ing from Borneo. The habit seems general, and, according to the above letters, not confined to venomous or non-venomous varieties.

EDWARD F. TAYLOR

St. Augustine's College, Canterbury, January 13

"*Sarawak, Borneo, November* 11, 1884

"The inclosed cutting from NATURE was sent me by H. Brooke Low, Esq., resident of Rejang, with a desire that I should forward my experience (which was similar to Mr. Evans's) to your paper. A young Dyak youth was walking up the hill towards my house, when a snake sprang out of the bank and fastened itself on the boy's jacket, just under the right arm. Fortunately, its fangs got caught in the cloth, and the boy escaped unhurt. Eventually, the reptile was killed and brought to the house. It measured five feet and some odd inches in length. In examining its fangs I noticed in its mouth the tail of another snake, and, on pulling it out and comparing them, I found it to be a few inches *longer* than the outside snake, though not quite so thick. I have come to the conclusion that this snake is the *Ophiophagus elaps* of the Straits. The native name for it is 'Ular Kendawang.' It is more deadly, more agile, and more beautifully marked than the 'Ular biliong' mentioned by Mr. Evans. So fascinatingly beautiful is the appearance of this snake, that in Dyak poetry one of their heroes is described as 'Crowned with the cast skin of the Ular Kendawang,' thus attributing to the hero that comeliness, agility, and fearlessness for which the 'Kendawang' is noted. I have reason to believe that the 'Ular biliong,' or axe snake (from the shape of its head), mentioned by Mr. Evans is an Ophiophagus, but it is not what is called the 'Elaps.' Its movements are sluggish, and its poison is not nearly so deadly as that of the 'Kendawang.' The distinctive marks of the 'Kendawang' are a reddish head and tail, the red of the tail being about twice the length of the head. The ground colour of the body is generally of a dark gray, but I have seen them of a silver gray, and also dark brown. A light streak of flesh-colour runs down the back, and the edges of it are serrated with vermilion and metallic-green spots, with just enough of white and yellow to make a most pleasing combination of colour. Besides these two, there are two other species belonging to the Ophiophagous class. The native names are 'Kengkang mas,' or 'Tinchin mas,' *i.e.* golden-ringed; and 'Matikor,' *i.e.* dead-tailed, and these four species are, I believe, very common throughout the Malay Archipelago.

"M. J. BYWATER,

"S.P.G. Missionary in Sarawak"

The Canadian Geological Survey

A PHRASE used in your condensed report of my remarks after Sir J. H. Lefroy's paper, read on January 13 at the Colonial Institute, may, I fear, be misunderstood by some of my friends in Canada. I am reported speaking of the Geological Survey of that country as "being slowly conducted." My remarks were not intended to imply the slightest reproach. I explained that progress could not be rapid because of the vast extent of the territory and the natural difficulties of many parts of it. I think, indeed, that it is surprising that, having regard to the means at their disposal, the Survey have accomplished so much. I urged that, as it was impossible for the present staff to prospect specially for minerals without abandoning the general work of surveying, which is of the more importance for science, some specialist should be added to it, to whom the former duty should be assigned. I did not use quite so strong a phrase as that I "*believed* the district north of the St. Lawrence was rich in valuable minerals." My opinion is that, as certain parts are known to be rich, and as there is great uniformity in the geology of the district, it is very probable similar deposits exist in the (very large) unexplored portion.

T. G. BONNEY

23, Denning Road, Hampstead, N.W., January 19

ASTRONOMICAL PHENOMENA FOR THE WEEK

1885, JANUARY 25–31

(AS an experiment we have here adopted for the reckoning of time the civil day, commencing at Greenwich mean midnight, counting the hours on to 24.)

At Greenwich on January 25

Sun rises 7h. 50m.; souths 12h. 12m. 40.9s.; sets 16h. 35m.; Decl. on meridian 18° 50′ S.; sidereal time at sunset 0h. 55m.

Moon (1 day past First Quarter) rises 11h. 55m.; souths 19h. 29m.; sets 3h. 12m.*; decl. on meridian 15° 59′ N.

Planet	Rises h. m.	Souths h. m.	Sets h. m.	Decl. on meridian ° ′
Mercury	6 23	10 27	14 31	21 47 S.
Venus	6 31	10 29	14 27	22 44 S.
Mars	8 6	12 29	16 52	18 54 S.
Jupiter	19 6*	2 7	9 8	11 10 N.
Saturn	12 43	20 46	4 49*	21 32 N.

January 26, 16h.—Mercury at greatest elongation from the Sun, 25° W.

