he got no draught at all when the air was blown in as warm as the air of the room. In answer to the further questions he said the same apparatus would be useful for the extraction of vitiated air as well as forcing in fresh or warm air; but it was more practicable to employ the system of forcing air in. The filter consisted of about 25 yards of cloth, so arranged that the air passed through it, and the dust was collected. As there was always such a pressure of air blown in with a good deal of force from this apparatus there could not be any draught coming in from the windows or doors, and that would be a very desirable thing in hospitals. The air as it came into the room was a little warmer than that in the room. That being so it naturally went to the top and created no draught. He had observed in connection with the blower that when they blew in cold air they were likely to feel a slight draught, but with warm air, which rose to the top, there was no draught. The air was taken down about 30 feet, and it could be made to go into pipes for heating, or it could be sent direct into the blower if the outside temperature was desirable. If driven by a small engine the blower could attain great velocity, and it could be used to heat as well as ventilate rooms. For this purpose it was very economical. If the steam engine were used for other purposes, and the waste steam were employed for the blower, the heat would cost nothing at all. The hot air could be blown into any part of the building where desired.

Sir Douglas Galton, K.C.B. (London) said that if warm air were supplied at the upper part of the room he could understand that there would be no draughts; but such a method should be attended by some system of extracting the air also, and not merely trusting to the chance of escape of air through the windows if they were to have a really healthy room. He thought they should have outlets to provide the constant circulation of air, without which there could be no very satisfactory ventilation. He quite saw the advantages in this system, and he should like to have further facts as to the point just raised—that it was a more economical method of heating than that of steam or hot-water pipes. He could quite understand that in a hospital ward or school buildings especially a system of ventilation analogous to this would produce a circulation, and provide infinitely healthier schoolrooms than now existed. To the ventilation of schools their attention ought to be very largely directed, because they were in a most unsatisfactory and unhealthy condition.

SECTION III.

CHEMISTRY, METEOROLOGY, AND GEOLOGY.

ADDRESS

By John W. Tripe, M.D., M.R.C.P.E., &c.

PRESIDENT OF THE SECTION.

"Winds, with some remarks on their Sanitary Effects."

I have selected this subject for my address, not only as it is one belonging to meteorology, but because winds are necessary to the well-being, if not to the existence of the animal world. Thus, if it were not for winds, the air we breathe would not be changed sufficiently often to support vigorous life. There are also other reasons for introducing the subject at a meeting of the Institute, viz., that winds frequently carry infectious matter to a distance from the source of infection.

The earth is enveloped by an atmosphere, consisting chiefly of oxygen and nitrogen; but it contains in addition varying proportions of aqueous vapour, carbonic acid, various products of imperfect combustion, dust, spores, baccilli, and other microscopic bodies. In its rotation the earth carries the atmosphere with it at the same speed as itself, so that there would be but little wind if the surface of the earth were not unequally heated by the sun's rays. As the sun is always vertical over some part of the earth, on either side of the equator, it heats that portion of the earth, and consequently of the atmosphere above it more than elsewhere. And, as heated air is lighter than cold, it ascends and creates a vacuum when cold air rushes in to fill its place. There is, therefore, always a lower current of air from the poles to the equator, and upper currents from the equator towards the poles or other colder regions. The latter currents becoming colder in their transit, descend at a greater or less distance from the equator, thus creating winds. In addition, as the earth rotates more rapidly at the equator than it does at the poles, in consequence of its nearly globular shape, the velocity of the atmosphere is about two hundred and fifty miles per hour greater at the equator than near the poles. As one other result of the varying speed at different parts of the earth's surface, all winds have a tendency to be deflected to the right. Northerly and southerly winds in the northern hemisphere are deflected in a north-easterly and south-easterly direction, inducing a north-east trade wind in the northern and a south-east trade wind in the southern hemisphere. Where two trade winds meet at or near the equator, there is a region of calms. The currents returning towards the poles to replace the air that has gone towards the equator to form the trade winds, assume a more or less south-easterly direction in our hemisphere, and a north-westerly in southern temperate latitudes, and have been named by Sir John Herschel the "Anti-trades."

The direction of the winds in the cyclones of subtropical seas, is, as regards north and south winds, partly determined by the rotation of the earth, but chiefly by unequal heating through local causes of limited portions of land or water. Where the heated air rises there is diminished pressure, as shown by the barometer, and cold air consequently rushes in from all directions to fill the vacancy; that which comes from the poles travels the slowest, and that from the equator more rapidly, owing to the different velocities with which the surface of the earth rotates. As before stated, the polar wind in our hemisphere is a north-easter, and the equatorial a south-west wind; when these enter the place of low barometric pressure they assume a cyclonic direction, rotating towards the north-west to south-east, and then again to north, or contrary to the motion of the hands of a watch. Winds from the west or east have no effect on the rotatory movement of a cyclone.

As the behaviour of land, under the heating influence of the sun's rays, differs much from that of the sea in the reception and power of retaining heat, the force of the wind varies very much according to the surface on which the heat falls. When the rays strike upon water they penetrate to some depth, but a large portion of the heat absorbed does not affect the thermometer, as it becomes latent, and is known as "the specific heat of water." The sea and large bodies of water, therefore, do not become so highly heated as land with the same amount of heat. The water of the sea especially is nearly always in motion, and thus leads to the diffusion of heat in the water, so that the surface is not so hot as it otherwise would have been. Evaporation also goes on with greater or less rapidity according to the rate of movement and dryness of the air, and thus reduces the temperature of the sea. Land, on the other

hand, retains the greatest part of the heat for a time, and gives it off slowly, but does not become heated to so great a depth as the sea. Some kinds of soil hold the heat more than others, especially sand and rocky grounds, whilst a wet soil does not become heated so much as dry, partly because the moisture absorbs much heat, which becomes latent. Ground covered with vegetation does not become so hot as it otherwise would do, because part of the heat is used in growth and part given off by the evaporation of its moisture.

There is a constant change of wind morning and evening at the sea side, forming what are known as land and sea breezes. The ordinary theory for these is that in consequence of the unequal heating of the sea and land already referred to, the air rushes from the cooler to the warmer localities, causing sea-breezes by day and land-breezes at night. Mr. Laughton, however (Jour. Roy. Met. Soc., Vol. 1), doubts this being the true explanation, as it does not fully elucidate the chief phenomena of a sea-breeze. Thus, Dampier remarks that the effect of the coming sea-breeze upon the water is marked by "a fine black curle," which advances slowly, so that it can be seen perhaps for an hour before the breeze reaches the shore, when it has usually a velocity of not only 5 or 10 miles, but frequently of 30, 40, or even 50 miles an hour. Mr. Laughton believes them to be winds of propulsion rather than of aspiration, and that the causes are, first, that the heat of the sun induces increased evaporation at sea; and secondly, causes increased elastic force of the vapour in the air, so that pressure is exerted on the land air, which is then driven back in the direction of least resistance. After the sea air has been pouring on to the land until nearly evening, and has ascended high into the atmosphere, it becomes cooler, and descends towards the warmer sea, forming the land-breeze. He says these breezes are most marked in the vicinity of well wooded districts, and are scarcely perceptible when sandy deserts are near. Mr. Blanford (Vade Mecum., part 2, page 70), is dissatisfied with this explanation, and offers another, viz., that the air over the land having been expanded by the heat, forces its way upwards, and thus compels the heavier air to slide off towards the cooler sea, causing a locality of high atmospheric pressure some distance away. From this place the air flows towards a locality of diminished pressure on the heated land. At night a reverse flow takes place towards the warmer region, viz., the sea, causing a land-breeze. The Rev. F. W. Stow (Jour. Roy. Met. Soc.) offers yet another statement, as he says that the direction of the wind from the sea obeys Buy's Ballot's law, so that when we look to the sea the wind comes from the right and blows along the coast line. Whatever the explanation may be, land and sea breezes are generally met with at sea-side places, and make them not only more pleasant, but more healthy, than inland localities, especially in summer. This frequent movement prevents stagnation of the air, increases the evaporation of moisture from the body, and consequent removal of the effete matter given off in the perspiration and breath. Winds occurring in the vicinity of large rivers partake of the good qualities of sea-breezes, but do not contain so much ozone or saline matter. I may mention that these breezes are said to be rarely higher than 400 feet above the surface. As a corroboration of this, I may mention that on the second stage of the Eiffel Tower, about 450 feet high, there was a calm when the wind blew strongly on the earth, and on another occasion the contrary happened. These facts are within my own knowledge. Similar observations have been made on the Forth bridge.

Although wind charts show that the wind rarely goes in a straight line on the earth's surface, yet I believe, as each wind nearly always has its peculiar characteristics, that the following statements are fairly correct:—

The direction from which the wind comes influences materially our health and comfort. Thus, a north-easterly wind, so dreaded in this country in winter in consequence of its coldness and dryness, usually passes over the northern portion of Russia, including Siberia, before reaching us. In summer it is often pleasant, but very frequently treacherous, causing colds. Easterly winds which come from the direction of Russia and Germany are, as is too well known, dry and biting, having the character of a land wind a little tempered by the German Ocean. A northerly wind which blows from the locality of the Arctic Ocean, and when somewhat westerly, from Greenland, is cold, although bracing to the strong and healthy. Westerly winds which come from the direction of Labrador pass over so large an amount of sea before reaching us as to have lost most of the characteristics of a land wind. Due south, and especially south-westerly winds, are essentially oceanic in their character, being moist, comparatively warm, and in summer relaxing. Much of the moisture and heat are derived from the Gulf Stream. South-easterly winds are drier than south-westerly, as they pass over France, and often have their origin in Africa. By a dry wind, I mean one capable of absorbing a rather considerable quantity of moisture before it becomes saturated, or nearly so. The feeling of dryness depends not so much on the quantity of moisture contained in the air, as on its capacity of absorbing more. Thus, a wind at 40° F. nearly saturated, will contain much less moisture than a wind at 60° F. not nearly

saturated. The former would consequently feel damp, and the other dry. The quantity of moisture abstracted from our bodies by a wind will not only depend on its capacity of absorption, but on its rate of progress, so that a high wind will exert a greater evaporating force, with the same degree of saturation, than a wind having a lower velocity.

The results of the intermixture of different winds vary considerably at different seasons. Thus in winter we often have, even when the barometer is high, a heavy rainfall with a north-easterly or easterly wind. This occurs usually after the prevalence of fine weather and a southerly or south-westerly wind, owing to the cold air causing so great a reduction of temperature in the mixed air, as to render it incapable of holding all the moisture previously suspended. On the contrary, when easterly winds have continued for some time, and a south-westerly wind supervenes, a cloudy sky often becomes clear and the air drier, in consequence of the rise in temperature and, consequently, increased capacity for the retention of moisture. In such cases, the barometer often goes back from fair (30 inches) to wet (29 inches). As a rule, however, there is dry weather and a rising or high barometer with easterly winds, and rain with southerly or south-westerly winds.

The most convenient arrangement for discussing winds is that proposed by Dove, viz., Permanent, Periodical, and Variable, the latter being the winds of high latitudes. Permanent winds include the Trades and Anti-trades, to which I have already referred. They are stronger in the South than in the North Atlantic, blowing about eight knots in the former, and six in the latter. The chief Periodical winds are the north-east and south-west Monsoons, or, as they are named by Blanford, the winter and summer Monsoons. The direction of these winds varies to a certain extent, being locally changed in India by the unequal heating of the soil, where the south-west Monsoon, on reaching the valley of the Ganges, is changed into a south-easterly wind before passing over the hot surface of the Punjab. In China, on the contrary, it assumes a more southerly direction. I mention these facts to show that even a Periodical wind may become changed in its direction from local causes. In the same way the north-west Monsoon is changed into a north or north-east wind near Madagascar, and into a due west, or nearly so, at Torres Straits. At the time of change of the Monsoons, violent storms of wind and rain frequently happen. Variable winds are those which occur in this country, and, as all will admit, well deserve their name. They are not confined to this island, but are felt on those parts of the earth's surface which are outside the influence of the

Trades. They vary in their direction and force almost constantly, in consequence of the varying temperature and consequently varying air pressure in different localities, as they circulate round areas of high or low pressure.

Mr. Glaisher published a paper in the "Journal of the Royal Meteorological Society" (1870), showing the direction in which the wind blew in this country during 8,765 consecutive hours, which I shall now discuss, as well as other tables published by the Astronomer Royal for a longer period. I have reduced them to percentages, excluding calms.

Percentages of hours during which the wind blew from different points of the compass.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	TOTAL.
Glaisher ..	10·1	12·4	7·4	7·0	7·9	33·1	15·2	6·9	= 100
Greenwich Reports.	12·3	14·4	6·8	6·0	10·3	31·4	11·5	7·3	= 100
Averages ..	11·2	13·4	7·1	6·5	9·1	32·2	13·4	7·1	= 100

This latter shows, as might have been expected, that by far the most prevalent wind in this country is the south-west, as on the average of the two sets of observations, nearly one-third (32·2 per cent.) blew from that quarter. The next most prevalent winds are the north-east and the west, which had the same percentages, viz., 13·4 per cent., or, to speak more exactly, 13·4 per cent. of north-east against 13·35 per cent. of west. The fourth place is occupied by the north winds, with 11·2 per cent. against 9·1 per cent. of due south winds, and 7·1 per cent. of east and north-west winds. As these percentages were obtained from a considerable number of observations—and the two sets do not differ much except as regards winds from due east and west—they may be regarded as fairly approximative, especially as they were taken in the same locality.

I now give a table prepared from Mr. Strachan's paper, published in the "Journal of the Royal Meteorological Society," on the percentages of winds blowing from different points of the compass on wet and on dry days. The number of observations was 3,148, each of which was made at 9 a.m. I have given percentages instead of the actual figures as published, for more ready comparison.

Percentages of observations on rain and wind on 3,148 days.

	N.	N.E.	E.	S.E.	S.	S.W.	W.	N.W.	CALMS.	TOTAL.
With Rain.	6·5	12·3	11·0	4·9	14·2	30·5	15·7	4·0	0·9	= 100
Without Rain.	10·0	10·5	12·3	3·7	7·2	17·2	25·7	10·3	3·1	= 100

The table shows that with a north wind rain occurred on 6·5 days, and was absent on 10·0 days; with a north-west wind there were 10·3 dry and 4·0 wet days; and with a north-east wind there were 12·3 days on which rain fell and 10·5 without, making a total of 22·8 days with, and 30·8 days without rain, during the prevalence of northerly winds; the dryest periods being those during which north-west winds prevailed. On the contrary, the greatest number of wet days occurred with southerly winds, as there were 49·6 days of wet against 28·1 days without rain. The days in which south-west and south winds prevailed showed a smaller proportion of wet as compared with dry days than might have been expected, viz., 34·7 rainy and 24·4 dry days. South-easterly winds, comparatively, rarely occurred; and the number of wet and dry days were more equal, viz., 4·9 with rain and 3·7 without. The days on which the wind blew from the north-west were marked with much less rain than from any other quarter. Under these circumstances when anyone proposes to go for pic-nic or any other out-of-door enjoyment, I should advise him to select a day on which the wind blew from the north-west or the north, unless the latter were too cold.

Local occasional winds extend in some cases over large tracts of land or sea, whilst in others they are confined to some small locality. The winds to which I refer occur more or less all over the world, and are characterized by their violence and generally by their dryness. They are hot or cold, according to the surface over which they have passed; both of these varieties are met with in this country. The Helm wind, which occasionally occurs in Cumberland, is a notable instance of one kind; and sudden blasts of hot wind, such as one described by Symons, is another. He saw a tract or narrow passage, along which everything had been killed by a hot blast which passed across the land whilst a friend of his was taking a thermometrical observation. His friend noticed the thermometer rise rapidly, then felt a pain in the back of his neck, and had to lie down; on rising he saw a narrow path, along which everything was withered where previously all was green.

The Simoom is a deadly wind occurring occasionally in the deserts of Kutch and Upper Scinde, as well as in other like countries. Dr. Cooke, who lived many years in India, and in that part of the country, says it is often sudden and singularly fatal in its effects, "invisible, intangible, and mysterious." It is a dread to the desert traveller, as it sometimes causes sudden extinction of life, both in man and beast, and destroys all vegetation. He cites a case in 1851, when some officers in General Jacob's house at Jacobabad were awakened out of their sleep by a sense of suffocation and great heat. Next morning the path of the wind was shown by the destruction of every green thing in the garden for a width of nearly twelve yards, and in a straight line. A native who was caught by one, stated that he and two friends were struck down and rendered senseless by a blast like air from a baker's oven. They all recovered after a time. When death occurs the flesh is withered and can be plucked from the bones. In one instance three out of five persons were killed.

The hot wind of Australia is better known, as it occurs in Sydney and the interior of the country, when the temperature rises to 107° F., or something a little less. Captain Sturt says that in Central Australia his thermometer rose to 131° F. in the shade. Dr. Mann, who made many observations in Natal, stated that he had not known the temperature higher than 97°, and that as many as from 26 to 30 hot blasts occurred in a year. They always commenced in the middle of the night and continued up to 9 or 10 in the morning, when the greatest heat was attained. About 12 or 1 at midday rain would begin to pour in torrents and the temperature to fall rapidly, sometimes 30° in half-an-hour. The rain usually continued until night, when the atmosphere became remarkably translucent, as stars of the seventh magnitude could be seen by the naked eye.

