although quite independent of natural selection, is in *no way opposed* to natural selection, and may therefore be regarded as a factor *supplementary* to natural selection." This passage occurs in the most conspicuous part of the paper, viz. at the close of the introduction. In the next most conspicuous part—viz., at the close of the paper itself—it is said, "Without natural selection, physiological selection would be powerless to create any differences of specific type, other than those of mutual sterility, and trivial details of structure, form, and colour."

So much for distinct professions. But as I am tired of controverting the statement that I both intended and perpetrated an "attack" on Mr. Darwin's theory, I will not now burden your columns by supplying the context, or otherwise easily explaining the passages which Prof. Lankester quotes in support of this statement. On a future occasion, however, I hope to avail myself of a more fitting opportunity fully to display the relation in which my "laborious essay" stands to the work of Mr. Darwin; and then I trust it will be clearly seen that, whatever we may severally think about the "complementary principle" of physiological selection, at all events it is in no way hostile to the cardinal principle of natural selection.

Edinburgh, November 19. GEORGE J. ROMANES.

How not to Teach Geometry.

As I have come across an almost unforeseen development of the above heading, I take the liberty of bringing it before your readers. For myself, I may state that I have considered the "learn a proposition off by heart" method was sufficiently bad, but what is to be made of the method described in the following extract from a note which I recently received from my friend:—"We have half of a proposition written on the board, and then we write it at home from memory; then the other half is written on the board, and we write that at home from memory. Then we have to learn the whole proposition at once, to be able to write or say it with different letters. We are not allowed to have a printed Euclid book—we are only allowed to have a book of Enunciations."

Of course this refers to Euc. i. 1.

I beg to commend the above extract to the Association for the Improvement of Geometrical Teaching. I do not know whether to add the name of the school where the above system is followed by one of the teachers.

HERBERT J. WOODALL.

Normal School of Science, South Kensington,
November 11.

P.S.—I should like to see opinions on the teaching described.

A Brilliant Meteor.

Is not the meteor seen from Warwick School on November 4 the same as that mentioned in the following from my daughter, written from the school at Brookfield, Wigton, Cumberland?

"On Monday night (November 4), at 7.55 p.m., when out on the playground viewing the stars, I saw a most beautiful meteor. It seemed to be very near, and was in sight for quite a long time. It appeared just over Skiddaw—that is to say, due south—and went towards the south-east. It had a long tail of light, and burst, and sent out beautiful colours, and disappeared near the horizon."

I may add that, last Sunday, November 10, at about 5.56 p.m., I saw here a very bright meteor pass from a point perhaps south-south-west, and altitude about 25°, to a point perhaps south by east, and altitude about 10° or 12°. It was brighter than Venus when the planet is at its brightest, I think; and it seemed to flash out still more brightly just before disappearing; but the colour did not change perceptibly from its former soft white light, and there was no appearance of bursting. At the time of disappearance, its train of light must have extended over several degrees. WM. SCARNELL LEAN.

Ackworth, November 16.

THE CAUSES AND CHARACTER OF HAZE.

UNLIKE fog, haze commonly occurs in this country when the lower air is in a state of unusual dryness. It is not only a frequent accompaniment of a spell of fine dry weather, but may be, when in combination with certain other conditions, a sign of its approach. Night or morning fogs, and in winter persistent fogs, often signify a calm and settled condition of the air and the prevalence of fair weather. Heavy dews, especially in the autumn, likewise portend fine weather, but usually of shorter duration. Fogs appear usually in one of two conditions: either the air is nearly saturated up to a considerable height, or else is unusually dry, except in a stratum immediately above the ground. In the first case, radiation or condensation from some cause produces, by a slight lowering of temperature, a large precipitation of vapour; and in the second case, radiation from the earth's surface being excessive, owing to the diathermancy of the dry atmosphere, the stratum next the ground rapidly reaches its dew-point, fog is formed, and this fog continues to radiate to the clear sky and further to reduce temperature. Haze, on the other hand, appears often in weather distinguished by unusual dryness, on the surface as well as at a considerable altitude above the ground. The air remains for many days uniformly dry, the nights being nearly dewless, and the sky often free from clouds. The chief difference to be observed, then, is this, that fog requires saturation where it occurs, while haze seems to be favoured rather by a dry atmosphere.

