-rate remained far below the average. On December 13 and 14 in the same year, again, there is a dense fog, an average temperature, and only an average death-rate; and the same thing happens on February 4 in 1890, when, notwithstanding a dense fog, the death-rate remained remarkably low; and last winter, on November 13 and 14, there was again a dense fog, a high temperature, and an average death-rate. With these four exceptions depression of temperature goes with fog. There is no case of depression of temperature not followed by increase of death-rate.

That many people suffer much, both physically and mentally, from the effects of fog, there can be no doubt; but, as far as I can interpret these returns of the Registrar-

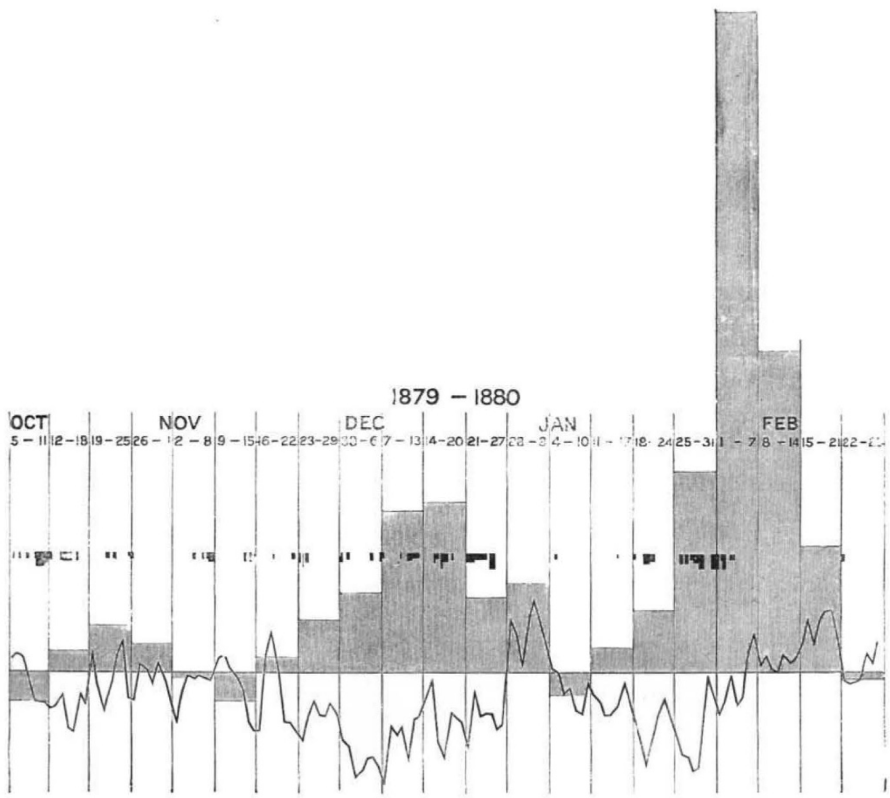

FIG. 1.

General, they do not confirm the popular impression that fog is a deadly scourge; at the same time, it is beyond doubt that an atmosphere charged with soot, dust, and empyreumatic products is an unwholesome atmosphere to breathe; but I think that the principal cause of the great increase of death when fogs occur is attributable rather to the sudden fall of temperature which usually accompanies fog, than to the fog itself.

So many toxic effects are now traced to the action, direct or indirect, of bacteria, that it is satisfactory to learn, from the experiments of Dr. Percy Frankland, that fogs do not tend to concentrate and nurture them, for he found there were remarkably few bacteria in London air during a time of fog. The deleterious action of town fogs on plants is more marked and more easy to investigate than its effect on animals. Nurserymen have long known from experience that a town fog will penetrate even their heated greenhouses, and with certainty will kill many of their plants, specially their orchids, tomatoes, and, in fact, most tender and soft-wooded plants; but on this point, I cannot do better than read to you what the Director of Kew Gardens, Prof. Thiselton Dyer, says in a letter to me:—"With regard to plants under glass, the effect of fog is of two kinds—(1) By diminishing light. This checks transpiration. The plants are therefore in the condition of being over-watered. A well-known consequence of this is to make them shed their leaves wholesale. Many valuable plants which ought to be well furnished with foliage become perfectly bare, and it is impossible ever again to recover them into sightly specimens. (2) The toxic influence of the fog. This is most striking. It is illustrated in the most forcible way by the inclosed memorandum. I attribute it in the main to sulphurous acid, though I cannot help suspecting that some hydrocarbon may also have something to do with it. The toxic effect varies from one plant to another, some are scarcely injured, others are practically killed." He adds:—"I hope you will be able to arouse some interest in this horrible plague. If the visitation of last year is annually repeated, it must in time make all refined horticulture impossible in the vicinity of London."