A similar wind occurs in New Zealand, which is followed by what is called a "*Southerly Buster.*" The effects of exposure to this is described by Lady Barker (Station Amusements in New Zealand). "The wind is parching and scarcely endurable, but at last, when the skin felt as if it were tightly drawn like parchment, and our ears and eyes had long been filled with powdered earth, the wind dropped as suddenly as it had risen five days before; clouds then came up rapidly with an icy breeze, followed in an hour by rain. The following day was delicious."

The *Föhn* is a hot dry wind which blows in winter in the north-eastern valleys of Switzerland. Mr. Laughton (Modern Meteorology) says that on a wind driving up a mountain slope, its expansion, owing to diminished pressure, causes a corresponding lowering of its temperature. The moisture is then condensed and the latent heat set free, thus warming up the surrounding air, making it relatively hot and dry, and forcing it into the valley below. The temperature rises sometimes to 80°, and the humidity decreases to about one-fourth part of that which the air could hold.

The *Sirocco* is another hot wind which is met with on the borders of the Mediterranean, especially the coasts of North Africa, Sicily, and South Italy. In Sicily the thermometer sometimes rises to 110°. It does not destroy life but destroys

temper, and causes an intense feeling of langour and prostration. The *Khamsin*, a hot wind of Egypt, lasts for forty or fifty days, and carries large quantities of fine dust many miles out to sea. The *Harmattan* is a hot east wind on the West Coast of Africa, which blows a reddish dust on to the sails and decks of ships far out in the Atlantic. In Spain a similar hot wind is known by the name of *Solano*.

Warm and hot moist winds are depressing and sedative in their action on the system, and diminish the elimination of moisture from the lungs and skin, and consequently of the organic matters ordinarily given off by these organs. Warm dry winds, unless very hot, produce a contrary effect, as they encourage the evaporation of moisture from the skin and lungs, being greedy of moisture. When very hot and dry, they remove water so rapidly from the body as sometimes to destroy life.

Occasional Cold Winds are almost as numerous as hot winds, and when accompanied by fine snow are called *Blizzards* in the United States of America; the *Purga* in the Yenessi Valley; and the *Bura* in Central Asia. They are much more destructive to life than the hot winds. In a *Blizzard* the snow falls in the form of fine dry crystals of ice, which do not melt readily, thus rendering respiration difficult, and sometimes impossible, eventually causing death by asphyxia. In April, 1873, a most violent *Blizzard* occurred in Dakota, when the wind blew at the rate of thirty-nine miles an hour for nearly 100 hours, so that no one could leave the house. This, however, was not so bad as the Blizzard of January 11th, 1888, which extended over Dakota, Minnesota, Kansas, and Texas, causing loss of life to more than 100 persons. Many of those who died completely undressed themselves, although the wind blew at the rate of from forty to fifty miles an hour. The temperature fell 50° in $4\frac{1}{2}$ hours, and 64° in less than eighteen hours. On January 18th and 19th, 1881, a Blizzard occurred in London, when the crystals of ice found their way into the passages and rooms, although the doors, windows, and shutters were closed. I was out in the storm, and on returning found above an inch of the fine dry snow on the seat of a railway carriage, which it had not wetted. What are known as "*Northers*" in the United States are dry cold winds, often accompanied by snow. Mr. Russell, in his book on North America, says that the temperature during a "Norther" in Southern Texas fell from 81° to 18°, or 63° in 41 hours. Other cold winds are the *Mistral*, which blows along the Gulf of Lyons, and is so strong that an eye-witness told me that he saw a man blown off his horse, waggons overturned, and much damage done to vegetation. The

Bora and *Tramontana* are, like the Mistral, dry and cold, and sweep over the Adriatic and adjoining countries. In Peru, in a district called Punos, a table land having an elevation of 13,000 feet, Prescott says that the south-east Trade wind becomes so cold and dry before reaching this district, that the ancient Peruvians preserved their dead by exposing them to its desiccating action.

Easterly winds in this country are very trying, even to healthy persons, and often fatal to the old and young, causing more deaths in London, when combined with fog, in one week, than the most violent Blizzard. Thus, in three weeks of very cold weather with easterly winds, the deaths from inflammatory diseases of the lungs rose from 250 in one week to nearly 700 in London alone; and in 1886 the deaths from these causes increased steadily from 418 in February to 828 in the third week of March during the prevalence of these winds. When these winds are dry, they act injuriously by causing rapid evaporation of moisture from the skin and lungs, and corresponding evolution of heat from the body. When cold and moist, such a wind acts injuriously by carrying away heat from the lungs and skin by conduction, and not by increased evaporation of moisture. This is the reason why a combination of great cold and fog is felt so keenly.

The velocity of wind is ordinarily calculated on land from Robinson's Anemometer, which consists of four hemispherical cups, firmly fixed on the extremities of two bars placed at right angles to each other, bolted together and perforated in the centre, so that when mounted on a standard they will revolve, and by means of gearing transfer the motion to a recording apparatus. The velocity of the rotating cups was supposed originally to be equal to one-third of the velocity of the wind, but this has been found to be too great; so that rather less than 2·5 is the factor for multiplying the velocity recorded by the apparatus. Anemometers do not ordinarily record any movement of the wind less than three miles an hour, but it is evident that records may be obtained by occasional puffs when the steady rate of three miles an hour has not been reached. A light air is defined by the Meteorological Office to be a wind moving at the rate of eight miles an hour; a light breeze of from 13 to 18 miles an hour; a moderate breeze 23; a fresh breeze 28; a strong breeze 34; a moderate gale 40; a fresh gale 48; and a strong gale 56 miles per hour. In a storm the wind is said to blow at the rate of 75, and a hurricane of 90 miles per hour.

General Greely, in his account of American weather (pp. 176–77), gives some extraordinary velocities observed in the

American Signal Service. He says that at Cape Mendreino a velocity of 144 miles an hour was reached in Jan., 1886; of 104 miles at Fort Canbig, Dec., 1884; from 90 to 100 miles on the North Carolina coast; and at Cape Lookout of 138 miles on Aug. 17th, 1879. The following also were recorded; at Pike's Peak 112 miles in June, 1881; 186 miles on Mount Washington, and also the rate for less than an hour of 110 miles on March 13th, 1888, at Montreal. In the same book he states that he had recorded a velocity of 65 miles an hour in the Arctic regions, when the cups were blown away. He estimates the gusts to have travelled on this occasion at the rate of 90 to 95 miles an hour.

Tornadoes in America usually come from the south-west and travel to the north-east. General Greely says that the path of greatest violence varies, generally, from 100 to 600 yards in width, and from 1 to 50 miles in length; that its rate of motion is between 20 and 50 miles an hour, and the time taken in the passage of the immediate centre is between 5 and 10 minutes, during which the largest trees may be blown down, houses and bridges lifted from their foundations, and frequently overturned. In a series of tornadoes on Feb. 9th, 1884, above 10,000 buildings were destroyed, 800 people killed, and 2,500 wounded. On Sept. 9th, 1884, the value of the property destroyed by a tornado in Minnesota and Wisconsin was estimated at 4,000,000 of dollars.

The relations between wind velocities and pressure were until lately in a chaotic state of confusion, but, thanks to Mr. Dines and his late father, we now have some definite information on the subject. They erected a whirling machine, driven at various rates by a steam engine. The machine consisted of a long bar, supported by stays, carrying plates of different shapes and sizes, and, for the purpose of comparison, a uniform velocity of 20·86 miles per hour was finally adopted. The results showed that with a velocity of 21 miles per hour the pressure exerted upon a plane area, of a fairly compact form, is about 1½ lbs. per square foot. As the wind pressure up to a velocity of 70 miles per hour has been found to vary in these experiments as the square of the velocity, the pressure with any intermediate velocity can be readily calculated. If we take the pressure of 1 lb. per square foot as a basis, it is found that a velocity of 17 miles per hour gives this pressure. This varies, however, to a certain but small extent according to the size and shape of the plate.

As Beaufort's scale is used not only by seamen, but by most meteorological observers, to express the velocity of the wind, I give the table adopted by the Meteorological Office, and used in the comparison of weather with storm signals, and by captains at sea :—

Force. Beaufort's Scale.			Approximate velocity. Miles per hour.
0. Calm			0—5
1. Light Air, or just sufficient to give steerage way			6—10
2. Light Breeze...	Or that in which a well-conditioned man-of-war, with all sail set, & clear full, would go in smooth water from	1—2 knots	11—15
3. Gentle		3—4 "	16—20
4. Moderate		5—6 "	21—25
5. Fresh	Or that in which she could just carry in chase, full and by	Royals, &c.	26—30
6. Strong		Single-reefed topsails and topgallant sails	31—36
7. Moderate Gale		Double-reefed topsail, jib, &c.	37—44
8. Fresh "		Triple-reefed topsails, &c.	45—52
9. Strong "		Close-reefed topsails and courses..	53—60
10. Whole Gale, or that with which she could scarcely bear close-reefed maintopsail and reefed foresails			61—69
11. Storm, or that which would reduce her to storm staysails			70—80
12. Hurricane, or that which no canvas could withstand, 80 miles and upwards.			

There are, of course, serious difficulties, especially in steamships, in noting according to this scale, but observers on land can soon judge as to what place in these scales a wind at a given time should be assigned, but as wind comes in gusts, observations made only for a short period can scarcely be so useful as a continuous record such as that given by Robinson's or other anemometer. Mr. Laughton, however, objects to the velocity fixed for a calm as being too high, and says that anything like 5 miles per hour during a calm would be caused by occasional puffs of wind. Also that the highest is too low, as in tropical cyclones the velocity frequently exceeds 90 or 100 miles; and Mr. Thorn, judging from the damage done in these storms, is of opinion that the velocity often exceeded 120 miles per hour. This estimate agrees fairly well with Greely's statements.

Carrying power of winds.—Perhaps the most important evidence on this point was afforded by the Krakatoa eruption, which occurred on August 26th and 27th, 1883. An important volume has been published by the Royal Society, edited by Mr. Symons, giving full details of the phenomena. An immense column of smoke, steam, and ashes proceeded, on the 26th, from the volcano, and reached a height calculated at 17 miles by the captain of a vessel out at sea. The dust and ashes were caught by the wind and carried round the world in 13 days, as shown by the haze, the peculiar coloration of the clouds at sunset and sunrise, and the greenish colour of the sun and moon. After the first passage it was again carried round the world in less than 14 days, making the double passage in rather less than 27 days, so that it must have had a velocity of 76 miles an hour. The stratum was at first estimated by Mr. Archibald to be 121,000 feet, or 23 miles, above the surface of

the earth. It appeared to be far higher than ordinary cirri, and afforded spectroscopic evidence of being a cloud of solid particles. In November the cloud had expanded so as to include Europe, having at first been carried in a westerly direction over the Indian Ocean, Africa, Brazil, the Pacific, and thence back again to Japan. The density and elevation diminished during its passage, so that in January, 1884, the highest part had fallen from 121,000 feet to 64,000 feet, being a diminished elevation of 57,000 feet. The volcanic dust fell on several ships in September, 1883, one being more than 3,700 miles from the volcano at the time.

Another instance of volcanic ashes being carried a considerable distance occurred in March, 1875, when several ships at sea, and a large area in Scandinavia, extending from the Gulf of Bothnia to the West Coast, were more or less covered with a deposit of ashes. The matter was fully investigated by Professor Mohn, who concluded that they had been brought by the wind from the volcano Hecla, in Iceland, which was in a state of eruption. Numerous other instances could be given.

Chas. Darwin, in his "Naturalist's Voyage Round the World," mentions in several places deposits of dust which had been carried from 1,000 to 1,600 miles out to sea. On microscopic examination of some dust obtained near St. Domingo, it was found to consist in great part of infusoria with silicious shells, and of the silicious tissues of plants; and out of sixty-seven different organic forms, all but two were inhabitants of fresh water. The dust fell on his ship in such quantities as to dirty everything on board, to hurt people's eyes, and even to damage the astronomical instruments. He remarks (p. 5): "After this fact one need not be surprised at the diffusion of the far lighter and smaller sporules of cryptogamic plants." At p. 454, when speaking of Keeling Island, six hundred miles from Sumatra, he gives a notable instance of this kind. After mentioning various kinds of seeds he had obtained, which were unknown to the Malays settled there, he says: "All these are supposed to have been driven by the north-west Monsoon to the coast of New Holland, and thence to these islands by the south-east trade wind." The plants he obtained there are common littoral species in the East Indian Archipelago, so that the seeds must have travelled before germinating between 1,800 and 2,400 miles. The pollen of trees has at times so coated the ground as to have been mistaken for a "sulphur rain," as occurred in Friesland about sixty years ago; and showers of fish in inland places have been frequently recorded. The fish were usually of small size, but a shower of herrings is mentioned as having fallen in Edinburgh. The contents of fish ponds have been also caught up by the wind and deposited some distance away. In 1804, the wind carried the wheat on a Tetuan threshing floor across the Straits of Gibraltar, and let it fall in Andalusia. The roof of a house was carried away in a storm, and deposited whole about one hundred yards away. A loaded waggon was lifted off a road over a hedge, and fell into an adjoining field. Very numerous similar occurrences could be given as to the lifting and carrying power of the wind.

One of the most interesting phenomena connected with the carrying power of the wind is the occurrence of water-spouts at some distance inland. One lately occurred on High Stoy, Batcombe, Dorsetshire, and is described in the June and July numbers, 1889, of Symons' Monthly Meteorological Magazine. About six in the evening, after a storm of thunder and lightning, with but little rain, great waves of water, from 8 to 10 feet high, rolled down the Batcombe Hills upon the little village of Chatmole. Great damage was done, stock having been drowned, trees carried away, roads injured for miles, the cottagers' furniture washed away, and other damage done. An eye-witness described the cause as a solid stream of water, about the thickness of a man's body, which washed holes in the ground 8 or 9 feet deep. The Rev. H. J. Poole states that the ground above these pits was undisturbed, there not being the slightest disturbance of the soil, although below them large holes were frequent. Mr. Symons observes that "it is much to be regretted that no record has been preserved as to whether the water was salt or fresh. Our impression is that it was probably sea water lifted from the English Channel by a whirlwind and dropped upon the top of High Stoy." These water-spouts are by no means uncommon, especially at sea.

There is one unpleasant experience which most Londoners and residents in large cities and towns have suffered from, viz., the quantity of dust, vegetable, and other debris which is blown at times by a high wind in our faces, and into the nose, mouth, and lungs, to the great injury of the mucous membranes lining these passages. I have treated many cases of illness arising from this cause. In the country hay fever and attacks of asthma are caused by the pollen of grass, and of some other vegetation, carried by the wind.

Winds are also carriers of ozone from the sea and country places to cities, and thus counterbalance, to a certain extent, injuries such as those just mentioned. Ozone is oxygen in a specially active and energetic state, which burns up much of the effete matter given off from the skin and lungs, and renders the air more pure and invigorating. When wind charged with ozone passes over a city the ozone is removed, as I showed in

1856 and '57, by observations conducted by myself at Hackney, and by the late Mr. Burge (Medical Officer of Health for Fulham), at Fulham. We then found that when wind containing ozone blew from Hackney to Fulham I noted ozone and he did not, and the contrary with wind from Fulham to Hackney.

The relations of wind to fog are well worth notice, as most fogs are of local origin, and are carried by the wind to the places where they occur. Thus, the "London particular" is usually the result of an admixture of mist from the Thames or sea, with the products of combustion given off from the fire-places and furnaces of London. In Hackney we sometimes have fogs from the Lee valley and less frequently from the Thames. When the wind is scarcely moving the fog remains for a longer time than when it is brisk, as the fog is then blown away. Occasionally fogs come across the land from the sea as far as Hackney, and I have known spray from the sea to destroy the leaves of trees at Upper Clapton on the side exposed to the blast. I have on more than one occasion passed through a mist extending from the sea to London; and Dr. Burney Yeo, in his paper on "Change of air," just published, says that he has followed a sea fog from Ryde to Portsmouth, and thence by rail to London, where it became a London fog in the south-western districts, whilst the eastern districts were clear. He also says in his paper, after referring to dust carried by the wind backwards and forwards from place to place, and inhaled by every one out of doors, "and yet we marvel how infectious diseases are spread abroad!"

I have dwelt at considerable length on this part of my subject because I think it explains many otherwise unaccountable outbreaks of infectious diseases. In 1882 I gave evidence before the Hospital Commission on small-pox and fever hospitals, and then stated that I could not in any way account for the repeated outbreaks of small-pox in a street parallel with the Eastern Hospital, situated 400 feet away, and separated from it by the City of London Workhouse, unless they were caused by infective matter carried by the air and blown over the workhouse. In my report to the Hackney Board of Works for the year 1884 I discussed this matter fully, and as I think proved that an outbreak which occurred on the 21st and 22nd of March in that district had its origin on the 6th and 7th of the month, when the wind, after veering about, blew steadily at a very low rate of speed, or was calm, viz., about three or four miles an hour, in the direction of the localities affected. Mr. Power also pointed out in 1882, a similar coincidence as regards the wind and small-pox outbreaks in the vicinity of the Fulham Small-pox Hospital. During the epidemic of 1883—4

I identified several outbreaks of the disease in the vicinity of the hospital with periods when the wind was moving over those portions of the district at a very low velocity. High winds seem to blow infective matter away so rapidly, and diffuse it so extensively, that probably no harm has happened during these periods; but I believe the converse holds good when a low rate of wind prevails. Some physicians doubt the possibility of small-pox infection being carried more than a few feet, but I cannot understand how, if the disease be set up by a living organism falling on a soil in which it can develop, it should be able to infect a person at 20 feet distance, and not at 100 feet, or even at half a mile. Surely a living organism cannot be destroyed (oxidised) in its passage through the air for half a mile, when the wind is travelling at the rate of only four miles an hour, that is to say, in 7½ minutes. The idea seems to me preposterous, especially as we know that articles of infected clothing and scabs of small-pox will retain infective power for months. I believe the reason why zymotic diseases, and especially small-pox, are not more frequently spread by the wind to be that a certain dose or intensity of the poison, as well as a susceptible condition of the recipient, must co-exist to set up the train of symptoms constituting an attack of the disease.