Haze does not prevail on the continent of Europe or in the interior of North America to anything like the same extent as in England; nor, probably, in mid-ocean to the same extent as near the shores of northern countries. On the east coast of Scotland, and, indeed, over all North Britain, it is exceedingly common, especially in the spring, and during the prevalence of east wind, although with west winds the atmosphere is frequently clearer in summer than in Southern England. Over Southern England it is a common accompaniment of winds between east-south-east and north-east inclusive. It appears to prevail more on the eastern than on the western coasts when east winds are blowing. In Western Surrey, when the lower air moves from a westerly direction or is calm, the approach of east wind is announced by a light haze obscuring distant views, before the east wind has actually arrived on the spot of observation. This is not in all cases due to the descent of London smoke from a higher stratum, where the east wind first gains ascendancy, for the phenomenon may be observed in other localities. The haze produced on the first arrival of the east wind is thicker than that which remains when the east wind has gained a strong hold, and the neutral band where calm prevails between a south-west and a north-east current is marked by the thickest mist. In winter a dark fog frequently marks this neutral zone, often not more than one or two miles in breadth, and the zone moves eastwards or westwards according as the west or east wind exercises the strongest pressure. I have frequently observed this phenomenon with great distinctness. In winter, the approach of the equatorial after the prevalence of the polar current is often betokened by a damp fog and the contrary change by a dry fog; the same changes in summer are respectively marked by a great increase of transparency and by a spreading haze or mist. The following observations taken in Scotland illustrate the phenomena accompanying a change from west to east in August. St. Fillan's Hill is a small, steep, isolated volcanic cone about 300 feet in height, standing in the middle of the valley of the Earn, about two miles from the lower end of Loch Earn, in Perthshire. The air was clear, and a fresh westerly breeze was blowing when I was on the summit, about 5 p m. The breeze suddenly began to slacken, and in about five minutes had dropped altogether. Then down the valley eastwards a blue haze began swiftly to climb the glens tributary to Strathearn, and the whole air eastwards grew obscure. The calm only lasted a little more than two minutes, and then suddenly a strong wind from the east set in, and soon the air, westwards as well as eastwards, was robbed of its transparency. The east wind

continued, and in a few minutes the tops of the hills, which rise precipitately from Strathearn to a height of about 2000 feet, were obscured with cloud-banners growing continuously and descending till in about two hours not only the hills above a level of about 1000 feet, but the whole sky, were covered with gray cloud. The duration of the neutral calm, from two to four minutes, seems to be about the usual time occupied by a moderate east wind in driving back the opposing current, according to my observations in the neighbourhood of London. In the suburbs south-west of London such a change is signalized in the neutral band of calm by a dense yellow haze, producing great darkness, the result of a banking up of smoke to some altitude, together with the condensation of aqueous vapour by the mixture of currents differing in temperature. With lighter winds about equal to each other in momentum, such a band often lasts much longer, and I have known a west wind prevail at Richmond simultaneously with an east wind in London, both without fog, while at Wandsworth, between the two, a calm continued for many minutes, with dense, almost nocturnally-black, smoke-fog, the pressure in each direction being apparently equal. Generally speaking, the mist thus produced at the junction of the two winds is exceedingly dense in winter, moderately dense in spring and autumn, and thinnest in summer, varying, in fact, from a black fog in the cold season to a mere haze in the warmest weather. Hence we have an ascertained condition for the production of haze—the mixture of two opposite winds. It may be here remarked that a very sudden squall of wind from the north, displacing an equatorial or south-westerly current, produces a somewhat similar dense wall of mist, which it soon drives away before it.

Haze very frequently prevails during a north-east or east wind in all parts of Great Britain; in the east of Scotland it is, perhaps, more marked than in other localities, and attends both wet and dry weather. A dense blue mist or haze brought by the east wind sometimes invests the landscape for days before a continuous downpour from that quarter. This haze extends far out to sea eastwards. The southern parts of England are less troubled than the northern by this disagreeable infliction, and the northern parts of France less still. In the eastern counties, and probably in other parts of England, the density of the haze seems to increase in some proportion to the dryness of the air, when only a slight wind blows. On thoroughly rainy days, such as the north-east wind sometimes brings to the London district, the amount of haze is below the average; and when the north-east wind is accompanied by snow-showers, as it often is in February and March, or by rain-showers later in the year, it is remarkably and conspicuously clear. I cannot remember any showery days with a steady north-east wind showing a true haze, beyond the influence of London, but have often observed the extraordinary clearness of such days, and the apparently dissipative action of the air on London smoke.