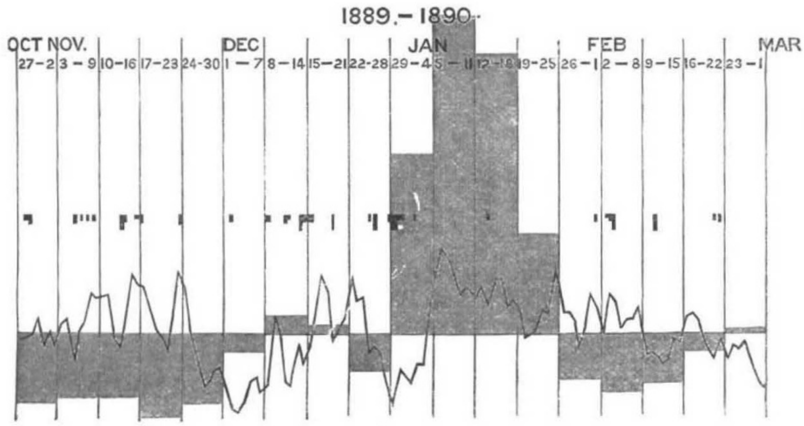

FIG. 2.

I append to this paper the very interesting and important report to which Prof. Dyer refers, from Mr. W. Watson, "On the Effect of Fog on Plants grown at Kew." This fog action on plants is so clearly marked, and so deadly, that it has, I am happy to say, led the Horticultural Society, aided by a grant from the Royal Society, to undertake a scientific investigation of the matter. Plants are so much more easily dealt with than people, all the circumstances of their attack by the fog and its immediate results so much more easily noted and traced, that the investigation has already yielded important results, and we shall, I hope, hear from Prof. Oliver—who is devoting himself specially to the investigation—some account of his latest results. A marked and admitted difference between town and country fog is, that while a country fog is harmless in a greenhouse, a town fog will produce most destructive results.

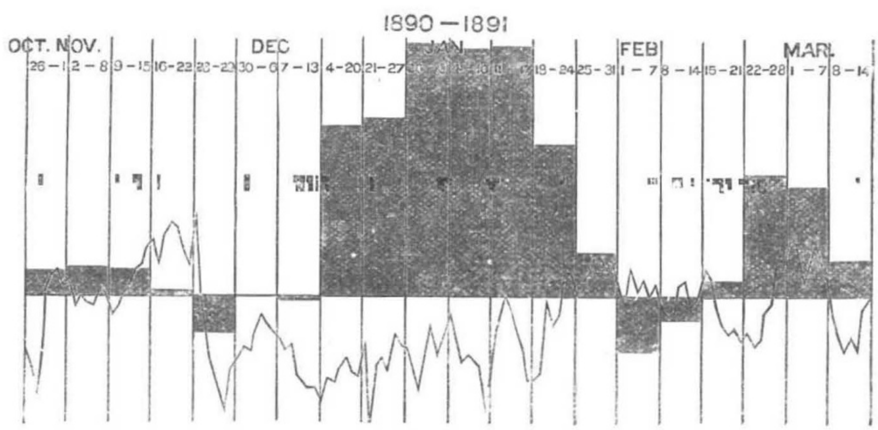

FIG. 3.