Time will not allow me to do more now than to mention the spread of diphtheria and some other diseases by the wind, which has been insisted upon by several competent observers. I must, however, just mention the results of a careful and extended investigation as to the occurrence of diarrhœa and zymotic diseases in the vicinity of the Thames, which I made some time since, and concerning which I gave evidence before the Royal Commission on the discharge of sewage into the Thames. I then showed that these diseases caused fewer deaths in the vicinity of the river than at a quarter of a mile distant from it, owing, as I believe, partly to winds blowing away from the various streets and courts, the effete matters given off by the body, which are, I believe, injurious to health by affording pabulum for the growth of low forms of life. There are many other points on which I should have touched if I had not already exceeded the usual length of an address, and trespassed so long on your patience.

Mr. G. J. Symons, F.R.S. (London), said that there were one or two points on which he would like to say a word or two, because one did not like an address of this character to go *pro forma*. There was one of which they had had a very remarkable confirmation quite recently, and it was respecting the monsoons. In Worcester there was an average rainfall of about 30 inches per annum, whereas more than that quantity fell in Hong Kong in a single day during the May monsoon of this year, which fact was a good confirmation of what Dr. Tripe had said regarding the monsoon rains. With regard to Dr. Tripe's reference to picnics, he might remind them it was necessary to make arrangements for a picnic a day or two beforehand. If they all knew *when* a north-east wind was going to blow they would be in a much happier frame of mind. As to the intensity of mistrals, near the Gulf of Lyons there was one remarkable fact that had not he believed been mentioned in this country, and he did not think investigated fully on the other side of the Channel, namely, the tremendous force of wind in that country. Over a line of railway running from Cette to Perpignan the wind swept so violently as to have overturned several trains as they were running along. True there had been isolated cases of trucks being blown over in this country. He might mention another thing with regard to the velocity of winds. Some people said before the Eiffel Tower was constructed that it would be useless, but no one thinks so now. It had only been erected a short time when the French Government established valuable meteorological apparatus on the summit, and the observations were recorded below, showing something like three times the velocity of wind at the summit as at the base, and also that the diurnal curve of wind intensity is wholly different. He would also like to make a remark as to the distribution of germs, and the opinion expressed by Dr. Tripe as to the condition of the recipient. He thought that if their own bodies were in a good sanitary condition they might swallow any number of those germs without danger therefrom.

On "The Extension of Public Analysis," by Charles E. Cassal, Public Analyst for St. George's, Hanover Square, Kensington, Battersea, and High Wycombe.

No one who has taken the trouble to consider the state of things which existed before the days of the "Lancet Sanitary Commission" of 1854–56, and prior to the Adulteration Act of 1860, can entertain any doubt as to the great benefits which have been conferred upon the community by the legislation directed against the adulteration of food and of drugs, in spite of the tentative character and of the numerous other defects of that legislation, and in spite of the inadequate manner in which it has been applied. It is proverbial that things move slowly in this country, and although, as a set-off against this, it is generally asserted, perhaps with justice, that they move surely, the profound and general ignorance upon the subject of adulteration is a little astonishing, when it is considered that the matter has engaged the attention of English legislators from decidedly early times, in reference at least to the adulteration of particular articles of food. The first enactment directed against adulteration in this country dates back to 1267, and provision was made for the punishment of persons guilty of certain forms of food adulteration in 1580 and 1604; but, it cannot be supposed that the public generally had been at all moved upon the subject, until the appearance, in 1820, of Accum's celebrated work called "Death in the Pot," with a title-page embellished with urns, death's-heads, hour-glasses, serpents, and palls: "A treatise on adulteration of food and culinary poisons, exhibiting the fraudulent sophistications of bread, beer, wine, spirituous liquors, cheese, tea, coffee, cream, vinegar, confectionery, mustard, pepper, olive oil, pickles, and other articles employed in Domestic Economy, and methods of detecting them." And the public, if moved at all, were not moved to much purpose then, as no general Adulteration Act existed before 1860; and it is well known that the passing of that Act was almost entirely due to the startling revelations made by Drs. Hassall and Letheby—as members of the Commission previously referred to —in the pages of the *Lancet*. The Select Committee appointed by the House of Commons, in 1855, reported as follows as to the adulterants discovered at that time: "Without entering into voluminous details of the evidence taken, your Committee would enumerate the leading articles which have been proved to be more or less commonly adulterated. These are—arrowroot, adulterated with potato and other starches; bread, with potatoes, *plaster of Paris, alum, and sulphate of copper*; bottled fruits and vegetables, with certain *salts of copper*; coffee, with chicory, roasted wheat, beans, and mangel-wurzel; chicory, with roasted wheat, carrots, *sawdust, and Venetian red*; cocoa, with arrowroot, potato-flour, sugar, chicory, and some *ferruginous red earths*; cayenne, with ground rice, mustard husks, etc., coloured with *red lead, Venetian red*, and turmeric; gin, with *grains of paradise, sulphuric acid, and cayenne*; lard, with potato flour, mutton suet, *alum*, carbonate of soda, and *caustic lime*; mustard, with wheat flour and turmeric; marmalade, with apples and turnips; porter and stout, with water, sugar, treacle, salt, *alum, cocculus Indicus, grains of paradise, nux vomica*, and *sulphuric acid*; pickles and preserves, with *salts of copper*; snuff, with various *chromates, red lead, lime*, and *powdered glass*; tobacco, with water, sugar, rhubarb, and treacle; vinegar, with water, sugar, and *sulphuric acid*; jalap, with *powdered wood*; opium, with poppy capsules, wheat flour, *powdered wood and sand*; scammony, with wheat flour, *chalk, resin, and sand*; confectionery, with *plaster of Paris* and similar ingredients, coloured with various pigments of a *highly poisonous nature*."

This, as a matter of fact, is by no means a complete list of the adulterants said to have been detected at that time. It is not too much to say that the practice was almost universal, and a very striking feature about it was the dangerous character of many of the adulterants used. The list as it stands, however, is to be thought of not merely as proving the necessity of stringent legislative action, but as a description of the sort of thing which would, with certain exceptions of course, again occur if the existing laws were to be repealed or even relaxed. I do not suppose it will be seriously maintained that the commercial morality which devised and practised the forms of adulteration described, has suddenly vastly improved, and attained a standard of excellence upon which the country may congratulate itself. Certainly, matters are better now than they were twenty-five or thirty years ago, but if this be so, it is not owing to an epidemic of virtue in commercial life. If the adulterator is more virtuous now than he used to be, it is because he has, to some extent, been dragooned into virtue. Indeed, some members of certain trades nowadays not unfrequently make a virtue of necessity. We are accustomed to the frequent delivery of jeremiads about the spotless tradesman, whose last thought would be to undersell his neighbour, or to get anything illegitimate out of the public, and who has been dragged into court, held up to general obloquy, and mulcted in fines at the instance of a wicked public analyst—a form of complaint which is the more interesting when it is emitted, as is not unusually the case, by members of particular trades whose past history in reference to adulteration will not bear much investigation. Much of course depends upon education and consequent enlightenment. It may freely be admitted that some forms of adulteration would no longer be employed in the present day, because their employment was due merely to ignorance, and no special pecuniary advantages were attached to their use; but if it is contended that injurious and even actually poisonous adulterants are things of the past, it is only necessary, in order to refute the contention, to call attention to our past experience of commercial virtue in these matters, and to present facts. There is no difficulty in finding recent instances. Pepper containing chromate of lead has recently been sold in Bristol; salad oil made up with mineral (or "paraffin") oil has been seized in Wandsworth; vendors of a sweetmeat called "chewing gum," made up with paraffin-wax, have been prosecuted in Birmingham; sweets coloured with red iron-earths have been taken in London; and there is the extending use of so-called preservatives, such as salicylic and boracic acids for perishable foods. The adulteration of drugs and the inaccuracy of prescriptions, may be cited as further instances.

It ought surely to be tolerably obvious that what law there is should not only be maintained, but that it should be applied as extensively as is possible. It is, of course, not likely that any change in the law in the direction of relaxation will take place. All the tendency of modern legislation is the other way; but the application of the existing law is still absurdly inadequate. It is supposed to be an expensive business, and local authorities, whose general devotion to the "penny-wise and pound-foolish" policy is notorious, object to spending money in order to institute and maintain a really thorough and comprehensive system for ensuring the purity of the various supplies which are required by the communities they are supposed to serve. On the other hand, there are not a few members of local authorities who appear to think that it is actually desirable for ulterior motives—so that, in fact, their own sordid interests may not be affected—to keep the Acts against adulteration in the dead-letter state. One has only to glance at the annual reports of the Local Government Board to become convinced of the necessity of enforcing an extension of public analysis, in so far, at any rate, as public analysis is now allowed to go; that is to say, in regard to "foods and drugs." In the whole of England and Wales, during the year 1887, only 24,440 samples of all kinds were taken for analysis, of which by far the greater number were samples of milk. In London generally, calculating upon the populations in 1881, about one sample for every 596 persons was taken, but in the provinces only about one for every 1,228 persons. In two populous districts of London, one having a population of 107,850 and the other of 17,508, no samples whatever were taken. In another, having a population of 36,024, eight samples were submitted, of which two were adulterated. Very insufficient attention is paid to the large "stores," of which there are now so many in London. *Not a single sample* was taken in the *county* jurisdictions of Berkshire, Oxfordshire, or Pembrokeshire, and the same was the case in not less than seventy-two boroughs—including Plymouth, Lincoln, Gloucester, Carlisle, Oxford, Colchester, Grimsby, Shrewsbury, Scarborough, and Devonport. To this black list must be added several other counties and boroughs where the application of the Acts was disgracefully inadequate and, in fact, no better than a farce; and in further quotation from the Board's report, it has to be stated that the provincial districts referred to—those where no samples were taken and those where hardly any were taken—contained in 1881 an aggregate population of more than *five millions*.

The table on the following page shows the total number of samples taken in the Metropolis and in each county, including boroughs, in 1887, with the populations and the proportion of samples returned as adulterated in that year and in 1886. The table, to a great extent, speaks for itself. It would, of course, be necessary to make a large number of calculations in order to determine with accuracy the relative degrees of inertia displayed by the authorities of the different counties, and it would hardly be worth the trouble. Some of the figures given, however, must appeal to all persons who are not entirely devoid of a sense of humour. Dorset, Shropshire, and Anglesea, for instance, with their eight samples apiece (being 1 for about 20,400 inhabitants in the aggregate), and the proud position of the county where one sample was taken which was found to be adulterated, thus giving 100 per cent. of adulteration, may be especially pointed to. Excluding the Metropolis, of the 54 counties in the list, it cannot be said that more than 14 have made any serious attempts to apply the Acts, and these 14 all contain large cities or boroughs.

—	Population, 1881.	Total.				—
		Examined.	Adulterated.	Percentage Adulterated.		
				1887	1880	
The Metropolis.	3,815,704	6402	894	14·0	*13·2*	Metropolis.
Counties, including Boroughs.						Counties, including Boroughs.
Bedford	149,459	146	8	5·5	*7·1*	Bedford.
Berks	218,363	22	0	...	...	Berks.
Bucks	176,323	102	18	17·6	*13·1*	Bucks.
Cambridge	185,594	46	6	13·0	*9·8*	Cambridge.
Chester	644,037	669	96	14·3	*8·3*	Chester.
Cornwall	328,366	50	3	6·0	*6·5*	Cornwall.
Cumberland	250,647	136	7	5·1	*9·7*	Cumberland.
Derby	461,914	148	44	29·7	*18·1*	Derby.
Devon	603,595	174	23	13·2	*14·4*	Devon.
Dorset	191,028	8	1	12·5	*11·1*	Dorset.
Durham	867,201	739	86	11·6	*14·7*	Durham.
Essex	576,434	608	128	21·1	*14·5*	Essex.
Gloucester	572,433	612	38	6·2	*7·9*	Gloucester.
Hereford	121,062	34	2	5·9	*21·7*	Hereford.
Herts	203,083	78	8	10·3	*7·9*	Herts.
Hunts	59,491	34	2	5·9	*1·8*	Hunts.
Kent (ex-Met.)	709,482	776	103	13·3	*11·8*	Kent (ex-Met.)
Lancaster	3,454,441	4119	561	13·6	*12·8*	Lancaster.
Leicester	321,258	391	37	9·5	*10·7*	Leicester.
Lincoln	469,919	175	25	14·3	*15·7*	Lincoln.
Middlesex (ex-Met.) ...	369,929	737	78	10·6	*7·2*	Middlesex (ex-Met.)
Monmouth	211,267	47	8	17·0	*6·9*	Monmouth.
Norfolk	444,749	65	5	7·7	*6·7*	Norfolk.
Northampton	272,555	105	20	19·0	*13·1*	Northampton.
Northumberland	434,086	141	14	9·9	*12·2*	Northumberland.
Nottingham	391,815	120	49	40·8	*28·7*	Nottingham.
Oxford	179,559	......	...	...	*14·3*	Oxford.
Rutland	21,434	20	2	10·0	...	Rutland.
Salop	248,014	8	3	37·5	*31·6*	Salop.
Somerset	469,109	1134	53	4·7	*3·9*	Somerset.
Southampton	593,470	583	82	14·1	*13·0*	Southampton.
Stafford	981,013	1073	147	13·7	*13·3*	Stafford.
Suffolk	356,893	50	10	20·0	*23·1*	Suffolk.
Surrey (ex-Met.)	473,143	523	86	16·4	*19·2*	Surrey (ex-Met.)
Sussex	490,505	359	18	5·0	*7·1*	Sussex.
Warwick	737,339	1390	184	13·2	*9·4*	Warwick.
Westmoreland	64,191	60	4	6·7	*18·8*	Westmoreland.
Wilts	258,965	69	6	8·7	*7·1*	Wilts.
Worcester	380,283	168	18	10·7	*9·2*	Worcester.
York, E. Riding	364,979	307	21	6·8	*14·3*	York, E. Riding.
„ N. Riding	346,317	50	1	2·0	*4·3*	„ N. Riding.
„ W. Riding	2,175,325	1074	142	13·2	*12·5*	„ W. Riding.
Anglesea	51,416	8	2	25·0	*18·2*	Anglesea.
Brecknock	57,746	41	6	14·6	*37·8*	Brecknock.
Cardigan	70,270	3	0	...	...	Cardigan.
Carmarthen	124,864	13	3	23·1	*38·5*	Carmarthen.
Carnarvon	119,349	18	1	5·6	*29·2*	Carnarvon.
Denbigh	111,740	30	2	6·7	*16·7*	Denbigh.
Flint	80,587	17	5	29·4	*7·7*	Flint.
Glamorgan	511,433	745	68	9·1	*9·7*	Glamorgan.
Merioneth	52,038	9	4	44·4	*44·4*	Merioneth.
Montgomery	65,718	1	1	100·0	...	Montgomery.
Pembroke	91,824	......	...	...	...	Pembroke.
Radnor	23,528	3	1	33·3	...	Radnor.
Totals		24440	3134	12·8	*11·9*	Totals.

With reference to the percentages of adulteration shown in the foregoing table, I think every Public Analyst of experience will agree with me that an improved method of taking samples would in all probability very considerably affect those percentages in the direction of increase. To place the taking of samples in the hands of country police constables, as is done in most counties, is a good way of still further lessening the value of the Acts, and is a factor which, without doubt, affects the percentage of adulterated samples detected.

Since we are in Worcester, it may not be amiss to point especially to the Worcester returns, and I venture to express the hope that our visit here may do something in the direction of improving the existing condition of things.

In 1887, in the county jurisdiction of Worcester, with a population, according to the census of 1881, of 308,810, 133 samples were taken for analysis, of which eight were returned as adulterated. In the borough of Worcester, with a population of 40,354, sixteen samples were taken, and one was reported as adulterated. In Kidderminster, with 24,270 population, nineteen were taken, and nine of them were adulterated. In Bewdley and Droitwich no samples were taken (populations respectively 3,088 and 3,761). So that in the whole county, including four boroughs, with an aggregate population of at least 380,283, only 168 samples of all kinds were taken, of which 18 were reported against, giving a percentage of 10·7. Surely, this is hardly a creditable state of things, and it is but a poor excuse to say that other places are worse. The number of samples taken was equal to one for every 2,263 persons. With regard to the percentage of adulteration detected, I venture to think that the remarks previously made about the method of collecting samples will apply here with some force. There can be no doubt, from the lessons of past experience, that a very different story could be told after the application of some improvement in this direction.

I desire then to insist upon the necessity of largely extending the public analysis possible under the existing Acts of Parliament. I believe that in this respect I have the sympathy of my colleagues, the public analysts of the country. I trust that we shall be able to enlist the sympathy and the support of the public generally. There are few offices perhaps more thankless than that of the Public Analyst—few, if any, public offices the work of which it is more difficult for the public to appreciate, hedged about as it is by all sorts of technical matters incomprehensible to the lay mind; but in spite of misunderstanding and misrepresentation, and of opposition both active and inert; despite the dense atmosphere of ignorance in which we live, which it is necessary in some degree to pierce and lighten; and with all the narrow sordid interests which have to be overcome, I cannot believe, with some of my friends, that we shall remain unsupported in our endeavours to bring about substantial and permanent improvement. We desire to see an adequate application of the existing law; but not this alone, for an extension of public analysis far wider than is possible under the present law must be fought for and obtained.