Generally, the density of the haze is less as the strength of the wind increases. A gale from the north-east is seldom accompanied by much haze inland, although on the east coast the combination is not uncommon. Haze appears to diminish as the north-east wind grows more established, and in winter a long period of this wind may be experienced without the continuance of haze. It is also important to observe that, when high upper clouds are seen to be moving from a direction between east and north inclusive, but especially from north-east, the air is usually clear, and a long continuance of the polar wind may be expected. It is a sign of the firm establishment of the north-east wind when high cirro-cumulus is seen passing over from that direction, whatever deviations may take place temporarily on the earth's surface. The extension of the north-east wind to a great altitude seems to deprive it of its accustomed haziness. When, on the other hand, thick haze accompanies the north-east wind, if upper clouds are in view, they are generally seen to be borne by a different current, and in winter the lower wind does not, in such conditions, often remain long in the same quarter. Hence we have the means of making forecasts with tolerable safety as follows:—

(1) If the lower air be clear, whether clouds at a high level be seen to move from the north-east or none be visible, the lower wind from north-east will probably last some days, perhaps some weeks.

(2) If the lower air be very thick and misty, the north-east wind is not strongly established, and is likely soon to be succeeded either by variable airs and calms, or by breezes from a different quarter.

In spring and summer, haze prevails sometimes for many days together, with a dry atmosphere, over the whole or a large part of Great Britain. The wind is either easterly or variable, the barometer high, temperature high by day and low by night, and the deposition of dew either small or heavy. The haze seems to be uniformly distributed through the atmosphere, and varies neither from one day to another, nor from day to night. The sky is pale blue, the sun rises and sets red and rayless, and the moonlight reveals the blue mist unchanged by the absence of the sun's rays.

Haze has been known to affect a great part of Europe during a period corresponding with the prevalence of drought.

The formation of haze seems to be more common and more sudden in mountainous regions than on the plain. I had once an opportunity of observing the rapid production of a very dense haze from the top of Cader Idris, in Wales. The morning was bright, fine, and clear, but the heat very oppressive. About midday, signs were seen of an approaching thunderstorm, which, however, spent its force at some distance down the valley. Before the storm, a haze quickly gathered, and completely obscured even the nearer ranges. This haze resembled that which prevails sometimes during many hours before the occurrence of a thunderstorm in the level country.

The conditions favourable to the production of haze may be conveniently summed up as follows:—

(1) A gentle wind from east-south-east to north-east inclusive, and east wind in general, especially with dry weather in spring and summer. If the east wind be established up to a great height, the lower air is usually clear, but if the upper current is from a westerly direction, haze prevails.

(2) Fine settled weather, with variable currents, a dry air, and little dew.

(3) Opposition of currents—such as occurs when several shallow barometric depressions exist over the country—and the atmospheric state preceding thunderstorms.

(4) Damp weather, with light winds and varying temperature, as thaw after frost, with snow on the ground.

Turning to those conditions which are most unfavourable to the production of haze, or in which the air is most transparent, we find them to be—

(1) A state of great humidity, such as that which occurs often before bad weather, the wind being between south and west.

(2) Strong winds and showery weather.

(3) Winds between south-west and north.

(4) Fine settled summer weather, with westerly or southerly winds.

(5) Settled easterly or northerly winds, with either clear sky, or high clouds moving from those directions.

(6) Easterly or northerly winds, with a high continuous cloud canopy moving in the same direction, small range of temperature, and steady conditions; or, with detached cumulus in the daytime, and clear nights.

(7) North-west following a wind between north-west and south is particularly clear, except in thundery weather.

It thus appears that the most striking characteristic which may accompany the formation of haze is an unusual dryness of the air, and that a total absence of haze is often observed when the air is unusually charged with vapour. It does not follow that haze, or a light fog much resembling it, is not also seen in a damp state of the air, or that a saturated air is always free from haze; indeed, something much resembling a dry haze does occur with sudden changes of temperature in all ordinary hygrometric states in our climate. But the very condition to which haze in England is commonly, and in a certain sense correctly, attributed—namely, atmospheric humidity—is, if sufficiently uniform and extended, least favourable to its manifestation. A constant moisture-laden westerly breeze would give a climate nearly as clear as that of the south-west corner of France.

Two principal factors go to the production of ordinary haze: the first, a rather large amount of vapour between the earth and a great altitude, say 60,000 feet; and the second, a mixture of two heterogeneous masses of air. Evidence of the correctness of this proposition is to be found in the geographical distribution of haze and the state of the winds when it occurs.

The causes of fog are either radiation of heat from the earth into space and cooling of the overlying humid strata of air to a temperature below the dew-point, or else the mixture of two winds, differing in temperature and other conditions, one of the currents being usually near its point of saturation previous to contact with the other.