There is still another action of town fogs, and one which I believe is of great importance. I mean its power of absorbing light. This power of abstracting light depends principally on the amount of coal products which the fog contains. The slower-vibrating red rays can struggle through a fog which is absolutely impervious to the more refrangible ones. Even a mist but slightly tinged with smoke is opaque to the blue rays, and thus screens us from their action but as Aitken has lately shown, the heat rays can pass readily through. This opacity of town fog to light is, I believe, one of its most serious and detrimental characters. Animals can no more thrive in semi-darkness than can plants; and, important as the red rays may be, still it is undoubtedly the blue rays which are most active in producing the principal chemical charges going on around us. Experiments lately made have strongly impressed me with the wonderful activity which light confers on a mixture of air and moisture, oxidations which in dullness and darkness are impossible are easily and rapidly effected by aid of a gleam of sunshine, or even a bright diffused light. It is not possible, I believe, for people to remain healthy where this source of chemical activity is cut off, or even seriously diminished. In addition to the loss of physical energy, mental depression is induced by the absence of light, the whole tone of the system becomes lowered, and may be a prey to actions which, under brighter conditions, it would have been able to resist.

There is another action of light which is potent for good. I mean its destructive action on many forms of bacteria. Prof. Koch, at the last meeting of this Congress, pointed out how his tubercle bacilli are killed by even a short exposure to sunlight, and it is now well established how inimical light is to the growth and development of most kinds of bacteria. I wish I could show you in some perspicuous way the enormous power which town fog has of absorbing light, and bring forcibly before you the great difference which exists between the amount of light which reaches the inhabitants and buildings of a town, as compared to the amount on an equal area free from smoke. A simple actinometer is much required, and I hope the want will soon be supplied; but at present the only records bearing on this point are the observations of direct sunshine made at various stations, by the Meteorological Society and Meteorological Office, with the Campbell-Stokes instrument, and some interesting observations, by Mr. H. Raffles, on the distance at which objects were visible during a London winter.

First, with regard to the sunshine experiments. One station is situated in the heart of the City, in Bunhill Row, and it is of much interest to compare the amount of sunshine there with, first, the amount in the immediate neighbourhood of London, where we are not beyond the effect of town fogs, viz. at Greenwich on one side, and Kew on the other, and also with a place not far from London, which is beyond the influence of its smoke, viz. Apsley Guise, near Woburn. I have also noted the results obtained at Eastbourne, which is about as far distant from London as Apsley Guise, but in the opposite direction, and is one of the sunniest places in England.

Hours of Sunshine during the Year 1890.

	Bunhill Row.	Greenwich.	Kew.	Aspley Guise.	Eastbourne.
January	29·9	44·0	56·0	57·3	56·9
February ...	42·4	62·8	57·8	70·5	106·5
March	71·3	90·8	109·3	110·4	133·5
April	127·4	141·5	144·8	137·3	170·1
May	215·7	223·9	223·9	214·3	267·9
June	128·0	125·2	141·4	119·1	165·3
July	134·1	120·6	139·9	141·3	185·6
August	164·0	153·1	182·5	189·5	200·2
September ...	131·6	153·2	169·5	166·1	207·4
October ...	89·6	96·9	121·6	135·6	125·3
November ...	23·4	40·8	57·6	64·7	66·9
December ...	0·1	2·4	0·3	13·4	38·0
Total ...	1157·5	1255·2	1404·6	1419·5	1723·6

Taking the totals of last year, the table shows that the hours of sunshine registered at Bunhill Row were 1158, at Greenwich 1255, at Kew 1405, at Apsley Guise 1420, and at Eastbourne 1724; but for our present purpose we must compare the amounts of sunshine at these places during the winter months—November, December, January, and February—and we find that at Bunhill Row there were 95·8, Greenwich 150, Kew 171·7, Apsley Guise 205·9, and at Eastbourne 268·3 hours of sunshine; that is, if Apsley Guise be taken as giving the normal amount, Bunhill Row received only half its due amount, and at Eastbourne there was nearly three times as much sunshine as in the City. Now, on comparing the two other periods of 4 months, which are comparatively free from fogs, the amount of sunshine is far more nearly the same at all stations.