In Great Britain the Public Analyst can only deal officially with "foods and drugs." I contend that an extension and amendment of our legal machinery is required to enable him to deal with a large number of articles, the manufacturers and vendors of which at present enjoy a free hand to do with the public as they please. It is not to our credit that the first steps in the direction of such an extension have been taken by other nations, and that we should be compelled to cite them as examples for imitation, and to compare their more comprehensive laws with our own, greatly to the disadvantage of the latter. Such comparisons might here be made, but it is impossible within the limits of this paper to enter fully into a question which presents so wide a field for discussion, and I cannot do more than give such indications as may serve to prove my point.

The term "adulteration," as generally understood, does not adequately describe the moral and legal offences which, for want of a better word, it is convenient and desirable to designate by it. The popular idea is that adulteration means nothing more than the mixing of some extraneous matter with an article of food or with a drug. In the absence of a better, it would be convenient to use the word to apply to all cases where any article whatever, designed for human use, on the ground of possible injuriousness to health and on the ground of fraud, or again, on account of ignorance, *(a)* has had any constituent omitted or removed wholly or in part; *(b)* contains any foreign substance giving it a fictitious value or lowering its real value, by respectively increasing or decreasing its bulk, weight, or strength, or altering its nature or quality; *(c)* is an imitation of, or substitution for, another article; and *(d)* contains any substance which can be certified as likely to be dangerous or injurious to health. It is necessary to distinguish carefully between an article which contains impurities, and an article which has been purposely adulterated. An article of food may be of inferior quality, and it may even be unwholesome, without necessarily having been adulterated, and it may come under the only possible definition that can be applied to it under the existing law: careless manufacture, use of damaged or inferior

materials, non-maturity, commencing decomposition, and so forth, may render a food product unwholesome and inferior; and while, as a consequence of such causes, adulteration may be constituted by the presence of certain specific substances, or by the existence of impurity beyond a certain limit, it is important that clear distinctions should be drawn between inferiority, unwholesome inferiority, and adulteration.

The Public Analyst appointed for a district, in addition to the analyses which he is now empowered to make, should have placed in his hands, officially, the examination of the gas and of the water supplies in his district. As things at present stand, the examination of gas in the metropolis is carried out to an extent far less than is desirable by gas-testers appointed by the County Council, who are far too few in number, and who are paid an absurdly small remuneration. In some places the Medical Officer of Health is supposed to examine the gas. This is a mere figment, and in any case he is under no circumstances the proper officer to be entrusted with this work. In the provinces, as a general rule, the official examination of gas is either not carried out at all, or it is a mere farce. As regards water, the metropolis is flooded with reports, very useful and excellent in their way, upon the water supplied from the mains; but analyses of water from the cisterns of houses—a thing continually required—is again a matter that is shelved or bungled. In the provinces, water analysis, too, is placed, most improperly as a matter of principle, in the hands of the Medical Officer of Health; and at this point I beg to be allowed to say that, in my opinion, Medical Officers of Health should have nothing to do with analysis, except in regard to interpreting the results of professional analysts. The appointment of Medical Officer of Health, further, should never be combined with that of Public Analyst. Even when the medical officer is competent to carry out the work, which (and I say it with all respect) cannot be said to be universally the case, the working of one of the two appointments must suffer, for they have nothing, or hardly anything, in common. They do not require the same kind of training, experience, or personal qualities, and their combination is accordingly liable to lead to abuses of various kinds, such as the farming-out of analytical work to a cheap chemist, or of hygienic work to a cheap doctor.

There are, it is true, questions relating to probable or possible production or propagation of disease, upon which a Public Analyst has obviously no business to express official opinions. If he does so he is not unlikely to commit himself seriously. Local authorities should be guided in their action, in cases where the expert knowledge of three distinct professions is involved, by competent representatives of those three professions—that is to say they should be guided by the combined advice of the Physician, the Public Analyst and the Engineer; and not by that of any single presumably phenomenal member of any one of these professions, who is supposed, upon more or less unsatisfactory evidence, to be in full possession of the knowledge and experience of the other two.

Patent medicines, the various quack nostrums, hair-dyes, soaps, cosmetics, and the large class of similar articles about which our most imaginative advertisements are concocted, should be made liable to seizure by Inspectors, and examination by Public Analysts; and where, as would be very commonly the case, absolutely poisonous substances or ingredients likely to be injurious to health were found, their vendors should be subjected to severe punishment, and the fullest publicity given to the case. A similar course of action should be adopted with articles of clothing, with reference to the materials of which they purport to be composed and to the dyes which have been placed upon them. The use of certain substances having been prohibited by law, their discovery should be made punishable; this is the only way of dealing with the matter. Poisonous dyes, poisonous paints on articles of decoration, such as wall papers; or upon children's toys, which are frequently loaded with pigments of the most dangerous description, should not be permitted to be used at the sweet will of any manufacturer, as is now the case. I have over and over again found arsenic, for example, in articles that were in daily use, and that in large quantities; for instance: in certain muslins—sold in London by hundreds if not thousands of yards—in children's butterfly nets, in gloves and other articles of dress, and my experience in this respect can be amply confirmed by many of my colleagues. The Committee of the House of Commons, upon whose report the Sale of Food and Drugs Act of 1875 was framed, reported that the public appeared, so far as foods and drugs were concerned, to be cheated rather than poisoned. This is true perhaps about food; it is not true about drugs; and it is not too much to say that as regards numerous articles at present untouched by public analysis the public are poisoned as well as cheated. To take another example: the vendors of the different kinds of rubbish sold under the name of "disinfectants," and with which the uninitiated feebly attempt to combat the spread of disease, should be made amenable to some sort of control. None can be better than their seizure by an Inspector, and their public condemnation by an authorized and responsible officer.

The connection between public analysis and sanitary science is a very intimate one, although, perhaps, not always very obvious. The adulteration of drugs, for instance, has of course a very direct and evident bearing upon public health; the adulteration of milk with water has again many well-known bearings in this direction; but when the evil is extended over a wider field, as it were, the serious import of adulteration in sanitary science is not, at first sight, so plain. Yet, to prevent the food of a community from being systematically robbed of a part of its nutritive value; to prevent the inhabitants of a country from being provided with clothing, the protective value of which is not what it is expected to be, or which contains materials directly detrimental to health; to prevent, in fact, an insidious kind of competition which may have many ulterior and unexpected ultimate effects upon the health of a people, may justly be regarded as a very important function of a Ministry of Health, if such were brought into being. And while one of the great benefits of the present law and of any extension of it is to be found in the prevention of the under-selling of the honest tradesman by dishonest competitors, these matters will necessarily still be dealt with most conveniently, and, in most instances, appropriately, by sanitary authorities.

An extension of public analysis in the general direction, which I have not been able to do more than indicate, if it is to be of real and full service to the community, must necessarily be carried out with a more intelligent appreciation of the heavy responsibility attaching to the duties of both public analysts and inspectors. Even as it has been, and as it is, the public analysts, by their work, have powerfully influenced for good some of the most important trades. The extension of public analysis ought to mean, and would mean, a far stronger and more widespread control over the trade morality of the country.

Dr. J. W. Tripe (London) said one of the most useful points on which the discussion might turn, not to the exclusion of any other point, was as to the necessity of some alteration in the law regarding the unlimited sale of articles of food and patent medicines containing matters injurious to health. He proposed a vote of thanks to Mr. Cassal for his paper, which was carried with acclamation.

Mr. J. Willis Bund (London) said he would not like the statement Mr. Cassal made as to the magistrates of Worcestershire to go out to the world uncontradicted. As a magistrate of the county, and one who had had a good deal to do with the Executive Committee of the County Magistracy, he felt rather jealous of the honour of the county. He would not be doing his duty to his fellow magistrates if he did not explain why it was the number of samples taken in the county was so small. The Act was carried out by the police; and they only acted when a purchaser complained to them. The conduct of the Act had raised the question whether they could and ought to act if some one did not complain. The paucity of samples taken was owing to the paucity of complaints. He agreed that there should be larger powers for interference, but as the law now stood they had to find the aggrieved person, who was not easily to be found. When they got a complaint, and then only, were they able to act under the Adulteration Acts. He ventured to think that unless very great care was taken, there would be far fewer samples and prosecutions taken in the future than they had at present. Before the Local Government Act was passed the Quarter Sessions appointed an Analyst who carried out the Act; now, there would be three authorities: the Court of Quarter Sessions, or magistrates who had certain powers with regard to the Act: the Standing Joint Committee, who would give orders to the police; and the County Council, who would appoint the analyst. It was said no man could serve two masters: how much less then could he serve three! It was only one instance out of a great many where the result of the Act would be to divide the responsibility and make the laws less aggressive. If an Act could be framed saying that any person selling any goods and representing them to be what they were not, should be liable to a penalty, the difficulty would be abridged.

Dr. C. R. C. Tichborne (Dublin) said that he felt the objects set forth by the reader were perfectly right and just. At the same time he had hardly attributed enough to the deterrent influences of the Adulteration Acts. It struck him that the analyst had not the power, according to the law, of acting himself. He was merely empowered to carry out analyses. The Act should be improved in this respect. He, the speaker, was analyst in the county of Longford. Action there was always taken by the constabulary. There were periodical fairs for the sale of horses, and booths were erected in the fields in which persons who held licenses were allowed to open. His attention to the sale of whiskey there was directed some years ago by a constabulary officer, who told him that the whiskey was so bad that it was allowed to run away after the cessation of business. The reason of this was it was only made to last one day, and it would not last till the next. When emptied upon the grass at the end of the fair, it left a black stain like ink. The so-called whiskey really consisted of methylated spirits, sulphate of iron—which turned it black after a time—and capsicum. Anything would do for them so that it gave the impression that it was a regiment of soldiers going down their throats. It was largely sold. A raid was made at one of these fairs and thirty samples were taken. In some thirteen of these samples prosecutions were taken. Since this occasion they had frequently made raids, and they only had obtained three prosecutions. In these latter cases it was simply because the whiskey had been diluted and

reduced below the standard of strength. The prosecutions had thus had a very deterrent effect. The adulteration of the present day was much more scientific than it used to be. The adulterations practised during the time of the author of "Death in the Pot," were now quite obsolete. The old practice of colouring pickles with copper was not practised in any respectable house.

Mr. G. J. Symons, F.R.S. (London), did not think that, in the matter of adulterations, we were by any means A 1. He recollected a rule in Paris which seemed an extremely good one. He saw an official notice in a shop window there, stating that the proprietor of it had sold something which, upon being taken to the laboratory of the municipality, proved to be very seriously adulterated; and he was told that a person convicted of such an offence was not merely punished, but compelled by law to place a placard in the front of his house to that effect. The copying of this example would be wonderfully preventive of British tradesmen going wrong in the same direction. Unfortunately English Acts of Parliament did not usually contain such practical preventives. He hoped that if any amendment of the Act was passed a clause would be inserted making it compulsory for the convicted tradesmen to exhibit one of these notices.

Mr. Wetherall (Worcester) said Mr. Cassal had stated the case very well from the standpoint of an analyst. Why did adulteration exist? By far the greater reason was that the public desired a cheap article, whether it was pure or not. That this Congress would be helpful in educating the public taste, and leading them to see that it was to their own interest to buy articles which were absolutely pure, he fully hoped. There were eight persons out of ten who preferred to buy impure mustard: and, if they were supplied, the public taste could alone be blamed. He thought it was unjust and unfair to convict the retailer, unless it could be proved that he had adulterated his goods with the view to gaining increased profits. The bulk of samples taken were had from small shops. It was utterly impossible for the people keeping them to adulterate one tithe of the articles sold; and if they were prosecuted they were saddling the wrong horse thereby. Let them put the penalty on the shoulders of those entitled to bear it.

Mr. Cassal (London), replying on the discussion, said that no valid excuse had been brought forward for the inefficient manner in which the Adulteration Acts had been applied in Worcestershire. It was no excuse to say that a few samples only had been taken for analysis because only a few complaints had been made. To wait until complaints were made before taking any action was practically to reduce the present law to the level of the Act of 1860, which laid upon private purchasers the *onus* of having samples analysed if they thought that they were being supplied with adulterated articles. The general public were helpless in this matter, and it was absurd to expect people to make "complaints" who were altogether ignorant of what they were being supplied with, and had no means of finding out. The plain duty of the magistrates of Worcestershire, and of authorities elsewhere, was to appoint and pay an inspector or inspectors to carry out the Acts, and it was their business to see that those Acts were carried out thoroughly and efficiently. It was very obvious that a great many local authorities required far clearer notions of their duty to the communities they were elected to serve, in reference to the enforcement of the laws against adulteration, than they seemed to possess at present. Much might be done, if it were possible to bring the pressure of public opinion to bear in the direction, at least, of getting the present laws adequately applied. Mr. Bund's suggestion that inspectors should be empowered to take samples of any articles exposed for sale, so that they might be examined with a view of determining whether the purchaser got what he asked for and had a right to expect, struck him (the speaker) as affording an easy way of extending the present law so as to allow of a much wider application of public analysis. He agreed with Mr. Tichborne that the present Acts exercised a very great deterrent influence. This was shown by the enormous decrease in the percentage of adulteration since 1875. While this was so, he had no doubt, and no person who had any experience in these matters could reasonably entertain a doubt, that some of the worst forms of the old adulterations would again recur if there were any relaxation in the law; and there was very good reason to believe that forms of adulteration which had been practically suppressed in those districts where the law was applied, still existed in those where it was a dead letter. Apart from the punishments inflicted, which as a rule were absurdly insignificant, publicity was a very great deterrent. The French system of placarding the details of an offence upon the shop door of an offender, which had been alluded to by Mr. Symons, had a great effect. Vendors who had been summoned for adulteration were always, and very naturally, most anxious to prevent any publication of the fact by the press. They were sometimes very assiduous in their attentions to the representatives of the press in court. The objection raised by Mr. Wetherall was an old one, and was easily met. The retail vendor had his remedy against the wholesale dealer or the manufacturer; but it was a common thing for the wholesale vendors to pay the fines inflicted upon the retailers. Certain retailers simply afforded so many channels through which the wholesale vendors, or the manufacturers of bad articles, could distribute them at a profit over a wide area. He contended, further, that the desire of the public to buy cheap things was no excuse for adulteration. This, in fact, ought to be self-evident. The objection about mustard was also an old one. It was asserted that the admixture of flour with mustard was necessary for, and was indeed, desired by, the consumer. It was remarkable that if the latter was really so anxious to have his mustard mixed, the vendors did not publish the fact of the admixture far and wide. They did not do so at any rate when the adulteration amounted to 20 or 25 per cent. It was curious that it should be necessary to point out that mustard mixed with flour was not mustard; but the mustard question was not the most important one. Adulteration should be regarded as a most serious offence, and not as a mild and trumpery one as was so frequently the case.

On "*Some Recent Results obtained in the Practical Treatment of Sewage*," *by* PERCY F. FRANKLAND, Ph.D., B.Sc. (Lond.), Assoc. Royal School of Mines, F.C.S., F.I.C.

ALTHOUGH it is not difficult to obtain reports, substantiated by more or less elaborate chemical analyses, on the efficiency of patent processes for the treatment of town-sewage, yet the value of such testimonials is generally but slight, inasmuch as the experiments upon which they are based have usually been made under circumstances of such an exceptional character that similar results are rarely if ever realised in actual practice.

Having recently had occasion to inspect a number of the largest sewage works in the country, in connection with a proposed scheme for the disposal of the sewage of one of our most important towns, it appears to me that the results of this enquiry into the daily practical working of the more important processes now in operation, may not be without interest to those directly or indirectly concerned with the disposal of town-sewage.

The sewage works examined were six in number, and were representative of all the principal methods of treatment now in vogue. For various reasons it will be preferable to refer to the several towns by distinctive letters instead of by their names. In the case of three of the towns the method of treatment was by precipitation only, whilst in the other three the latter was supplemented by application to land.

TREATMENT BY PRECIPITATION ONLY.

Town A.—In the case of this town nine to ten million gallons are treated daily, and the only precipitant used is lime, which is added in the proportion of one ton to 1,000,000 gallons of sewage. The lime is made into a thin cream, which then mixes with the sewage in the pump-well and becomes thoroughly incorporated with it in the process of pumping. The mixture then flows into a series of twelve depositing tanks, of a total area of 71,270 square feet, or 1·75 acre, and of an average depth of six feet, the cubical contents being 2,500,000 gallons. The sewage has thus to pass a distance of 1200 feet through the tanks, and this passage occupies about two hours. The tanks are divided from each other by walls, over which the sewage flows. As indicating the distribution of the precipitate it should be mentioned that the first four tanks are cleaned out consecutively about every fourth day, the fifth and sixth about every seventh day, whilst the remaining six scarcely ever require cleaning.

From the analyses given below, through the proportion of chlorine it appears that the samples of effluent collected were all derived from somewhat weaker sewage than that represented by the sample of raw sewage. The suspended matter in the effluent sewage, however, may be taken at about two to three parts per 100,000, and of this about one half was organic in nature.