If the above-mentioned statement of the causes of haze be correct, we shall be enabled to account for the appearance of haze in certain conditions, which have been given, and for its absence in others. Taking them in order—

(1) A gentle wind from east to north-east inclusive is favourable to haze, especially if it extends to no very great height. Often the approximate depth or height of the easterly current is difficult to ascertain; but, in general, if it be of short duration, it is shallow, and sometimes upper clouds from a westerly direction may be observed. In these cases especially haze prevails. Considering the shallowness of lower winds compared with their extent—an easterly wind, for instance, which has travelled 300 miles beneath a westerly wind only four miles above the earth's surface—it is quite certain that a very large admixture of the two currents must take place. And we may be sure that in the majority of cases the easterly surface wind has above it an upper current from a westerly direction. Mr. William Stevenson (*Edinburgh Philosophical Magazine*, July 1853) observed the cirrus cloud at Dunse, Berwickshire, for eight years, and from his summary of the direction of the motions of that cloud we derive the following figures:—

	Per cent.
Direction of motion of cirri from between south-west and north-west inclusive	75·2
Direction of motion of cirri from between north and east inclusive	10
Other directions	14·8
Direction of wind at surface of the earth from south-west to north-west inclusive	54·6
Direction of wind at surface of the earth from north to east inclusive	32·4
Other directions	13

Thus there remains a difference of over 20 per cent. excess of westerly upper current over westerly surface wind, and at the level of the cirrus a wind between north and east only prevails once to every three occasions of a surface wind from that quarter. The significance of these figures is not seriously affected by the idea, first suggested by Admiral Fitzroy, that visible cirrus is less likely to form in the polar than in the equatorial current, and any careful observer can easily satisfy himself that westerly winds are more common and easterly winds less common at the cirrus level than on the surface. Mr. Buchan ("Handy Book of Meteorology," p. 230) remarks that, as the north-west current advances into southern latitudes, the increasing heat of the sun will tend to dissolve the cirri which mark its course, and he therefore thinks that the north-west upper current is the most prevalent in Great Britain. The actual numbers obtained by Mr. Stevenson during the eight years were 243 for north-west, and 256 for south-west direction of cirrus.

Mr. Ley ("Laws of the Winds," Part I. p. 154) remarks:—"The fact, indeed, that the observed westerly upper currents prevail over the observed easterly upper currents, even more than the westerly surface winds do over the easterly surface winds, has been admitted by most of the observers who have investigated the subject in different parts of Western Europe; and the same phenomenon is noticed in similar latitudes of North America. . . . Be this as it may, the theory of prevalent polar upper currents derives no support from our own collection of examples. Again, the results of the observations classified in Table IV. appear altogether adverse to the supposition that an easterly upper current is common over the northern portions of those depression systems whose westerly winds are the strongest at the earth's surface. . . . Instead of easterly upper currents, we find a great preponderance of southerly currents."

Out of nine balloon ascents recorded in Glaisher's "Travels in the Air," in which the wind at starting from the surface was easterly, there was not one in which a different current was not encountered at a moderate elevation. The changes were as follows:—

Date.	Surface Wind.	Wind at
April 18, 1863.	N.E.	A moderate height, N.
July 11, 1863.	E.	A moderate height, N.
		5400 feet, N.N.W.
May 29, 1866.	N. by E.	Above 2000 feet, N. by W.
		5100 feet, nearly calm.
Mar. 31, 1863.	E., gentle.	Between 10,300 and 15,400 feet, W.
		About 15,400 feet, N.E.
		Higher still, S.W. and W.
Jan. 12, 1864.	S.E.	1300 feet, strong S.W.
		4000 feet, S.
		8000 feet, S.S.W.
April 6, 1864.	S.E.	About 9000 feet, N.W.
June 10, 1867.	Surface calm, low elevation N.E.	Higher, N.N.E.
		Higher still, N.
Aug. 12, 1868.	N.E.	5000 feet, S.W.
June 16, 1869.	N.E.	10,000 feet, S.W.

On one occasion—January 12, 1864—the temperature from 3000 to 6000 feet was higher than on the surface, but at 11,500 feet it was more than 30° colder—namely, 11°. A large number of balloon ascents show not only a variety of currents, but large and sudden variations of temperature within a few thousand feet.