	Bunhill Row.	Greenwich.	Kew.	Aspley Guise.	Eastbourne.
March till June	542·4	581·4	619·4	581·1	736·8
July till October	519·3	523·8	613·5	632·5	718·5

Mr. Raffles, during the winter of 1887-88, which it should be noted was remarkably free from fogs, made a series of observations of the distances to which he could see from Primrose Hill, and found that looking south on the 152 consecutive days from November to March, only on 78 days could he see a quarter of a mile, and only on 83 days could he see to the same distance in a south-westerly direction: this conveys a good idea of the opacity of our London atmosphere.

We attempt to compensate for the darkness which fogs cause by the use of artificial light, and I have again to thank my friend Mr. Livesey for the information he has given me with regard to the extra quantity of gas burnt in London during a day of fog. He tells me that if a dense fog covered the whole of London, and lasted all day, the additional amount of gas consumed would be 30 million cubic feet; but since so extensive a fog as this probably never exists, and certainly never lasts all day, the actual amount consumed may be correctly reckoned at 25 million cubic feet; and if the cost of this be calculated at 2*s*. 6*d*. per 1000 cubic feet, which is rather below than above the actual cost, it amounts to £3125; but after all, it is not the single days of dense fog that measure the extra amount and cost of artificial light used on account of fog—it is rather the continually occurring dull days and local transitory fogs which demand an extra supply of gas, and this is often 5 to 15 million cubic feet in a day, and gives a total by the end of the winter which is very considerable. As a standard of comparison, I should state that the total consumption of gas in the London district in a day of 24 hours, during the depth of winter, is 140 million cubic feet.

Such, then, is an imperfect outline of the chief features and effects of town fogs; and now what is to be said with regard to the possibility of getting rid of such fogs? This question, it seems to me, resolves itself into this: fogs cannot be prevented from forming over towns; there are, and probably ever will be, special inducements, in the way of dust particles and products of combustion, for fogs to form there; but whether they must always be dark in colour, and loaded with soot and tarry matter, is another question. The answer involves not only chemical but also social considerations. With regard to the first, my answer is that as long as coal is burnt you will have dense fogs; grates, kitcheners, furnaces, may be, and probably will be, much improved, and fires may be stoked in a better way, but that the improvements will be so great that all imperfect combustion will cease I think is improbable; if this be so, there is only one other alternative, as long as coal is our source of heat: it is to alter our form of fuel and adopt gas and coke; the soot and tarry matters will be then done away with; the question of sulphuric acid in the air would remain, but our fogs would at least be white. There is still the social part of the question, which is not without serious difficulty—namely, how to induce or compel people to give up the use of coal. At the present day it would not be possible to do as it is recorded was done in the reign of Edward I., try, condemn, and execute a man for burning coal in the City of London. W. J. RUSSELL.

Effects of Fog on Plants Grown in the Houses at Kew.

The heavy fogs experienced in the last two or three winters injured many plants in the houses at Kew. When thick fog occurred almost daily, the injury it did to many plants amounted practically to destruction. The leaves fell off, the growing point withered, and in some cases, such as Begonias and Acanthads, the stems also were affected. Flowers, as a rule, fell off as soon as they opened, or whilst in bud. Almost all flowers which expanded were less in size than when there was no fog. The flower buds of Phalænopsis, Angræcum, some Begonias, Camellias, &c., changed colour and fell off as if they had been dipped in hot water.

In the Palm-house bushels of healthy-looking leaves, which had fallen from the plants, were gathered almost every morning. Plants which appeared to be perfectly healthy, when shaken would drop almost every leaf. Herbaceous plants suffered most, *i.e.* Begonias, Poinsettias, Bouvardias, Acanthads, &c. Some herbaceous plants, however, did not suffer at all, nor were their flowers injured, as, for instance, Cyclamen, Primula, Hyacinth, &c. Many hard-wooded plants lost their leaves and were otherwise damaged, viz. Boronias, some Heaths, Grevilleas, Acacias, &c. *Protea cynaroides*, a Cape plant with large laurel-like leaves, was much injured in the temperate house (minimum temperature 40°), the leaves turning black as though scalded. The same species, however, in another house where the atmosphere is drier and the temperature a few degrees higher, was scarcely affected by fog.