Occultations of Stars by the Moon

Jan.	Star	Mag.	Disap. h. m.	Reap. h. m.	Corresponding angles from vertex to left ° °
26	B.A.C. 1526	6	19 13	19 49	19 328
27	B.A.C. 1930	6½	20 38	21 30	33 316
29	λ Geminorum	3½	2 23	3 21	132 284
30	B.A.C. 3122	6½	20 54	21 59	30 237
31	π Leonis	5	17 53	18 35	5 255

Phenomena of Jupiter's Satellites

Jan.	h. m.		Jan.	h. m.	
25	4 1	I. tr. ing.	27	0 47	I. tr. egr.
	6 21	I. tr. egr.		19 8	I. ecl. disap.
	21 40	IV. tr. egr.		21 33	II. ecl. disap.
26	0 40	I. ecl. disap.		21 58	I. occ. reap.
	3 31	I. occ. reap.	28	1 33	II. occ. reap.
	3 52	II. tr. ing.		19 13	I. tr. egr.
	6 47	II. tr. egr.	29	19 54	II. tr. egr.
	7 27	III. ecl. disap.		23 19	III. tr. ing.
	22 28	I. tr. ing.	30	2 54	III. tr. egr.

* Indicates that the rising is that of the preceding, and the setting that of the following nominal day.

DUST [1]

MY business this evening is to talk about dust: meaning by dust all suspended foreign matter of whatever kind, and including smoke and fog under the one heading. Coming from England I should naturally begin by saying, well, we all know what dust and smoke are; and even in Canada, I suppose, I may venture to say the same, though I am bound to say that your country, at present, shows a remarkable deficiency in this respect. In an English town dust and smoke are the most noticeable features, and are always ready to perform any insanitary or other function that may be expected of them. In this clear atmosphere none of these functions can be properly performed; disease-germs must languish and die, and their sworn foes, the white corpuscles of the human blood, must thrive amain. Let me say, however, that the air here is not so absolutely free from smoke as I had hoped to find it. Compared with an English town it is a splendid contrast; compared with one's ideal it falls short. Your houses may indeed burn anthracite and wood, but your passenger locomotives do not: I can attest from very recent personal experience, in a journey across this continent, that some of your locomotives emit almost as much smoke as a Clyde steamer, and that the journey would have been much pleasanter if they had emitted less. I also see some factory chimneys rising here and there. If you be not warned in time, you will not realise the blessing of fresh and pure air until you have lost it. It is good to have large manufactures, it is better to retain healthy and pure air. But with proper care the two may go together. Once lose ground in this respect, as we have done in

[1] Evening discourse to the British Association at Montreal, on Friday August 29, 1884, by Oliver J. Lodge, Professor of Physics in University College, Liverpool

England, and terribly uphill will be the retracement of your steps. The old country has in many things made experiments for you—experiments of which you may reap the benefit, without repeating them, if you choose. The experiment of Protection, which we have tried and abandoned, I dare not here mention except just by name; but I dare mention the experiment we have tried only too successfully, and by no means yet abandoned though we groan under it—that of fouling the atmosphere, wherever a large number of human beings have to live in it, to such an extent that it is not fit to breathe. We have made a terrible mistake, and one that will take perhaps a century to undo. Tax all the necessaries of life and it is a small evil, for the tax may at any time by an Act of Parliament be removed, but pollute the air in which a people have to live and no one can see the end of the evil. You will soon have towns here rivalling Liverpool and Glasgow and Manchester in size, and some day London. Be warned in time.

However, in speaking of dust, I am not going to confine myself to such artificial dust as is made in towns, I shall include everything which Tyndall means when he calls it "the floating matter of the air," all diffused and floating foreign matter, fine or coarse. But the term "floating" is not free from possible misconception, and a better term than floating is sinking. If the two sound antagonistic, then floating was wrong. Foreign particles, whether solid or liquid, are not floating, and cannot float, in air; they are all necessarily sinking through it, and sinking at a well-defined and fairly calculable rate. Consider, for instance, the water globules of a fog, or mist, or cloud. The drops of water appear to float in air, but they are not floating, they are slowly settling down. They may in truth be buoyed up by convection currents, but they never move up *through* the air, they move up *with* the air to some extent, but are always slowly falling through it whether the air be moving or stationary. Are they then like a slowly-falling balloon or soap-bubble? No, they are not buoyed up at all—they are falling as fast as ever they can. Water is 800 times as heavy as air, and a drop of water falls under the influence of this enormous difference in weight. Why does it not fall faster? Just for the same reason as prevents an Atlantic liner from being propelled at 50 knots an hour—skin friction. A ship requires a great force to propel it at 15 knots an hour; break it up into small pieces and it will take vastly more; pound it into infinitely fine dust and it will require an infinite force to propel it at any slow pace. I do not say that a small body as it moves through a fluid experiences more resistance than a large one—it experiences less; but the decrease of resistance is not so rapid as the decrease of its bulk or weight, and consequently a small falling body is resisted more *in proportion to its weight* than a large one. Consider a bullet or a raindrop falling from a great height. As it falls it keeps moving quicker and quicker, but not without limit. Its weight remains constant, the resistance it meets with increases with its speed; hence there comes a time when the two balance and the body is in equilibrium. It then ceases to gain speed: it has attained its "terminal velocity." Even if thrown down faster than this it would slacken till it attained it. Now this terminal velocity is greater for a bullet than for a small shot, is greater for a large raindrop than for a small one, and for a mist globule is very small. The old idea concerning cloud globules, that they were hollow vesicles and therefore floated, is quite erroneous. They do not float, they sink. Slowly sinking particles, then, constitute dust, whether these particles be solid or liquid. Water dust is so important that it has various names, such as mist, fog, rain, cloud, and, in popular usage, steam.