Thus we may confidently assume, in the majority of cases of east wind, and especially when this wind is of brief duration, local, or gentle, that a westerly wind flows above it at no great distance from the surface of the earth. Considering the perpetual rapid interchanges (hardly to be called diffusion) going on in the atmosphere, the lower wind must be largely mixed with air of a different condition derived from the westerly current. If a cold dry east wind be permeated by patches and filaments, however minute, of moister and warmer air, they must be cooled by contact with the polar wind, and a slight deposition of vapour may take place. Or the countless invisible dust particles may, by increased radiation towards space through a drier air, either cause a slight deposition of moisture upon themselves or collect still smaller particles together, as dust is known to collect on cold surfaces in a warm air. If deposition of moisture take place, the dryness of the air prevents the water particles from growing to anything like the size of the

particles of a fog; a relatively small diffused quantity of vaporous air in minute parcels could not produce by condensation any but extremely small and transitory water particles, in the aggregate visible through long distances, but probably individually beyond the power of the microscope to discern. They may be compared to the blue mist escaping from the safety-valve of a boiler under high pressure: the invisible steam turns for a moment blue, and then to the ordinary white of visible steam. The haze may possibly be equally momentary in duration, dissolving long before reaching the white stage, but fresh filaments are perpetually keeping up the process and giving the appearance of a persistence like that of smoke or dust. According to Espy, every cloud is either forming or dissolving (Buchan's "Handy Book of Meteorology," p. 175).

The action of a north-east wind setting in over England would be represented by a trough of water, say 2 feet square and 2 inches deep, containing warm water flowing in one direction, while cold water enters from the whole length of the opposite side. The cold water would force its way under the warm, and the two opposite currents would continue to flow; but through friction and diffusion there would be a great deal of mixture of portions of the upper with the lower stream.

A haze similar to that accompanying the east wind is frequently seen where two currents of the same wind meet at different temperatures, as at the junction of two valleys, or at projecting headlands (Buchan's "Handy Book of Meteorology," p. 171). It is also common with a humid wind, otherwise clear, when it passes over ranges of hill and valley of moderate elevation, owing probably to the mixture of parcels of air of different temperatures by alternate upward and downward thrusts. The thin white mist which appears in gales from the south-west on sunshiny days is probably due to the forcible and rapid mixture of air warmed by the ground with colder portions from a higher level, the deposition of minute particles of dew being aided by the abnormal amount of salt carried up from the sea in spray, and borne to great distances inland.

A very good instance of the powerful influence of the mixture of two currents of air, not greatly differing in temperature and other conditions, to produce haze occurred on August 26, 1889, in southern Surrey. The wind over a wide area, including the south of England, was variable and gentle from west to north-west. At the place of observation it had been about west-north-west during the afternoon, and the views were fairly clear. Cirro-cumulus, both at a moderate and at a great elevation, moved from north-west. At about 5.30 p.m. the landscape was suddenly invested with haze, which, during the following hour, was thick enough to obscure altogether hills about six miles off. Simultaneously the wind dropped a good deal and shifted to north-west and north for a short time, but soon backed, and the air again became clear about 7.30. It would thus seem sufficient that a reduction of temperature a little more than the ordinary about the time of sunset should occur, in order to precipitate visible moisture upon the dust-particles of the air. Both the sensation and the appearance of the sky resembled that during a disagreeable misty east wind, and, just before the change, a very dark bank of cloud appeared in the north, which, on passing over, was seen to be more mist than a well-defined cloud stratum. It seems not unlikely, judging from the experience of aëronauts, that in this case a current from north or north-east was driven like a wedge into the general north-west wind a few thousand feet or less above the ground.

If the account of the formation of haze in an easterly wind given in the foregoing pages be correct, there should be a clearing of the atmosphere when either the east wind extends itself to the upper regions or the westerly wind succeeds in driving back its opponent out of the lower space. In point of fact, the air does clear itself in either of these events. Moreover, a clearing away of haze is a good indication of a strengthening of the polar current or its expulsion by the equatorial; other signs, such as the motion of cirrus and the aspect of the clouds, plainly informing us which of the two changes will occur.