Towns B and C.—These two may be considered together, inasmuch as the method known as "intermittent treatment" with lime alone is practically the same in both. At town C, the daily quantity of sewage dealt with is 10,000,000 gallons. The sewage receives fifteen cwts. of lime per 1,000,000 gallons, the lime being as usual added in the form of cream. The precipitation takes place in a system of no less than thirty tanks, the important distinguishing feature being that a period of perfect rest is given to the sewage in each tank. Each tank has a capacity of 50,000 gallons, the total tank-capacity being 1,500,000 gallons. The method of working consists in filling four tanks simultaneously, this occupies upwards of sixteen minutes; after about twenty minutes complete rest, the liquid is run off through a floating exit-pipe, from which it passes over a weir in a thin layer, and then downward through a filter which is constructed of lumps of coke, to a depth of about two feet, after which it passes upwards through a similar layer of coke. The coke in these filters is changed about every three months. The process of drawing off the clarified liquid from a tank takes about two hours, but it is considered advisable to allow even longer.

The analyses given below show that this complicated system of intermittent precipitation yielded results very similar, but by no means superior, to those obtained by the simpler method of continuous precipitation adopted in the case of town A.

Moreover, the process of filtration through coke, as carried out at these works, appears to deteriorate rather than improve the character of the effluent.

Treatment by Precipitation and Subsequent Application to Land.

In the case of the three other towns visited this compound method of treatment was in operation, but in order to be able to compare the efficiency of the methods of chemical treatment with those adopted in the three towns referred to above, the effluent from the precipitation-tanks, as well as that from the land, was in each case submitted to separate chemical examination.

Town D.—Here the sewage of 50,000 inhabitants, amounting to 2,000,000 gallons daily, is treated with 13 cwts. of quick or one ton of slaked lime and 18 cwts. of sulphate of alumina. The sewage first receives the requisite amount of sulphate of alumina, after which the lime is added, a thorough mixture being effected in a special tank of small dimensions. The treated sewage then flows into eight tanks arranged in parallel series, each tank being 5 ft. 6 in. in depth, and having a capacity of 120,000 gallons is not subdivided by any partitions. Thus, although a given volume of sewage only passes through a single tank, still the total tank-capacity is so large in proportion to the volume of the sewage, that the rate of passage through the tank is extremely slow.

On referring to the analyses it will be seen that this extremely simple arrangement also yields an effluent containing as little suspended matter as that from any of the more complicated systems of tanks already referred to. Two out of the eight tanks are daily completely emptied, and yield 74 tons of wet sludge. It is worthy of notice that at these works a ready sale for the pressed sludge is obtained at the rate of about 1s. a load, and in point of fact, at the time of my visit there was little or no sludge on the premises.

The effluent from this process of chemical treatment then passes on to a plot of land eight acres in extent, and laid out in intermittent filters, underdrained at a depth of 4 to 6 feet. This land yields seven crops of rye-grass annually, and realises from £2 to £3 a week.

The chemical examination of the effluent from this land shows that, whilst the proportion of suspended matter is undiminished, the dissolved organic matter has undergone very considerable reduction. It is evident, however, that the area of land is insufficient to completely deal with the quantity of sewage applied to it, inasmuch as the effluent is quite free from nitrates.

This town affords a very striking and interesting example of sewage-treatment, both by chemicals and filtration, the method of precipitation being remarkably simple and compact, whilst the area for filtration purposes is exceptionally small.

Town E.—In the case of this town, the principal purification relied upon is the application to land, towards which the chemical treatment is merely a preliminary operation.

The sewage, about a third of a mile before reaching the works, receives an addition of lime to the extent of about 16 cwts. per 1,000,000 gallons. On reaching the works the treated sewage divides into three large tanks arranged in parallel series, and in passing through which precipitation takes place.

Reference to the analytical table will show that the effluent from this single-tank precipitation contained only a small proportion of suspended matter, whilst the organic matter in solution was scarcely reduced at all. The effluent from the tanks is then distributed over the land by way of irrigation, each acre receiving on an average the sewage of 400 or 500 persons. The soil is extremely well suited for the purpose, being gravelly throughout, and is drained to a minimum depth of 4 ft. 6 in. The farm is made to yield a very varied produce; thus—milk is a large and increasing item, a considerable portion of the area is devoted to mangolds, swedes, and Kohl rabi, another large fraction to market garden produce, another to Italian rye-grass, another to cereals, besides a large part laid down as pasture.

A sample of the effluent from the land was collected, and found to be almost free from suspended matter, whilst the organic matter in solution was also very largely reduced. As evidence of the liberal allowance of land given to the purification of the sewage, a very large proportion of nitrates was found in the effluent, which in this respect presented a marked contrast to the conditions existing in the case of town D, where the sewage of about 6,000 persons is applied per acre.

Town F.—In the case of this town the allowance of land for purification is even greater than in that of town E, inasmuch as only the sewage of about 300 or 400 persons is applied per acre.

The method of chemical treatment is varied, sometimes lime and sulphate of alumina being used, whilst at other times, especially in summer, lime and refuse carbon are employed. The lime is added first (about 16 cwts. per 1,000,000 gallons), and then the sulphate of alumina (about 5 to 10 cwts. per

DR. FRANKLAND'S PAPER.—*Results of Analysis expressed in parts per 100,000.*

	Description.	Matters in Solution. Total Solid Matters.	Organic Carbon.	Organic Nitrogen.	Ammonia.	Nitrogen as Nitrates and Nitrites.	Total Combined Nitrogen.	Chlorine.	Matters in Suspension. Mineral.	Organic.	Total.
	Chemical Treatment only:										
Town A.	Raw Sewage	96·48	4·066	·987	2·30	0	2·881	16·5	17·12	29·40	46·52
"	Effluent *(a)*	64·08	·980	·333	1·20	0	1·321	11·2	·56	·56	1·12
"	" *(b)*	75·36	1·342	·503	1·30	0	1·574	15·1	1·58	·46	2·04
"	" *(c)*	88·76	2·000	·444	1·80	0	1·926	13·6	1·88	1·56	3·44
"	Limed Sewage from tank after subsidence in Laboratory	95·50	3·887	1·081	1·30	0	2·152	11·6	0	0	0
Town B.	Effluent	178·78	10·847	2·416	·80	0	3·075	7·9	2·34	1·28	3·62
Town C.	Raw Sewage	51·00	1·280	·181	1·30	0	1·252	10·6	23·56	15·16	38·72
"	Effluent from Settling-tank	45·12	1·629	·311	·52	0	·739	8·2	1·62	·46	2·08
"	" after passing over Weir	44·56	1·594	·305	·50	0	·717	8·4	1·64	1·86	3·50
"	" after filtration through Coke	39·72	1·059	·273	·50	0	·685	7·2	3·60	2·98	6·58
	Chemical Treatment combined with Application to Land:										
Town D.	Raw Sewage	75·00	3·253	·501	4·20	0	3·960	9·4	11·88	22·92	34·80
"	Effluent from tanks	75·00	2·208	·360	3·80	0	3·489	8·7	·98	·68	1·66
"	" land	60·40	·959	·159	1·30	0	1·230	6·2	·96	·78	1·74
Town E.	Raw Sewage	104·20	4·134	·700	3·70	0	3·747	21·0	23·20	28·64	51·84
"	Effluent from tanks	113·32	3·655	·705	2·50	0	2·764	23·8	2·08	1·52	3·60
"	" land	80·40	·605	·118	·09	1·548	1·740	11·2	·26	·18	·44
Town F.	Raw Sewage, first day	98·60	4·204	·623	3·00	0	3·094	8·3	10·24	11·76	22·00
"	Effluent from tanks (treatment with Lime and Sulphate of Alumina; ¼ hour's rest)	85·36	2·145	·358	2·30	0	2·252	7·2	1·88	2·12	4·00
"	Effluent from land	85·28	·906	·180	·05	·820	1·041	7·0	·22	·36	·58
"	Raw Sewage, second day	82·20	3·371	·563	4·30	0	4·104	7·1	6·56	9·52	16·08
"	Effluent from tanks (treatment with Lime and Carbon; ½ hour's rest)	73·28	1·617	·204	2·50	0	2·263	7·5	2·52	2·48	5·00
"	Effluent from land	77·00	·937	·275	·005	·611	·890	6·9	·40	·14	·54

1,000,000 gallons); the carbon is employed in about the same proportion as the lime.

After thorough mixture taking place during the process of pumping, the treated sewage passes into six tanks arranged in two parallel sets of three. In these tanks a period of perfect rest is given, which varies in duration according to the quantity of sewage coming down. The clarified liquid is drawn off by means of floating arms, and then passes on to the land. The mode of application consists in causing the sewage to flow twice over the surface of the land, as the attempt to filter it by under-draining proved very unsuccessful, in consequence of the heavy nature of the soil.

The principal produce of the farm is Italian rye-grass, which is cut five times annually; there are also smaller plots under oziers, mangel-wurzel, and market garden produce.

Two complete series of samples, taken on two different days, were submitted to analysis. On the first occasion lime and sulphate of alumina, with a quarter-of-an-hour's rest in the tanks, were employed, whilst on the second day lime and carbon were used with half-an-hour's rest in the tanks. The results obtained were essentially similar on both occasions; in neither case was the removal of suspended matter, by precipitation, very satisfactory, whilst a marked reduction in the proportion of dissolved organic matter was effected. In both cases the effluent from the land was almost quite free from suspended matter, and the dissolved organic matter was very greatly reduced.

General Conclusions.

The six examples described above may be taken as fairly typical of the average performance of some of the best managed sewage-works in the country.

The results show that if the only object of the treatment is the production of a fairly clear effluent, this can be satisfactorily attained by a number of processes of chemical precipitation.

As regards the chemicals employed, there would appear to be distinct evidence in favour of the use of sulphate of alumina along with lime, as by this means the dissolved organic matter is generally more reduced than if lime alone be employed. In no case, however, can any very great reduction in the proportion of dissolved organic matter be secured.

As regards the execution of these precipitation processes, the method of subsidence under complete rest, at any rate as at present carried out, appears to have little to recommend it; for although unquestionably correct in theory, it is difficult in

practice to afford rest of sufficient duration for the advantages to come into play; whilst the far greater complexity both of construction and management which this method entails are very much against it. In none of the three towns in which this method was in operation was the effluent remarkable for its freedom from suspended matter.

In practice the greatest success is to be anticipated by employing the maximum capacity in a single tank of moderate depth without partitions. In short, let the whole of the available money be devoted to the acquisition of the largest system of tanks, of the simplest construction and requiring the least attention.

In cases where not only a clear effluent, but also one as free as possible from dissolved organic matter is required, we must resort now, as heretofore, to the application of the sewage to the land. In such cases, however, the sewage should invariably be submitted to a preliminary process of precipitation.

As regards the amount of sewage which can be safely applied to a given area of land, this must depend mainly upon the nature of the soil; but in all cases the guarantee of active oxidation should be demanded in the shape of a marked proportion of nitrates in the effluent.

[*For discussion on this paper see page* 282.]

On "A Suggested Standard for Effluents from Sewage Works,"

by J. W. Willis-Bund, F.Z.S., Chairman Severn Fishery Board; Vice-Chairman Worcestershire County Council.

It is now generally admitted that by means of well-designed and effective sewage works, it is possible to purify sewage effluents to almost any extent that may be considered desirable; the question of the degree of purity being dependent on the amount of expenditure in respect of the means of purification, as to what the degree of purity should be, doctors disagree. The Rivers' Pollution Commissioners recommended certain standards, which have subsequently been inserted in various of the Bills for the Prevention of River Pollution; but neither Parliament or the public have accepted these standards as the proper test. The prevailing idea seems to be that no specific standard of purity should be required, but that it should vary in accordance with the requirements of the locality, that a very low standard would be sufficient in the case of towns on such rivers as the Aire, Calder, or Irwell, while on a clear-flowing river a much higher standard should be required. No two authorities are, however, agreed in saying what that standard should be. Admitting as a general principle that the standard should vary according to locality, I venture to suggest that, to fully carry out the principle, the standard should be, that the effluent should be purified to such an extent that no effect will be produced upon the fish that frequent the stream into which the effluent flows. The effect on the fish that are found in each river being the test of purity for each place, it being laid down as a fundamental principle that the effluent should be purified to the extent that it produced no result on the fish.

At first sight this seems a very small matter, and one that most sanitarians would have no difficulty in agreeing with, but when the details of the matter are considered it will be found to give rise to some serious considerations.

The rivers of the country may be divided into those in which members of the *Salmonidæ* are found, and rivers where they are not; curiously enough up to the present time, with one exception, all sewage works have been placed on rivers from which *Salmonidæ* are absent. The case of York, which is now under consideration of the Local Government Board, is, I believe, the first case of sewage works on a salmon river. It therefore forms a new departure, and it is with reference to it that the proposal contained in this paper was originally suggested.

It is well known that for a long time past it has been the fashion to say that the effluent from sewers does no injury to fish or fish life, because fish are often seen feeding at the mouths of sewers. If sewers only discharge a limited quantity of crude sewage in a fresh state into a river, it may be admitted that little if any harm is done, but the admission must be made subject to two important qualifications; (1) that the matter discharged is sewage, *i.e.*, night soil comparatively fresh, and that no large quantities are allowed to accumulate and putrify in the sewer or near its mouth, and (2) secondly, that the class of fish usually found near sewers and drains or near sewage works are what are usually known as coarse or white fish. With the exception that occasionally an old trout may be found at or near the mouth of a sewer, it is the fact that the *Salmonidæ* do not feed at the entrance to sewers, and are not found there.

It has often been urged as a test, proving that the discharge into rivers from sewers or sewage is harmless, that fish may either be found near the sewer, or that if placed in the effluent they will live in it. The fallacy of the argument lies to some

extent in the way the question is stated. Some fish may be found near sewers, some fish may live in the effluent from sewage works; but the deduction made from this, that all fish like sewers and all fish will live in sewage effluents—is a very different proposition.

Speaking broadly, the fish that inhabit the English rivers are divided into two great classes, *Cyprinidæ*, or fish of the Carp family, and *Salmonidæ*, or fish of the Salmon family. The first are resident in fresh water; the latter comprise migratory species. The first are far more tenacious of life than the second, and will live and even thrive under circumstances in which the second would die at once. Curiously enough, sewage experiments have been made almost exclusively on members of the *Cyprinidæ*, and usually on fish that are the hardiest and most difficult to kill of that family; and yet more curiously, the fish usually selected for experiment is a fish not indigenous to British waters, but one of the hardiest of all the *Cyprinidæ*, the gold fish. It is difficult to say in what amount of impurity a gold fish will not live. In this country he is never seen in really pure water; the water in glass bowls and aquaria, in which he usually dwells, are certainly not to be classed as standards of purity. Yet it is on this fish that the experiments of the effect of sewage and impure effluents are usually made; not probably with any dishonest intention, but because the gold fish can be bought more cheaply and more easily than almost any other live fish.

It may at once be said that experiments with gold fish, even if most honestly carried out, are worthless for any fish but gold fish, and as gold fish are not found in most British rivers, such experiments are worthless for British rivers.

If, however, the gold fish are laid aside and some other of the *Cyprinidæ* taken—roach, dace, or chub, the experiments have hardly a greater value. Leaving out of consideration the fact that the fish forming the *Cyprinidæ* are comparatively valueless when contrasted with fish forming the *Salmonidæ*, and that it is unfair to estimate the damage likely to occur to the fish from the damage that will happen to the least valuable sorts. It is equally unfair to take the hardiest and strongest fish to test the effect of a pollution on them, and ignore its effect on the more delicate kinds. The true test is the effect of the effluent on the most delicate fish found in the river, and this will be its effect on the *Salmonidæ*, not on the *Cyprinidæ*. No one with any knowledge of fish life will deny that *Cyprinidæ* are much hardier and will live under much more unfavourable conditions as to water, than the *Salmonidæ*. Carp may be found living in water so thick from impurity that it could almost be cut with a knife. *Salmonidæ* will only live in water that is practically pure. A practical instance of this is that the keepers of aquaria always select *Cyprinidæ*, and not *Salmonidæ*, for the purpose of stocking aquaria.

As far as I am aware, no data have been published giving the result of reliable experiments on different kinds of fish with the same polluted water. As far as my limited experiments go, I should classify our *Cyprinidæ* in this way: the hardiest are carp and tench, the rest in this order, namely, roach, chub, dace, bleak, gudgeon, minnow. In rivers that contain only *Cyprinidæ*, the test of the effect of an effluent from sewerage works, would be what effect would it produce on the above fish in the reverse order—beginning with a minnow, if minnows are found in the river, and finishing with a carp; not beginning with a carp and finishing with a minnow. It would be necessary to ascertain precisely the different kinds of fish inhabiting each stream, and then the effect on each kind might be ascertained—not merely by ascertaining if they would live in the effluent, an experiment of very small value—but how far it affects the fish as to their breeding, their size, and their food. Hitherto the idea has been does the effluent kill or not; but this is not the question; killing is only one of the ways in which pollution affects fish: their breeding is affected by the deposit on the spawning-beds, their size, from the lack of food or from the unwholesome food they get—their food the destruction of the various forms of life that they feed on. In a stream I am acquainted with, the effect of a pollution from a mine is not to kill the fish, they are as plentiful as ever, but to cause a great decrease in quality, size, and condition; a fact I put down to the destruction of some item of the food supply, or its general decrease.

If injury to fish is taken as the test, and taken in the way I have ventured to point out, it will make a minute study, far more minute than any we have yet had, of the forms of life in our rivers, absolutely essential before any standard of purity can be fixed upon.