As a rule, the plants that were in active growth suffered most. Monocotyledonous plants and ferns for the most part were not appreciably affected by the fogs, the injury they suffered, especially last winter, being clearly due to low temperature. The effect of fog on flowers is remarkable. Generally, white flowers are destroyed, but there are some notable exceptions—viz. *Masdevalia tovarensis*, *Odontoglossum crispum*, and Angræcum amongst Orchids, and Crinums, white Cyclamen, white Hyacinths, white Chrysanthemums, &c.

The green leaves of *Poinsettia pulcherrima* all fell off, whilst the red ones (bracts) remained, as also did the flowers. All Calanthes, of whatever colour, lost their flowers. The buds of the white-flowered *Angræcum sesquipedale* turned black as if boiled, whilst those of *A. eburneum*, also white-flowered, were not injured, and developed properly. These two plants are grown in the same house under identical conditions, and they come into bloom about the same time.

The conditions most conducive to rest from growth—viz. a low temperature and moderately dry atmosphere, together with diminished light, unavoidable during the prevalency of fog—were proved at Kew to be the safest for all plants during the prevalence of heavy fogs.

July 29. W. WATSON.

THE ANATOMY OF THE DOG.[1]

THE dog has played by far the most important part in the elucidation of the difficult problems of physiology and pathology presented by the higher animal organism. It is by a firm reliance on the results of experimental researches, conducted largely upon this animal, that the modern physician is enabled to form some idea as to the causation of the symptoms of disease in man, and the mode of action of the remedies which he employs; while the modern surgeon, after a preliminary testing of an operation upon the dog, fearlessly proceeds to attack the most deeply-seated tumour, and to explore the most hidden recesses of the human organization. What, after all, are the services of friendship and companionship, or the more menial duties which are often laid upon the dog, compared with the alleviation of human suffering and the advancement of human knowledge for which he has served as the passive instrument, and this (*pace* the mendacious asseverations of fanatical essayists) at the expense of the least possible amount of suffering to himself?

For these reasons, to the physiologist, the pathologist, the pharmacologist, and the scientific surgeon, a book which, like the one before us, endeavours to deal with the anatomy of the dog in the same detailed and systematic manner in which the structure of man is dealt with in text-books of human anatomy cannot fail to be of the utmost value. To the comparative anatomist it will prove an important addition to the limited existing series of monographs dealing in detail with vertebrate types, while to the veterinarian it will be an indispensable *vade mecum*, both in study and in practice.

For the work is done excellently well, a result which might be anticipated from the manner in which it has been set about. Not only has it been carried on under the auspices of a scientific anatomist so well known as Prof. Ellenberger and in a veterinary school where an unlimited supply of subjects was available for dissection, but with a far-sighted liberality, for which the Saxon Government is much to be congratulated, all the expenses for material and instruments have been defrayed by the State, and one of the collaborators has been enabled to devote his whole time during a period of two years entirely to the labour incident upon the preparation of this work.

The book is a large octavo of 650 pages, containing 208 woodcuts, a few examples of which are here reproduced. There is, in addition, an appendix of 37 lithographed plates, representing in outline frozen sections through the trunk and limbs. A study of these is in itself sufficient to make out the relations of the organs to one another, and the authors have accordingly burdened the text as little as possible with topographical details. Histological and developmental references are entirely avoided, partly for the reason that the facts are not materially different from those which are found in other mammals, partly because they have been dealt with, especially for the dog, in other works, and largely because it was obviously desirable not to increase the bulk of the work. References to literature are also for the most part omitted, for although other works have been consulted, it is claimed by the authors that the present account is

[1] "Systematische u. topographische Anatomie des Hundes." Bearbeitet von Dr. W. Ellenberger, Professor an der tierärztlichen Hochschule in Dresden, und Dr. H. Baum, Prosektor an der tierärztlichen Hochschule in Dresden. (Berlin: Paul Parey, 189.)