(2) The second favourable state for the production of haze was given as "fine settled weather, with variable currents, a dry air, and little dew." This state prevails often with anticyclones, and the movement of the air is to a great extent vertical, an interchange taking place between upper and lower strata. Consequently, there is a great mixture of portions of air at different temperatures, with a result like that already described. The heterogeneous character of the lower atmosphere in a horizontal direction declares itself by the poor transmission of sound. But a great deal remains to be explained in the production of haze in these conditions. The cause is probably the same as that which sometimes covers the whole of the British Isles with a damp fog, extending high into the atmosphere. This occurs when two winds of a different character meet in such a manner as to interdiffuse gradually over a wide area. But in the case of haze, how can it endure when the general dryness of the air is far above the point of saturation? Haze sometimes continues in summer right through the day, when the dry and wet bulbs show a difference of 12° to 15°. It would seem as if our methods of estimating the dew-point do not altogether hold for air in a certain condition and for certain particles in it. Is it not possible that condensation to a slight degree may occur upon some minute crystalline particles, such as the salt-dust which pervades our atmosphere, at temperatures above the dew-point? Such action would only be consistent with the effect of crystals in hastening the boiling and congelation of water. It is probable that, if means were available for testing the temperature of successive minute portions or strands of air passing over a thermometer, we should find a great variation from one moment to another. A difference of 12° between the dry and wet bulbs may represent a mean between much higher and much lower values; and on the driest days, when haze prevails, there may be extremely minute portions with a temperature at the dew-point—that is, containing more vapour than, at the particular temperature to which it is a certain moment exposed, can remain uncondensed. That volumes of air at different temperatures take a long time to become thoroughly incorporated, may be regarded as certain. Threads of smoke in a still room often remain for many minutes unbroken, and behave as if they were held together by some cohesive force, and, generally, strains of air or gas at widely differing temperatures, when mixed, tend to hold together rather than to diffuse. Thus, small surfaces, of which the vapour-particles are at different temperatures, are frequently in contact. When we consider that different currents of air frequently prevail within a a few thousand feet of the earth's surface, and that within five miles a temperature of −2° may exist early in September,[1] it seems possible that, in so bad a conductor of heat as air, temperature at different points on the same level may vary greatly. On September 1 and 2, 1889, the condition of the air was instructive with regard to the formation of fog and haze. The night of August 31–September 1 was fine, and radiation rapid, so that in the morning there was a copious dew. From 6 to 8 a.m. there was thick fog, which, as the sun's power increased, lightened and lifted, but the sun did not finally break through till past 11. The wind was fresh from north-east. A thin blue haze remained after the fog had dissipated, and did not altogether disappear during the day. The air was not damp, even before the fog had lifted, though there was a very slight drizzle about 9 a.m. On September 2 the night had been very fine and clear, but in the morning

[1] See "Travels in the Air," Glaisher's ascent of September 5, 1862.

a thick wet fog, with fresh north-east wind, prevailed. This fog cleared, and the sun shone through, about 9 a.m. A mist, however, remained much later. Now, in these cases, the fog was due to the cooling of the earth by radiation (for it did not appear till after midnight) and to the cool north-east wind co-existing with higher currents from a different quarter.[1] The persistence of the haze much beyond the fog reveals the difference between a general saturation and what might be termed molecular saturation. The fog breaks, decreases rapidly, and has gone when the last few shreds of clouds lifted from the earth vanish in the blue, but the haze looks unchanging and uniform over the country. When we see volumes of vaporous air separated, without any apparent reason, into dense clouds and clear intervals, *e.g.* cumulus in a blue sky, it becomes easy to understand that very small microscopic clouds, in which condensation is only momentary, may permeate air otherwise far from saturation.

It would hardly be reasonable to exclude electricity as a possible agent in the otherwise not wholly accountable phenomena of mist and cloud. It may be that the dust-particles of two currents of air differing in electric quality or quantity may be attracted to each other, or that the mixture of currents of different temperature may in some way set up molecular aggregations.

Whatever the cause, we should bear in mind the small quantity of non-transparent matter required to produce the dimming effect of haze. If the eye can observe the colour produced in a drop of water by the fifty-millionth of a gramme of fuchsine, possibly a weight of water or dust not much greater would suffice for visibility in a column of air 1000 feet long. The atmosphere is at all times charged with dust-particles to a degree which it is difficult to realize. The purest air tested by Mr. Aitken previous to his measurements on the top of Ben Nevis, contained about 34,000 dust-particles to the cubic inch—this was on the Ayrshire coast. In every cubic foot there would be 35,232,000 particles, and, in a horizontal column of 1000 feet, 35,232,000,000 particles. It is manifest that a condensation upon a small proportion of these, or an agglomeration of a small proportion into larger groups, or a momentary adhesion by electric attraction, would suffice to produce optical effects.

The evidence concerning the appearance of haze by irregular transmission of light due to unequally heated currents of transparent air seems to be quite insufficient, and however great the heat near the surface of the ground, say in the desert, with consequent distortion of images, it does not, as a rule, bring about the haze so common in temperate climates.

Haze of an abnormal kind need barely be mentioned here—namely, that due to smoke, palpable dust, and the products of volcanoes. It may, however, be very widely spread and very dense. In 1783 Europe was for months covered by the dust ejected by an Icelandic volcano, and the Atlantic for 900 miles west of the north-west coast of Africa is every year subject to a haze composed of fine particles of sand from the Great Desert.