Hitherto, the rivers on which sewage works have been erected, have either had no fish at all in them, or have had the hardiest member of the *Cyprinidæ*. In this class of rivers it would be unfair to compel the Local Authorities to give such a standard of purity to the effluent as was not required by the facts of the case; and on any class of rivers it might well be that the Local Authorities should not be asked to create a purer effluent than is necessary for the fish now inhabiting the stream, and should not be bound to regard the fish that might inhabit the stream when it became pure. Conceding this the test as to all rivers would be: (1) for those containing no fish; (2) for those containing fish, and this last would be subdivided as to rivers containing *Cyprinidæ* and *Salmonidæ*.

I have left the salmon rivers to the last, because in these a new set of considerations quite distinct from those affecting other streams arise. As is well known in salmon rivers, unless the migratory *Salmonidæ* have a free passage to the upper waters from the sea, the rivers are rapidly destroyed as salmon rivers, quite as effectually as if the fish were actually killed. Experience has shown that a river may be very highly polluted, but still salmon will pass up if the pollution is diluted with a large body of water; and as salmon usually only run up in floods, this is the usual state of things. But experience has also shown that if the pollution is concentrated, the salmon will not face it; and although an effluent from sewage works may be such that it will not actually kill salmon, yet it will just as effectually destroy the river if salmon will not pass it, for they will have to spawn in unsuitable places, and so gradually become extinct. This is the great danger that has to be feared from sewage works on salmon streams. The whole of the sewage will be discharged within very narrow limits; and the great question will be whether the effect of that discharge will not prevent salmon ascending the stream. I can call to mind certain chemical works on a tidal river, that discharge, once a week, certain refuse into the river; the effect of the discharge is that the ascending fish at once drop back. The fear is that a similar result will follow from sewage works, not that salmon or fish will be killed outright, but that they will be deterred from passing up to the river to breed.

The test suggested, that the effluent from sewage works should cause no injury to fish, thus opens out far wider considerations than at first sight appear. Hitherto the matter has not received from the hands of experts the consideration that it deserves. It has been thought quite enough to say—fish are not killed. For the future it is to be hoped such a test will not be considered sufficient, and the whole circumstances of the river and locality will be taken into account. I venture to think that some of the societies which are interested in the question of river pollution would be doing most useful work if they prepared a classified list of the rivers of England and Wales, shewing the fish that inhabit them and the standard of purity required for them. Such a classification would be somewhat as follows:—

Class A. Rivers not containing fish.
„ B. Rivers containing coarse fish, *Cyprinidæ* only.
„ C. Rivers containing coarse fish, *Cyprinidæ* and non-migratory *Salmonidæ*.
„ D. Rivers containing migratory *Salmonidæ*.

For each class a minimum standard of purity should be agreed upon, and the Local Government Board, if possible, should be induced not to sanction any scheme for sewage works on such rivers the effluent from which did not come within the agreed standard.

County Councils have now some powers in the matter of river pollution. It would not be asking too much of those bodies to prepare such a classified list of the streams in their districts, and agree on the standard of purity for each class in their district. If this was done, some progress would be made in the question of the prevention of pollution of rivers.

[*This discussion applies to the two preceding papers by* PERCY F. FRANKLAND *and* J. W. WILLIS-BUND.]

Dr. J. W. TRIPE (London) said that as Dr. Frankland's paper was on a kindred subject, the discussion of the two papers would be taken together. He thought they had a kindred bearing. He was obliged to Mr. Willis-Bund for bringing forward such a useful and satisfactory test as to the purity of the rivers; and they ought to give Mr. Bund their hearty thanks. This was carried amidst applause.

Mr. W. C. SILLAR (Blackheath) pointed out that whereas Dr. Frankland said that he had taken several samples from some of the best managed sewage works in this country, the whole of these samples were from one kind of process only, viz.—that by precipitation by lime. The effluent should be fit to go into the river without detriment to the fish, but this requirement the lime process never answered; besides, whereas the deposit should be preserved in a state fit for agriculture, lime invariably destroyed it. He defied anyone to go to works where lime was the principal ingredient used without being made aware by offensive odours that such was the case.

Mr. J. STANSFIELD-BRUN (Bradford-on-Avon) said he thought the system Dr. Frankland had referred to—intermittent filtration and irrigation combined—was a very good one. He spoke at some length of his experience on the subject at Oldbury, where on ordinary occasions the effluent was clear and free from smell. He could refer Mr. Sillar also to the system at Wolverton, Bucks, which had been referred to by engineers as the most perfect system of quiescent filtration in the country. At Oldbury there were exceptional advantages in the way of precipitation, quantities of chemicals coming from the chemical works, which deodorised the matter and left little expenditure to be incurred by the local authorities in the purchase of lime and other precipitants. Mr. Sillar said that fish would not live in the effluent where lime was used. However, there were fish in the stream into which the effluent ran at Oldbury.

Mr. H. SOUTHALL (Ross) said he lived on a salmon river, not far from a town which had sewage works in connection with the Wye. They wanted to be satisfied—those who were likely to be affected—that any scheme adopted would not destroy the fish. It was known that fish flourished at the present time, and on the opposite side of the river to where there were outlets of sewage, in analyses of the water a trace of sewage had been found. They wanted to be certain that matters were not made worse than at present. In constructing works they should consider the surrounding circumstances, and the character of the river the effluent would be discharged into.

Major LAMOROCK FLOWER (London) entirely agreed with the eminently practical and reasonable standards of purity which Mr. Willis-Bund proposed. The difficulty hitherto attending the establishment of a standard of purity of sewage effluents had been the different opinions held by chemists. Experience during the last 18 years in the Lee watershed showed that in the interest of fish life an excess of lime should not be used in the treatment of sewage. Wholesale loss of fish has resulted on several occasions from this cause—notably, some years since at Luton, where the authorities used lime and clay (which they had now happily abandoned in favour of disposal on land), and also at Tottenham, where a very small addition of lime was shown at once by the destruction of thousands of fish.

Dr. PERCY FRANKLAND said, in reply to Mr. Sillar, that he had only attempted to treat of *some* results obtained in the treatment of sewage. His paper did not profess to be a complete treatise on the subject of sewage purification, but was intended to record and compare results actually being obtained by the ordinary processes in vogue.

On the "Interception of Miasmatic Emanations from the Subsoil of Dwellings," by CHARLES R. C. TICHBORNE, LL.D., F.I.C., L.A.H.I., &c.

CENTURIES ago the Romans had arrived at a knowledge of the requirements of a good dwelling house, which puts us in the year 1889 to the blush, and Vitruvius would have had cause to smile at much of our modern hygiene. One of the points which received their special care was the construction of their basement floors. The barrier between miasma and their domiciliary supply of air food. When a man lays his head upon his pillow to enjoy those precious eight or nine hours of rest, does he, in nine cases out of ten, breathe the natural atmosphere of the district, wherever that may be. In my opinion he does not. He has simply placed himself under an inverted bell-jar, or a structure of a similar nature, which collects, and before morning is filled with, the volatile sweatings of the surface soil. This soil is distilling (I use the term as being strictly correct) into the building all the contaminations which it has received during the day. But the soil has besides its special poisons, which it generates in its own laboratory.

The old Roman mansions were protected by layers of concrete, and one of these upper layers contained powdered charcoal.

Some little attention has been given, within the last few years, to the subject of basement floors, but chiefly in isolated cases, where scientific men have personally superintended the construction of their own houses. Wherever trouble has been expended it has been attended with the best results. I state this not from hearsay but from personal knowledge.

In approaching upon a scientific basis the subject of the concreting of basement floors, the following question at once presents itself to our mind: What is the actual extent to which cement will prevent the passage of miasmatic, or deleterious vapours. Deleterious vapours may be divided into two distinct classes: 1st, the permanent gaseous poisons, such as sulphuretted hydrogen; 2nd, organisms, such as microbes, bacilli, &c. Where the 1st class ends and the 2nd commences it will require the bacteriologists of the next century to define, and for our purposes it will be as well to consider them as distinct forms of matter. First, then, to consider the question of porosity, or, in other words, how far are these different cements capable of passing gases. This point is roughly but efficiently determined by the following simple experiment, or series of experiments:—

Thin tubes were taken a foot long and ¼ of an inch internal diameter. These were carefully plugged with the cements to be tried, an exact inch of each cement being set in the ends of the tubes. Some of these tubes were allowed to stand four months before being used, so as to get perfectly set. The following materials were used as being typical:—No. 1, fine mortar, made by adding one part quicklime to two of sand; No. 2, plaster of Paris, or anhydrous gypsum; No. 3, Roman cement; No. 4, Portland cement; No. 5, hygienic cement.

This last is a cement with which we have obtained some very successful results in Dublin, and many of the tests given further on, prove that it is specially applicable to basement floors. The specimen experimented with, contained about 5 per cent. of carbolate of calcium, naphthaline, &c.

These different tubes were air dried; each tube was then

closed at the end by an indiarubber cap, which could be removed at will. They were then filled with mercury and inverted in a mercurial trough, so that a Toricellian vacuum was formed in each tube. The caps were then removed, and by observing the order in the fall of mercury, the relative porosity could be determined. It stood in the following order:—

		Relative amount of Porosity.
1.	Mortar	100
2.	Plaster of Paris	75
3.	Roman Cement	25
4.	Portland Cement	10
5.	Hygienic Cement	10 or 8

Their relative position as regards porosity could be determined with certainty; but in the second column is an endeavour to give the relative amount of porosity. This last column, although it conveys a very good idea, is only a rough approximation. It was arrived at by performing a number of experiments, and noting the respective times the mercurial column took to fall. Even if elaborate apparatus had been constructed to arrive at these results with great precision, such precise experiment would be of little use, as hardly two samples of similar kinds of cement would agree to a nicety.

The fall of a foot of mercury, in the case of mortar, is called one hundred, because it is the most porous material—in fact the fall in this case is almost instantaneous, and lasts about half a second. It can just be followed with the eye. The Portland cement is extremely slow, the last inch of mercury taking nearly a quarter of an hour.

A series of experiments were then performed with similar tubes, to determine the rate of diffusion of gas through the different materials. These experiments are confirmatory, but yet in a degree are distinct from the previous ones in their bearing. In such experiments we are drawing important inferences as to how layers of these different kinds of materials would influence what has been aptly called the "ground respiration." Any gas that may pass through such septa or layers of cement, will obey Graham's law of diffusion, viz.:—That the rate of diffusion is in inverse ratio to the square-root of their gravity. Hydrogen was the gas selected to try against atmospheric air. The tubes were again capped with indiarubber, and were filled by displacement with hydrogen gas. They were then inverted into a trough of water, and the caps were removed. A partial vacuum was created in each experiment, which raised the level of the water in each tube according to the respective rate at which it allowed the hydrogen to diffuse, which, as it was the lighter gas, passed through more rapidly than the atmospheric air passed in. It was thus found that the nature of the septum greatly modified the experiment.

The relative heights of the column of water, above the level in the trough, is given according to the time observed.

	1 Min.	3 Mins.	13 Mins.	20 Mins.	30 Mins.
Lime Mortar - -	$\frac{1}{2}$ inch	$\frac{1}{8}$ inch	0 inch	0 inch	0 inch
Plaster of Paris -	$\frac{1}{4}$ "	1 "	$2\frac{1}{4}$ "	$2\frac{1}{16}$ "	0 "
Roman Cement -	$\frac{1}{4}$ "	$1\frac{1}{4}$ "	2 "	$2\frac{9}{16}$ "	1 "
Portland Cement -	$\frac{1}{8}$ "	1 "	$1\frac{5}{8}$ "	$3\frac{1}{4}$ "	$3\frac{1}{4}$ "
Hygienic Cement -	$\frac{1}{4}$ "	$1\frac{1}{4}$ "	$1\frac{1}{16}$ "	$2\frac{1}{16}$ "	$2\frac{1}{8}$ "

It will be observed that lime mortar is hardly worthy of being called a septum, and is practically without any controlling action upon gases—in fact, under such circumstances, it should be viewed merely as a coarse sieve. It could not exert any control over ground respiration. In the case of the cements it is very perfect, but necessarily slow. The practical reading to my mind is that any ground gas would pass through such materials, as the hygienic cement, very slowly, if at all, because the atmosphere being of a lighter density than such gas as sulphuretted hydrogen, or carbonic acid gas, a downward diffusion would take place, or we may put it thus,—that a ground inspiration would be set up, and that atmospheric oxygen would be carried into the surface soil. There would always be a point or layer of the slowly diffusing ground air which would be presented to an excess of oxygen. The atmospheric oxygen would oxidize the noxious organic matter exactly on the same principle as it destroys the pollution of rivers—if we only keep the organic matter in a sufficient state of attenuation.

So far we have merely treated the question of gaseous diffusion, but it is probable that the most important part of the investigation is the action of cements on the germ contamination. Tyndall has pointed out that plaster of Paris, and even a surface of strong sulphuric acid, is incapable of separating germs. In fact the only filter which he found successful was cotton wool. This observation has been thoroughly indorsed and made use of by subsequent workers in bacteriology. Now to determine the action of cements in separating germs, a series of Pasteur's retorts or flasks were filled with sterilized hay-infusion, containing a little Liebig's extract, and were then plugged with different cements. The retorts, contents, and plugs were all sterilized at a temperature of 212 F. for some days. On being closed they were placed in an incubator. In a short time all of these solutions went with the exception of one—the hygienic cement—which is still perfect.* It is also

* 19th September, 1889. Three weeks old.

interesting to observe that the next best flask is the plain Portland cement. There is only one conclusion to arrive at, that the air in passing through this inch of hygienic cement, was perfectly sterilized.*

Asphalte acts as a perfect plug, but I should say that it is objectionable, because if we have every large area cemented by this material, the surface gases will be more or less under pressure, and if so will force their way through any of the numerous cracks and fissures, which must exist in an ordinary house; besides this, it will largely permeate up the walls which we now see are formed of very porous material.

As regards the permanency of the antiseptic action of hygienic cement, I may as well give here the analysis of a sample of concrete made with it and laid down in Gray's Inn Road in 1885. It was taken up in 1889. When it gave on analysis:—

Moisture	3·00
Antiseptic matter of an extractive nature ..	1·96
Carbolic acid	0·14
Granite with cement	94·90
	100·00

When broken it smelt strongly of the antiseptic used.

I believe that these experiments throw considerable light upon the question of atmospheric contamination from the basement of houses, and I have therefore thought it desirable to place them in a concise form before the Sanitary Institute.

Mr. G. J. Symons, F.R.S. (London), said that, as one of the uninstructed public, he should be glad to have some explanation as to the very small diameter of the tubes which had been employed by Dr. Tichborne in process illustrative of his paper; they had a tube only one-quarter of an inch in diameter. He thought if they wanted to test the permeability of anything, the proper course would have been to have had a large area of it. These illustrations rather showed the power of the materials adhering to glass than the power of penetration through the material itself, so large a proportion of the material being in contact with the glass tube.

Mr. W. White, F.S.A. (London), believed wood block flooring was one of the best of floors for basements, because there was no harbouring of dust, black beetles, mice, or vermin of any sort. It

* To construct a perfect floor not only should the ground be cemented, but the foundation walls should be cut off or rendered impervious to the diffusion of gas by being built for some two or three feet with hard glazed fire bricks, and by using hygienic cement in place of mortar.

would not decay if laid on some substance free from moisture. He was the first to introduce it. This was in the West of England. He first set in mortar or cement, but he afterwards found that it was a great mistake to set it in anything that contained moisture, because when the wood came to dry, the joints opened and it became loose.

Mr. H. R. Newton, F.R.I.B.A. (Weybridge), said that it was extremely satisfactory to find that in these tests Portland cement had come out so well; its use was so universal. He thought the results of the experiments and the order of suitability in which the materials had come out was just what they might have expected. So far as they could judge the experiments were very conclusive in the sense of proving the impermeability of the materials.

Dr. J. W. Tripe (London) said he thought that the discussion had been most interesting to Medical Officers of Health. People wanted to know what was the best material to use. These experiments showed that Portland and hygienic cement were about equal. He had always recommended Portland in preference to Roman cement, but the experiments showed a far greater difference between them than he had anticipated. The difference was exceedingly great, so that no one with the facts that had been laid before them should venture to use Roman cement to make concrete floors. The time occupied by experiments was as nearly as possible corresponding with what they might have expected. He did not think that the size of the tubes had resulted in any way to the detriment of the experiment.

Dr. C. R. C. Tichborne (Dublin), in reply, said that the illustrative experiments had been made in the usual way and the customary precautions had been taken. The smaller the scale of the test the more critical the experiment. Cases occurred of poisoning through the consumption of tinned food, and they all knew that mischief was caused sometimes by an air hole the size of a pin's head in the tin, the enclosed food becoming putrified. Now in the experiments detailed in the author's paper, it was true that the air had to pass through a hole a quarter of an inch in circumference, but then in doing so it had to pass through one inch of cement under experiment. In his opinion there was a practical experiment.

On "*Meteorology at the Seaside,*" *by* Surgeon-Major W. G. Black, F.R.C.S.E., F.R.Met.S.

This communication consisted of a sketch of the conditions of the *weather* which prevailed during the summer month of August, and autumn ones of September and October at places of resort on the English Channel.