(3) Opposition of currents, such as takes place when several shallow barometric depressions pass over the country, results in mixture of differing air, partial condensation, sultriness, haziness, and frequently thunderstorms. Not at all improbably, the differing electric conditions of two winds, the rapid condensation of vapour, and the projection of highly vaporous air to a great height, accelerate the growth of water-particles, until they fall to the earth in large drops. The saying that thunderstorms advance against the wind is merely a way of asserting that two winds are adjacent, one above the other, and that the clouds move in the upper current. The haze preceding thunderstorms announces beforehand the contention which is going on, and the conglomeration of dust or water particles by electric attraction or rapid cooling.

(4) Damp weather with light winds and varying temperature, as thaw after frost, with snow on the ground. The cause of haze in this condition is obviously the contact of warm moist air with air cooled by contact with, and by radiation towards, the ground. In this case, again, it is mixture of portions of air of different temperatures which produces partial condensation and haze. It must be remembered that the air is always charged with an immense quantity of fine dust, such as particles of salt,[1] that these are capable of radiating, and that when they fall 1° or 2° below the temperature of the air, moisture may be deposited upon them sufficiently to become visible. In the case supposed, of an equatorial current supervening after frost and snow, the mist produced by mixture of parcels of air at different temperatures will be thin and blue if the filaments in which saturation and deposition occur are very small in proportion to the surrounding unsaturated air, and white if the proportion of saturated air is large. For the blue mist or haze indicates deposition in very minute clusters of water-molecules, and instant reversion to the invisible state by the contact of unsaturated air, while the white mist is the result of condensation in much larger quantities in air on the whole very near or at the point of saturation.

Consider next the conditions of weather in which the air is most transparent.

(1) A state of great humidity, such as that which occurs often before bad weather, the wind being between south and west. What does this clearness signify, according to the views of the causation of haze above detailed? Chiefly that the air up to a great height is fairly homogeneous—that is, of the same kind and quality as regards moisture, electricity, and temperature, with due allowance for the normal changes depending on altitude. The humidity is not owing to this homogeneity, but often accompanies it, simply because the south-west and westerly winds have passed over a large extent of ocean. In fact the air throughout has been subjected to the same influences, and nothing has occurred to disturb its uniformity, so that it can for some considerable time carry a large amount of aqueous vapour without precipitation. When precipitation does occur, it is usually by the thrusting upwards of the warmer strata into cold upper strata, and then condensation proceeds without check and rapidly from invisible particles to rain-drops. Thus, on reaching the first mountainous region, or in passing over land heated to a temperature much above that of the sea surface, the ascent of the most humid strata into the cold upper air is often followed by rain. The remarkable transparency before rain signifies a correspondence in direction as well as in qualities between the upper and lower strata. If the wind be between west and south, as it usually is in these cases, we are informed of a similar wind at a high level—that is, that the upper current, as well as the lower, is more than commonly humid, and its vapour tending to condense by passing towards higher latitudes. It only requires slight disturbances in a vertical direction to precipitate the abundant vapour, and hence the frequency of showers, especially where large columns of heated air rise from the land, at a distance from the south coast, and in hilly country. The south-westerly wind being a warm one, is more likely to ascend and to have its vapour condensed to rain than a colder current. The clear lower air indeed owes its clearness partly to its ascending movement.

(2) Strong winds and showery weather. Strong winds usually prevail when the air up to a great height partakes more or less of the same movement. There is

[1] "On Saturday evening, August 31, a balloon, as it ascended, crossed and recrossed Luton several times."—*Daily News*, September 2, 1889.

[1] Salt is shown to be present everywhere in the atmosphere by the spectrum of a flame.

also no opportunity for the filtering through of small portions of dissimilar air, and, if portions do descend into the lower levels, they are broken up, diffused, and dispersed. Still, in the colder half of the year, if the lower wind blows from between east and north, and does *not* extend to a great height, a strong mist may be produced by its being mixed with detached portions of the westerly upper current, which take a long time to be thoroughly incorporated and dissolved, and contain more vapour than they can hold invisible in contact with the cold surface-breeze. Thus the prevalence of much haze with a north-easterly gale indicates an equatorial upper current, and the polar wind is apt to be replaced by it before long. With regard to showery weather, it may almost be said to be the opposite of hazy weather, and for the following reasons:—First, as we have seen above, showers are produced by the upward projection of lower air, containing a good deal of vapour, into upper cold air of the same kind. Then, they are often the expression of a state of the atmosphere when the interchange between the upper and lower strata proceeds by large ascending columns and large down-rushes, instead of by small convection currents, and ascending and descending filaments over a very large area. The clearness of the air with a showery north-east wind is quite surprising, for it is sufficient to banish to a great extent even London smoke. Here, again, the north-east wind prevails to a great height, and the air is homogeneous and rather dry. When a shower or even a cumulus cloud passes over a large town, the smoke is seen to be drawn up in a moving column to the height of the cloud. Probably the chief cause of the clearness of a showery north-east wind is the prevalence, as in other cases, of the same wind in the upper regions, so that there is no admixture of strange threads in its composition, no strands of extra-humid particles to be rendered visible by incipient condensation.