The remarks are founded on a series of observations by portable *meteorological instruments* carried in a hand-bag, which were set up and used where practicable at the time and place at the coast. They showed how easily such opportunities could be utilised at any place the *tourist* went to stay at. The best kind of weather for the visitor was of the *continental type*, or anti-cyclonic, with bright skies and sunny days, and when the air and sea kept up their temperature, and ozone was abundant and southerly breezes prevailed, and the seas were calm and brilliant. The *sea-bather* then indulged himself with water over 60° of temperature, and the air felt warm and dry afterwards to dress by; and multitudes on the beaches enjoyed it. Towards the *end of the season* the weather becomes broken into by irritating cyclonettes creeping up, or cyclones dashing through the channel, which create an uncomfortable surf, and cause a rough wind on the beaches and promenades.

These irruptions brought on *gales* with showery weather and cold *winds*, which cooled the air and afterwards the sea, which was also made uncomfortable by waves or surf on the beaches.

Besides, bathing in the sea now became *dangerous*, in consequence of the development of the backwash of the surf creating an undercurrent below sea level on the beach, which causes the drowning every year of numerous inexperienced sea-bathers.

The promenades and piers now get swept by disagreeable, damp winds, and by spray from the surf, and are soon abandoned; on or about the *equinoctial period* of September 26th, the bathing closes on both coasts, the cars and stages are withdrawn, and the beaches are deserted by their visitors. The *inducements* of climate that take people from grimy cities to the coast resorts, are illustrated by these instrumental observations, as consisting in more ozone, more breezes, more showers, more sun and air, and less heat, less calms, less smoke, less miasmata.

The prevalent *exodus* seems fully justified by observation of all considerations, and the *English coasts* of the British channel seem well adapted for health resorts for the citizen; and it will be to the interest of the town dweller that they should be *improved*, and extended as regards appliances and accommodation for these great migrations.

1.—Meteorology at the Seaside. English Channel. Summer Observations.

Having visited a few places on the coasts of the *Channel* during some autumns past, and observed the weather phenomena by ordinary instruments adapted for the traveller's use, the observations of three months are here summarised.

Of the months, *August*, 1886, was spent at Brighton; *September*, 1885, at Hastings; and *October*, 1887, at Havre and Boulogne, so that a fair idea was got of *Channel weather* during the seasons frequented by tourists.

All the observations have been collected together, and the numerical results put down and *summarised*, and averaged for eighty-five days or twelve weeks. During that time there were forty-nine forenoon tides, and thirty-six afternoon tides, and they were noted because they influence the state of both wind and sea.

(1.) *Ozone* was more prevalent in the *morning* observations than in the afternoon by 2·4 to 1·9, and this was probably due to the *S. Westerly gales* in the Channel being most then, and so more wind blew over the papers.

In ordinary settled weather there is generally *more ozone* in the afternoons, as the ordinary *sea-breezes* or winds then get up after mild mornings, and the coasts get warmed by the sun.

(2.) *Evaporation* was found much more than in towns inland, and averaged ·12 inch per diem, and amounted to a total of 9·98 inches for three months. This seems due to more wind and sun on the coast, and freer air than in inland towns.

(3.) There was a total of twenty-seven *rainy* forenoons, and twenty-five rainy afternoons, the former being due to the existence of drizzly mists, which go off as the day progresses.

(4.) The *winds* blew at a very steady rate generally, and were more in force in the morning than in the evening by 2·67 or 1·36 lbs, to 2·52 or 1·20 lbs., owing to gales dying off in the afternoons, leaving calms at sunset, and fine evenings.

(5.) *Cloudy* weather, for like reasons, was found more prevalent in the forenoons by 6·4 to 5·7 in the evenings, also due to the occurrence of the morning's mist and drizzle.

(6.) The *Temperature* of the air in the rooms *inside* averaged 60°·6 in the morning, and 63°·3 in the evenings, as might be conjectured readily by advance of the day's warmth. The same may be said of the temperatures *outside* the house, which were respectively 54°·5 for a.m. and 55°·9 for p.m., all generally low rates for summer and autumn seasons.

(7.) The *wave* amounts of the sea averaged 2·4 in the mornings, and only 1·8 in the evenings, owing to the greater strength, as shown, of the winds in the mornings, and the greater number of tides, then with high water up the beaches.

(8.) The general *Temperature* of *the sea* amounted to 57·1 F., as taken only in the mornings, and before it had been heated

by the sun, but it shows the *great heat* it holds always, as the temperature of the air on the shore at the time only came up to 54°.

(9.) The *specific gravity* of the sea water averaged what might have been expected, 1·025 in the Channel, where fresh rivers enter it, but it rose above this directly ocean seas got in, during storms blowing up it from the S.W. which stirred up the heavier layers from below the surfaces.

2.—Summary of Winds.

The number of times of the *winds* prevailing have been collected and added up, and there were 77 mornings in which there was some wind, and 78 evenings, leaving 8 *calm* mornings and 7 *calm* evenings, which mostly occurred during the fine summer weather in August, 1886, at Brighton.

The most *prevalent* winds in the mornings were S.W., occurring during the stormy weather of September and October on 26 days, and those in the afternoons were also S.W., blowing on the same occasions 24 days.

The *next* in frequency to the morning and evening were N. winds, 12 each, due to *anticyclonic* winds prevailing in August at Brighton, and in October, 1887, at Boulogne, and the next were *westerly winds* following the subsidence of the gales in September and October, 7 days a.m. and 12 days p.m.

Gales of more or less gravity were noted every month. *August* had 2 days' *stormy* weather from the S.W., occurring at the time of the new moon on the 16th at Brighton. *September* had 7 stormy days from the S.W. included in 5 storms, 1 of which occurred about the new moon, September 29th and 30th.

October had 6 stormy days, included in 3 gales, one of which was from the N. *anticyclonic* at Boulogne on October 24-25th, and the other from the S.W. at Folkestone, October 28-29th, *cyclonic* at the time of full moon on the 31st.

There was also a 3 *days' storm* from the S.W. on *November* 1-2-3rd at Folkestone, with rain and heavy seas. Altogether there were 12 *storms*, taking up 18 days, and 4 of these happened about the new and full moon, and 6 at about the quarter phases.

The *most storms* in number 3, and days 6, occurred with *tides up* about noon and midnight, when the seas were more conspicuous on the beaches at high water.

The *most winds* also occurred with forenoon tides 6, and days 9, and the least with afternoon tides 3 for 4 days, when the surf is least, also, in manifestation on the low shores.

3.—Summary of Storms.

The occurrence of *storms* about the change of the *moon* is a popular belief, and there appears to be certainly sufficient coincidence to warrant it, but that the moon itself is the cause may not yet be alleged.

The *storms* happening about the major changes appear more conspicuous on the coasts, as there the *tides* are higher, and the tidal currents stronger, and the waves larger than if the storm occurred at the neap tides, or at the quarter moons, when the water is low on the beaches.

The *gales* of September 5th, 4–5 p.m., 19th, 7 a.m., 27th, 6 a.m., 28th, 7 a.m., at these half periods lasted only *one day*, and were milder in their effects on the sea, because the latter was lower on the beaches.

The *systems* to which these various *storms* belonged need not here be discussed, as they formed part of larger storm areas beyond the Channel, but the majority belonged to the *North Quadrants*, either of cyclonic or anticyclonic forms.

The *Anticyclonic* one of October 24—25, 1887, at Boulogne, consisted of a sharp cold wind blowing from the *N.W.*, *N.*, and *N.E.*, down the coast, with rapid clouds, open sky, brisk waves, and much beach surf, but there was little rain and there were no nimbus clouds, but chiefly cumulus.

The *tides* were—morning, 4.8 a.m., and evening, 4.43 p.m., and the moon was three-quarters full, so that the conditions of heavy gale were not present, but the *force of the wind* got to 5–6 lbs. per square foot by anemometer, or 32–35 miles per hour.

The *Cyclonic* ones all had about the same characters, and beginning S.S.W. with warm air, veered to S.W. and then W.S.W. with cooler air, and finally went to W., when they gradually died off with clear cooler weather.

They are always accompanied with heavy rains and low *nimbus* clouds and dark stratus, and the *waves* raised by them are large, and may be recognised often as having come from the Atlantic up the channel.

The *Channel* seems to act the part of a *funnel* in attracting Atlantic storms to go through it; and there are along it two *dangerous gaps*, at Portland and Weymouth, and the Isle of Wight and Solent, through which the winds beat with great velocity, and raise tempestuous seas in Chesil Bay and Spithead Roads.

4.—Summary of Months.

(*a.*) The month of *August* spent at Brighton was warm and sunny, with thermometer at 63°·7 in the morning, and 67°·1 in the evening, and barometer averaging 29·96 a.m., and 29·92 p.m.

Ozone was of average quantity, 2·2 in a.m. and 2·3 in p.m., and increased with S.W. winds, and decreased with N.E. winds.

Evaporation was high, or at an average of 0·20 inch per diem, shewing that the air was very *dry*, though wafted from the sea itself; showers, however, fell occasionally.

The *winds* were principally from the S.W., though there were some from N. to N.E. to counterbalance them; but their *force* was only moderate from 2·2 in a.m. to 2·0 in p.m., and consequently the *wave* amounts were also small, 2·1 in a.m. to 1·9 in p.m., and there were 3 to 4 calm days.

The *sea* was warm, 62°·2 morning average, and so sea-bathing was indulged in by crowds every day; its *specific gravity* was below good average (1·024), and the air of the beach was also mild and suitable for open-air recreation, 64°·1 in a.m.

(*b.*) *September.*—The weather now begins to be more changeable, being disturbed by *storms*, which leave behind them a damper and colder atmosphere, as if there was a great struggle in the air to get its temperature reduced by little and little.

Notwithstanding the shorter day, the *ozone* at Hastings shews an *increase* morning and evening, owing to the increase in the S.W. or *Channel winds*, from 4 in a.m. to 3.8 in p.m.

Evaporation at Hastings decreased by half, or to 2·31 inches or ·10 inch per diem, to ·91 inch, or 0·07 inch per diem at Havre, owing to increased *cloudiness*, which is now one-third more than in August, and decreased *sun power* in consequence, bringing with it decrease of air and sea temperature by nearly 10°.

The *winds* have now increased from the S. to W. quarter, and decreased from the N., and *calms* have disappeared almost, and the winds have become stronger by 2·3 in a.m. to 2·8 in p.m. (Beaufort scale).

The *barometer* still continued high, but the *air* temperature on the other hand has decreased considerably.

The aspect of the *sea* at Hastings has become altered, as the *waves* have increased in size; their smooth serenity has now disappeared, and the sea *temperature* has decreased very much—to 58° at 6 a.m., whereas the *specific gravity* has increased.

(*c.*) *October.*—The *changeable* weather has now set in, and storms are common every week.

The *ozone* shows a flickering movement, being pretty high during south-westerly weather, but relapsing after these movements are over down to from 1·2 in a.m. to 0·4 in p.m.; and it was often absent at Boulogne.

Evaporation has notably decreased also, and only now comes to 0·65 inch to 0·67 inch, or 0·06 inch per diem: due to absence of sun power and increase of rain.

Winds have now broken in from the N. to W. quarter, as well as from the S. to W. quarter as before, and have become stronger in force, up to 4·1 in a.m. and 3·2 in p.m.; and *cloudiness* continues as high as in September, or 7·4 in a.m. and 6·4 in p.m., at Boulogne.

The *temperature* of the *air* has now come down to 10° below last month, or to 47°·2 in a.m. and 48° in p.m.; but the *barometer* still keeps well up, or about 30·28 inches a.m. to 30·36 inches p.m. but goes down at the end.

The *sea* has increased in *wave* amount 4·2 in a.m. and 2·5 in p.m. with the winds, and its temperature has gone down to 51°·4 Boulogne, and the *specific gravity*, 1·030, has risen from the uprising of the denser water from below.

5.—Description of Localities.

(*a.*) *Brighton* seems conspicuous by the *dryness* of the air, indicated by the amount of evaporation of 0·20 inch per diem in August. Coincident with the *warmth* of the *air* 63°·7 in a.m. average in the street, and of 64°·1 a.m. on the beach, open to the sun.

The *temperature* of the *sea* was also notably high, 66°·2 in a.m., but it had about the same specific gravity 1·024 as at Hastings.

The *town* looks south, and lies at the bight of the Sussex bay, and hence it gets *focussed* upon it climatic and solar influences from the south, which are reflected again from its white chalky cliffs and hills, called downs.

(*b.*) *Havre*, being a commercial *sea port*, suffers in its salubrity from the fact, and hence there is paucity of *ozone* 1·6 in a.m. and 0·7 in p.m. and diminished evaporation 0·07 inch, and therefore increase of *dampness*, due to harbour and to wet docks.

The *sea*, however, was of *first quality*, being high in temperature for September 59°·4 and of high specific gravity 1·028 for an estuary, and this may be due to its geographical position, being situated on a *promontory* jutting out westerly into the Channel, and hence catching the *sea currents* and breezes conspicuously from the west.

The *air* was *cooler* than at Hastings in September by 55°·7 to 56°·3 in a.m. and 56°·4 to 59°·4 in p.m. averages in the town, and at the shore 54°·5 to 56°· in a.m. also. A range of *hills* at the back of the town shelters the latter from northerly winds, otherwise it might have been as cold as Dieppe; but the

southern slopes are covered with houses and villas, and fully exposed to the sun and air, and hence it has been made a health resort.

(*c.*) *Boulogne* in respect to topographical merits has the same advantage as Havre in having a range of *heights* on the N. protecting the town below on the south from northerly winds, and so it also has been recommended as a *health resort* for shelter from winter winds. On the other side it is like Havre in showing *deficiency* of *ozone* 1·2 in a.m. and 0·4 in p.m., and increase of *dampness*, due to the influence of harbour and to its docks. The low *evaporation* having only been 0·06 in. per diem.

The *sea*, however, is as good as at Havre, being of high temperature for the month of September 51°·4 and of high specific gravity 1·028, and this, as before, in spite of there being a river close at hand to reduce it.

Folkestone.—The *climate* much resembles that of Boulogne, and its topography too is very similar, there is *deficiency* of ozone 2·6 in a.m. and 0·4 in p.m., and increase of *dampness* owing to harbour, and *evaporation* was low, having only been 0·06 in. per diem.

The *sea*, however, is of high quality being warm 50°·1 for October and of high specific gravity 1·030. The temperature of the *air* is much the same.

6.—Sea Bathing.

It will be pertinent to say something about *Sea Bathing* as due to the climatological object of these remarks on the weather, and to the season of the year when this recreative pursuit is adopted. In general terms it may be stated that warmth of the *sea water above* 60° is felt to be comfortable, and below that may become disagreeable to some people, but that anything *above* 50° may be tolerated perfectly by swimmers who enjoy a cool and refreshing plunge in open water.

However, it may be said that it is not the increased coldness of the water that brings the *bathing season* to an end so soon, but it is due to the more rapid increase of *coldness* and *rawness* of the *air* during our British autumns.

Thus at *Brighton* in *August* we have a sea temperature of 60° and air temperature of 64° on the beach of a very comfortable character, but at *Folkestone* in *October* the sea has come down to 50°, and the air to 47° on the beach, both of which are too low to be pleasant to the ordinary bather.

Sea bathing can very well be *carried on till September 26th*, the critical date for the channel sea-bathing seasons on both coasts to end.

As at *Havre*, where the temperature of sea was up to 59°, and the sea air at 54°, but the air was higher still at *Hastings* in the same month at 56°, though that of the sea was lower 58°.

The *temperature of the sea* seems *very stubborn* in giving way to the advent of winter, and retains its initial heat long after that of the air has descended. It is only *forced down* after prolonged bouts of Northerly (W. and E.) winds, which chill its surface and bring cold currents from the North Sea into the English Channel. The *Channel Sea* makes fitful struggles against reduction by the occasionally shooting in of a *warm current* from the Atlantic Ocean during the prevalence of a S.W. gale, which is readily *detected* by the thermometer and by the hydrometer, indicating an increase in the temperature and specific gravity of the water.

This *increase of density* seems due to the mixture of fresh salt water from the open ocean, and not to increase of cold, as the temperatures of sea and air both rise during *S.W.* gales, and this occurs in spite of the *heavy rains* that burst forth then, that would lessen it by mixing it with distilled water from the clouds.

Finally, the *sea succumbs* to the protracted batteries of *arctic currents* and winds, and settles down to a *winter* hibernation of character, disagreeable alike to sailors in ships and residents in sea-side resorts.

It will be observed that the *temperature of the sea* was much *lower* at Folkestone and Boulogne further east than at Havre and Hastings further west, even allowing for *some difference* in periods of season. This would seem to have been due to the former places being situated further *east* than the latter, and so have been first reached and exposed to the *cold currents* from the North sea coming through the straits of Dover.

The *close of the sea-bathing* season takes place about September 26th, or about the equinoctial period, when the temperature of both air and sea drops very rapidly in a few days down to the winter stages.

Proprietors of cabins or boxes and hotel keepers readily recognise the change as if by instinct and withdraw their dressing cars, and begin the displenishing of bedrooms and saloons as the visitors insensibly diminish in numbers.

7.—Sea Waves and Beach Surf.

Attention here may be drawn to the characteristics of the sea on the beaches at health resorts in reference to dangerous *sea-bathing*.

Enumeration has been taken of the *numbers of waves* and sea surf falling on the beaches per minute, which are found to be generally greater in height and less numerous at high water than at low water.

This seems owing to the *slope* of the beach being steeper about high water mark than at low water, when the tides recede far out to the offing, thus permitting deeper water to be maintained in shore.

These waves or *surf* have been *classed* into four sets, and designated ripple, smooth waves, crested waves, and storm surge, the first two of which are *safe to bathe* in, and the last two are dangerous even to swimmers.