(3) Winds between south-west and north. These are, on the whole, clear for a similar reason, for it has been shown that the upper currents in Great Britain usually move from between south-west and north-west. If, as occasionally happens, an east wind blows overhead, they are very far from transparent.

(4) Fine settled summer weather, with westerly or southerly winds, is clear not only for the reason above stated, but on account of the general moderate dryness of the atmosphere. In such weather, barometric pressure is frequently highest over Spain or France, and our upper currents are accordingly from north-west, becoming warmer as they advance southwards and increasing in capacity for moisture. There would be no condensation if portions of these currents were to descend into the lower air.

(5) Settled easterly or northerly winds, with either clear sky or high clouds moving from those directions. Haze does not form where the wind is steady, the air dry and homogeneous up to a great height, and equilibrium stable, for there is nothing to lead to condensation except at the particular level of saturation where clouds are manifested.

(6) Easterly or northerly winds with a high continuous cloud canopy moving in the same direction, small range of temperature, and steady conditions; or, with detached cumulus in the daytime, and clear nights. The same remarks apply here as to the last.

(7) North-west wind, reaching that point from west or south, is particularly clear. Great transparency in this case is not a sign of rain, but rather of fair weather. It is probably due to its agreement in general direction with upper currents, the increasing dryness as it reaches warmer latitudes, and to the uniformity and equilibrium attained by passing over the ocean.

F. A. R. RUSSELL.

THE PULSION MECHANICAL TELEPHONE.

(FROM A CORRESPONDENT.)

A NEW mechanical telephone of extraordinary power has recently been exciting considerable attention in London and some other cities and towns in this country. It is of American origin, like so many other modern improvements of exceptional character, being the invention of one Lemuel Mellett, I believe of Boston, U.S. There have been many previous mechanical telephones, as your readers are aware, some of which have obtained much publicity for a short time, and then have been heard of but little more; but having had opportunities of experimenting frequently with the new instrument, and observing its vocal power, so to speak, under very various circumstances, I cannot doubt that it has a great future before it.

It may be clearly stated at once that the pulsion instrument is absolutely independent of all electrical aids or appliances, and therefore needs neither battery power to bring it into play, nor insulation of any of its parts to keep them effective. It consists solely of two cheap and simple instruments connected by an ordinary non-insulated wire of copper, or, better still, of a double steel wire, the two parts being slightly intertwisted, say with about a single turn in a couple of feet. The wire (or wires) is simply looped to the instrument at either end, the connection being made in a few seconds. The instrument consists of a disk in combination with a series of small spiral springs inclosed in a case of some three or four inches in diameter. These springs, arranged in a manner that has been determined by experiment, and so as to produce harmonized vibrations, appear to possess the power of magnifying or accumulating upon the wire the vibrations which the voice sets up in the disk, and the wire seems to possess—undoubtedly does possess—the power of transmitting to great distances, and giving out upon a second pulsion instrument, the sounds of the voice.

The ability of this simple system of springs, disks, and wires to convey conversational and other sounds to considerable distances with great clearness and distinctness, reproducing the very tones of the voice and the qualities of musical sounds with but little reduction or modification, is most surprising, and to none more so than to the many men of science who have been recently experimenting with it.

The writer of this notice cannot, perhaps, do better than state his own experiences with this system. After examining and experimenting over several short lengths of wire, some of them exceeding a mile and a half, he last week went to the Finchley Road Station of the Midland Railway, from a point near to which a line had been conveyed to near the Welsh Harp Station, a distance of three miles by the line of railway, and of more by the track of the wire, which for the larger part was carried by the telegraph-posts, to which it was attached by very simple means. Conversation through this length of line, of over three miles, was exceedingly easy; indeed, so powerfully was the voice transmitted, that an ordinary hat sufficed for all the purposes of the second instrument, without going near to which conversation was carried on repeatedly by means of the hats of three gentlemen who were present, the tops of which were merely placed against the telephone wire.

I then went into the garden of the "Welsh Harp," where a short length of wire had been led between two points, the wire on its way from one point to the other being twice tightly twisted, at an interval of some yards, round small branches of trees, of about 1 inch in diameter, being wound round and round the branch three times in each case. Strange to say, this tight twisting of the wires round the branches in no way interfered with the transmission of the voice from end to end of the wire.