The *ripple* waves number about 18 to 20 per minute, and under 1 foot in height, and the *smooth* waves 12 to 18 per minute, and are under 4 feet in height; but the *crested waves* amount to 8 to 12 per minute, and are about 4 feet 6 inches in height; and the surge rollers come to 4 to 8 per minute, and reach about 6 to 9 feet in height on our coasts.

Another circumstance marks the limits of safe and dangerous sea bathing, and that is the length or extent of the *back water* or wash of the surge on the beach, and this is determined by, or is an expression of, the length of the wave itself outside at sea.

Everyone has experienced the discomfort and embarrassment in getting into deep swimming water by having first to *wade through* several feet of rapids and rolling stones before being able to float comfortably.

Now the wave interval of the *ripple* will be under 20 feet, so that the back-wash will probably be less than 10 feet; that of the *smooth* wave will be under 50 feet, and its back-wash will be under 25 feet, which are safe and comfortable limits for wading.

But, on the other hand, the *crested wave* will have a length of wave of 100 feet and a back-wash of 50 feet, or 16 to 17 yards, and the *storm surge* of 200 feet length of wave and 100 feet length of back-wash about, or 30 to 40 yards, all of which are dangerous amounts. The dangerous nature of this *surf-wash* would seem to depend on the powerful rush of the sea water descending the *slope* of the beach, and not ceasing then at the base of the surf, but extending far beneath it out to sea. The greater the slope of the beach the more *acceleration* will the back-wash gain in its descent from high water to low water, and this increased speed may thus exceed the wave speed on the surface of the water above.

Thus the *smooth* wave will have a speed of 300 to 600 feet per minute, or 3 *to* 6 *miles per hour*, which is just within the limits of swimming power; but when we come to the *crested* wave, and find its speed up to 800 feet per minute, or 9 *miles* per hour, we may readily see the futility of breasting it by human swimming capability.

We may now then come to perceive the powerful surf nature of the *back wash*, that it may even on steep shores exceed the figures given above of the wave speed, that it may amount to *much more* than six miles an hour in fair weather, or more than nine miles per hour in stormy times under water on dangerous coasts.

In consequence of this hydraulic *acceleration* the back wash will rush out to sea far beyond the tidal limits on the bottom of the shore out into deep water, and will then exhibit its powers and might by *debrading* the mud and silt, and making the sea in the offing *muddy* for a mile or two out from the shore.

This back-wash and under or bottom current on beaches will thus render *recovery of bodies* from drowning very difficult, as they will be borne away by it at the bottom of the sea to re-appear somewhere else where the current has slackened off.

In the same way the *cargoes of ships* wrecked on our stormy coasts will be drawn or sucked out of the holds by the back-wash, and carried off with the deep water, and there sunk if heavy, or be floated off to some more distant part if of lighter material.

In cases of *drowning* accidents the aim of the human rescuer should therefore be to get the person to be *floated* on the surface of the water, so as to get out of the under-wash, and into the *upper current* that is rolling on towards the surf on the beach.

8.—Difference between City and Seaside Climate.

The question may now be endeavoured to be answered, what is the *instrumental difference* between the two climates that makes the citizen fly from his dwelling and office at the end of the season, and take refuge at the seaside.

Preliminarily it may be stated that the weather concerned in human climatology should only be considered as connected with a *zone of atmosphere* of some 40 to 50 feet high, or the mean height of our dwellings and hotels.

Everything of weather observation or opinion beyond and above that, may be relegated to pure or *transcendental meteorology*, which is more or less entirely removed from the influence of the solid ground we live and move about on.

Previous to going to Hastings, eleven days were spent in London in 1885, from September 1st to 11th, when observations were taken in the town, as follows:—barometer 29·46 inches to 30·12 inches; thermometer inside at 63° to 67°, outside from 50° to 64°; evaporation total 0·72 inch, or about 0·06 in. per diem; rainy days seven; ozone total 2·0 or only 0·2 per diem; and winds ranged from S.W. 6 to S.E. 2 round by N. The *seaside climate*, after this at Hastings, showed four times as much ozone, twice as much evaporation, three times fewer wet days; thermometer about the same, but barometer much higher.

In comparing sets of *climatological observations* in the *Meteorological Record* for 1885, Vol. V., for Hastings and London (Old Street) for the month of *August*, it will be seen that much the same characteristics are noted. At Hastings the *thermometer* was higher than in London by 67°·7 to 67°·3, but the minimum thermometer was higher in London by 53°·4 to 52°·0, and the mean thermometer also was higher in London by 60°·3 to 60°·1.

The *humidity* of the air at Hastings was greater than in London by 77 to 71, but the cloud was greater in London by 7·5 to 6·3 than at the sea side.

The number of *Rainy Days* was about the same in each, viz., 12, but there was more rain in Hastings than in London by 1·14 inches to 0·89 inch.

Again, in 1886, much the same results are to be noted in the climatological nature of the observations in Hastings and London in *August*.

The max. *Thermometer* was higher in London by 72°·2 to 62°·5 at Hastings, and the min. thermometer also by 56°·6 to 54°·7, and also the mean thermometer by 64°·4 to 62°·1.

The *humidity* of the air was greater at Hastings by 88 to 78, but the cloudy pall was heavier in London by 9·0 to 6·8 at Hastings.

The number of *Rainy Days* was much the same in each, viz., 11; but the amount that fell was greater in Hastings than in London by 1·51 inches to 0·92 inch.

These contrasted results may point to the idea that the reflected or indigenous *heat of the ground* in London may be more conducive to the suspension of the aqueous vapour in cloud than at Hastings, excluding the effect of smoke. The extra *humidity* of the air at Hastings is evidently coincident with the heavier *rainfall*, not on account of the presence of the sea itself, but rather on account of the coast being the *first land* to receive the rain-laden clouds and breezes from the S.W. and S. before they proceed inland to London. By *changing* our habitat, therefore, from London to Hastings on the coast in August, we get more *ozone* to breathe and more *breeze* to fan us; more *moisture* in the air, more *sunshine* in the sky, and more showers and a cooler and fresher air. And we fly from the stuffy *house heat*, the gloomy haze and *smoke pall*, the dry dusty air, the *fusty calms*, the unwashed *exhalations* of the streets: all these tend to *vitiate the air* we breathe, render the blood impure, and depress and disarrange the nervous functions, both animal and mental. These statements above detailed are intended to refer solely to the instrumental observations here offered for inspection and consideration, and personally obtained by ordinary portable means.

They also only refer to such items of climate of the localities as would be of interest to the tourist and valetudinarian, but not to the requirements of the invalid or incurable, which are of a different shape and character.

Dr. J. W. Tripe (London) moved a vote of thanks to Surgeon-Major Black for his paper, which contained much interesting information. It was carried with acclamation.

Mr. G. J. Symons, F.R.S. (London), considered the paper an extremely useful one, though from a meteorological point of view it was based on imperfect data; still Dr. Black could not be in more than one place at a time. He had compared the different places from his observations in different years; and for that reason the results were not strictly comparable. However, as they could not have what they desired, they must be contented with what they could get. The conclusions at which the author had arrived were such as those who had experience in the matter would agree with. With regard to Dr. Black's remarks respecting evaporation he feared that they were the results of experiments on a small scale. Experiments were made some years ago with a large number of so-called evaporators, and the results were perfectly awful. The amount of evaporation from small vessels was between two and three times as great in proportion as the evaporation from large vessels. The water in small vessels became heated to a higher degree, in some it would rise to ninety-five degrees, but everybody knew that a pond would not rise to anything like the temperature. The average Dr. Black obtained, one-eighth of an inch per diem, was something like twice as much as the truth. Dr. Black went on to multiply this value, and computed the annual evaporation at about forty inches, but the evaporation was not the same all the year round. During the winter it was much less than in summer. From October to March the evaporation was extremely small, in some months practically nothing, so that the yearly total was probably less than half of the amount stated by Dr. Black.

Mr. Southall lamented the want of simultaneous comparison between the places. He was hardly prepared to accept the statement with regard to the difference in the atmospheres of Hastings and London. He could hardly think that in Hastings, with exposure to south and protection from the north winds, the difference would be ten degrees. The paper was an evidence of unremitting observation.

Surgeon-Major W. G. Black (Edinburgh) said meteorologists might work to obtain results by laboured exactitude, but it was his desire to get and retail to others information about the climate of the different places. He did not pretend to have contributed a scientific paper. The instruments he used were not verified at Kew, nor set up in an observatory. The objection might be raised to some of them that they were of small calibre, but they had to be carried in a hand bag and he used the same instruments throughout. With regard to the evaporation, he could not carry a proper scientific instrument with him, such as one could get in an observatory, but was satisfied with a portable one; and the same instruments being used throughout, the results might be used *comparatively* without great error. The evaporation at sea-side places was greater than he expected. It was in consequence of the amount of wind and sun. He thought the sea was as much a point of the meteorology of the sea-side as the air; and visitors to the sea-side enjoyed it as much as the air. He had made many observations of the waves. He had counted the number per minute, and he had noticed there were two sets of waves, the one set fit to bathe in, and the other unfit. He had also estimated their length and height. The waves came in on the surface of the sea driven by the wind, and having to recede in natural sequence were returned at great force owing to the decline of the beach below. Bathing in the upper waves would be safe, but if a person were caught in the under current he would be sure to be drowned, and carried away like a stone. The retiring waves were highly dangerous.

On "The Smoke Nuisance, under the Alkali Acts," by Herbert Fletcher.

Happy are the people of Worcester in knowing little of the evils of smoke. In the manufacturing districts it is blighting every natural beauty of the country, and rendering the much talked-of necessity for cultivating a sense of beauty in the artizan of the town as much an impossibility as it does the embellishment of either private or public buildings with any work of art an absurdity.

There are two distinct sources of the evil—domestic and manufacturing. That the domestic is of comparatively small importance may be seen on Saturday afternoons and Sundays, when the tall chimneys are almost inoffensive. There are at least half-a-dozen excellent mechanical means for extending the atmosphere of the end of the week to the whole of it, and there are at least 100 firms in England and Scotland using one or other of these with economy and convenience.

The pecuniary advantages of these machines are considerable, but a probable saving of ten per cent. in the coal bill is not sufficient to procure them a trial. The evil arises chiefly from the use of an inferior quality of fuel. Our only hope is in the law, but the administration of it must be placed in other hands than those in which it now rests.

A paper on the Smoke Nuisance was read to the Congress at its meeting in Bolton, two years ago. To that paper this is supplementary, and intended to shew the result of the movement then just recommencing after many years' repose, and to suggest a way of getting over the almost insurmountable difficulties, which beset interference with powerful people in practices, which, though illegal, have been long tolerated.

Seventeen years had elapsed since the Corporation of Bolton had a Smoke Inspector. Almost his first attempt to perform his duty was the bringing up of six of the most important firms in the town. That first attempt was also his last. The Bench, many of them defaulters themselves, dismissed every case, and efforts at smoke prevention, both mechanical on the part of manufacturers, and legal on the part of the Corporation suffered total collapse. Shortly after the visit of the Institute to Bolton a fresh start was made. The three nuisance Inspectors of the town of 112,000 inhabitants were instructed to proceed against the nuisance under certain limitations. When it amounted to the emission of dense smoke for $2\frac{1}{2}$ minutes or of light smoke for 10 minutes in the half-hour, the offenders were to be served with a legal notice. A copy of these instructions was sent to each steam user, as a hint to reform.

The instructions were accompanied by an important foot-note forbidding the inspectors to encourage the idea that abatement to the degree named would be permanently satisfactory, as the Committee had evidence that steam could be made in any quantity under conditions within the control of all manufacturers without any smoke by day or night, and that the present limits of time were made only to cause the worst offenders to be first dealt with.

With varying success the Corporation asked the Bench to order some dozen firms to abate their nuisance, in all cases being opposed by those firms, except in the one case of the L. & Y. Railway Company, who thanked the Corporation for bringing to their notice their neglect of duty. This was the case of a locomotive engine, standing in a siding, and the Company paid without demur the fine of twenty shillings imposed. Certain members of the Bench could not be persuaded that

black smoke was a nuisance at all; others accepted the statement of the defence, that compliance with the order—already made on their first prosecution—was impracticable; and no confidence could be reposed by the Sanitary Committee in the consistency of the judicial decisions.

In one important case of a large and politically leading firm, the legal adviser of the Corporation thought it necessary for the writer to enter the witness-box to swear that the emission of smoke was in the words of the Act "in sufficient quantity to be a nuisance," and to stand the punishment of the opposing counsel for his interference. At length a curious decision of the Queen's Bench was unearthed, which seemed to require the prosecution to specify the remedy to be applied; and though other firms, seeing the power this would place in the hands of an authority, refused to avail themselves of the point, it led to a change in the form of notice and the insertion of words requiring the provision of smoke consuming apparatus, but specifying no particular make.

This form has not yet stood the test of an action; but should it be objected to as indefinite, the objectors would soon feel the fetters they had made for themselves, on the Corporation ordering them to employ one of the several machines used in the borough, and, in order to make sure of success, to increase the number of their boilers.

These proceedings, as may be imagined, were very unpleasant for the promoter, who could not but feel that friendships of old standing were endangered, and that he was largely regarded (by the smoke-makers) as the greatest nuisance in the town.

Many local authorities have made inquiries, and been to see the examples of smokeless manufactories in Bolton; but these inquiries lead to little more than remonstrances from such authorities with their own offenders against the Public Health Act, and in no case yet have led to such violent proceedings on their part as the successful application for a magisterial order of abatement.

The possession of an old house that lends itself to entertainment, and the absence of any domestic authority therein superior to his own, has enabled the writer to entertain both authorities and societies—social, political, scholastic, and industrial; but the tendency of all such is rather to set the receivers of wages in opposition to the payers of them, and for social progress is to be deprecated.

It is only, however, through some such individual action as this, coupled with the constant effort to popularize the movement among the electors of the municipal or rural authorities, that the law can be set in motion, and it must seem obvious that the success of so important a sanitary reform should not be left to depend on the chance of individuals being found in every sanitary authority's district to incur the odium of such an initiative.

The remedies for this state of things are numerous, such as the omission of the words in the Public Health Act "in sufficient quantity to be a nuisance," or the taxing of furnaces not constructed to consume their smoke and unprovided with a certificate of having passed a certain test. An increase of penalties from a minimum of £10 doubling, as in the metropolis, on each conviction. But the object of this paper was to suggest a good practicable remedy, which has received the sanction of—indeed was suggested to the writer by—the Chief Inspector under the Alkali Acts, namely the scheduling of manufacturing smoke as one of the vapours to be dealt with by the Inspectors of the Local Government Board.

The Chief Inspector has, during the year, in his annual report dispelled the cherished fallacy of the generation of poisonous gases—Carbonic Oxide—in producing smokeless combustion.

The half-dozen almost perfect apparatuses now in the market can be reproduced rapidly to meet any demand.

No hardship is involved in requiring an expenditure of £100 on a steam boiler capable of driving £40,000 worth of mill plant. If such expense was thought a hardship, the ratepayers would in many cases be willing to assist impecunious boiler owners as a proper public expenditure for the public good.

The action of the chemical inspectors has been fraught with great advantage to the public and the chemical manufacturers themselves, and the placing of the smoke nuisance also in their hands would in a few years entirely alter the character for dirt and discomfort now possessed by the manufacturing districts.

This would not prejudice the action of local authorities, who may become impatient of the action of the central authority; but when it did not stimulate them it would relieve them.

We have laws, yet, defective as they are, interested persons in position of authority will not allow them to be put in force. The Government inspectors should be independent.

Mr. Wilkinson (Derby) said that Mr. Fletcher hit the right nail on the head when he said that the evil was in the administration of the Public Health Act. That was where the screw was loose. He had taken proceedings before the magistrates with the result that the miserable fine of one shilling and costs was imposed for practically stifling the inhabitants of a manufacturing town. There were frequent cases where the black smoke issued for thirty minutes in the hour, and yet one Justice of the Peace said, what they wanted was more black smoke, not less. In manufacturing towns that was the point which should be hammered at. Then Justices of the Peace, as well as members of Local Sanitary Authorities, required to be educated to see that black smoke was not a necessity, and was positively injurious.

Sir Douglas Galton, K.C.B., F.R.S. (London), said his attention had been directed to this question for a very considerable time, and it was true that so far as manufacturing processes were concerned there was no reason why towns should be injured by black smoke. He was afraid the reason there was so much black smoke was the cause sketched in the paper. He thought there were advantages in making the smoke from the factories come under the care of the Inspector under the Alkali Act, and he thought it would be desirable to call the attention of the Local Government Board to the matter to see whether it might be arranged. There was not the same excuse for the nuisance now that there was in the old days when it was less understood; but now every one had full notice, and every one who had constructed new works had only themselves to blame if the law were strictly enforced to compel the prevention of smoke in factories. It had been clearly proved that smoke was preventable with proper apparatus, but the great fault in many large towns would still remain, that of having smoke emitted from their domestic fires; and until something was done in this respect, either by taxation of chimneys which emitted smoke, or in some other way, he did not see how they were to obtain immunity from the smoke of their domestic fires. In London that was the cause of the greatest amount of smoke. A friend of his who lived twelve miles from London told him that flowers that used to grow in his garden six or eight years ago, were now no longer cultivated owing to the smoke. Even at that distance from London these evils were now become so great, and the population was extending so fast, that he was convinced some strong radical measures must be taken for preventing the emission of smoke from domestic fires just as much as from the manufactories.