Having now stated what dust is, the question presents itself, How did it get there? What are the sources of dust? There are certain human sources of dust—such as the traffic of towns, and the smoke of imperfect combustion. These produce coarse and heavy particles which never rise to a great height, nor float very far from their source: this dust may be regarded as mere dirt and filth. Besides this, however, a fine impalpable dust is produced by every terrestrial activity. The wind blowing through trees, the waves tossing up spray—all these natural activities disperse into the air very fine particles, which are upborne and carried so far from their source that they form quite a permanent part of the atmosphere. This fine natural dust is not limited to the lower atmospheric levels, but is almost equally abundant at great heights; to it we owe the blueness of the sky, and by it clouds and mists are rendered possible.

Another source of dust is found in volcanoes. During an eruption immense torrents of pumice and ashes are driven upwards to incredible heights, whence they slowly settle down again, the larger fragments sometimes covering the sea for acres with a thick floating deposit through which steamers slowly crunch their way, almost as if steering through land (see a graphic account in NATURE, signed Stanley M. Rendall, forwarded by Prof. Turner, vol. xxx. p. 288, July 24, 1884; see also vol. xxix. p. 375, abstract of paper by Capt. Vercker); the finer particles being carried hundreds of miles away from their source, and giving rise to brilliant appearances as they catch the solar rays—appearances recently observed over a great part of the world at sunset.

Yet another variety of dust is that which comes to us from ultra-terrestrial sources, fragments of interplanetary matter, cosmic or meteoric dust. You all know of the showers of falling stones—the August and November meteors; you know that these are lumps of interplanetary matter careering through space, mostly doubtless round the sun, but not aggregated together into planets. Cold lumps of iron they mostly seem to be, possibly fragments of some ancient world, possibly relics of the old nebulous world material, never yet aggregated into worlds at all. For ages they may have been rushing along, some almost isolated, others crowded together, and so they might rush on for millions of years; but a larger body bears down upon some of them; they feel the gravitative influence of the huge mass of a planet; they are deflected from their course notwithstanding their prodigious speed, and a few dip into its atmosphere. In an instant the terrific friction strips off their outer coat, scrapes and rubs the surface till it glows with a white heat; streams of white-hot particles are still scraped off, and form a luminous trail, but the white-hot masses plunge on: and one perhaps escapes to resume its wanderings, disturbed a little by its encounter but not destroyed; another may be rubbed to fragments altogether; another may be heated so rapidly and unequally as to explode; while another may enter the atmosphere at a more moderate velocity—may be heated indeed, and violently scraped, but not destroyed, and may embed itself in the ground, to be dug up by some peasant as a thunderbolt and to be preserved in some museum. The frayed particles of such meteors must constitute no inconsiderable portion of terrestrial dust; and since it comes from altogether extra-terrestrial sources, it is to us of most intense interest. One other visitant from other worlds we know of, and that is light. Light is found to be charged with information, though it took man many centuries to learn how to read it—first with the telescope, now with the spectroscope, and next with who shall say what still more potent revealer and analyser of hidden truth. Meteoric dust may not be so laden with information as light is—certainly we have not yet learnt to read it. It is only within the last few years that, at the instigation of Sir William Thomson, a Committee of Section A of the British Association was appointed to consider the question whether such dust could be collected and detected at all. Under the able and energetic guidance of Dr. Schuster, this Committee has done good work, and some dust from the ice-fields of the Himalayas and from Greenland has been definitely proved to be meteoric.

At present however no sign of organic matter or evidence of extra-terrestrial life has yet been detected in it, but any year this statement may have to be modified, and a discovery of the most intense interest may have to be announced. You have probably all heard of this theory of Sir William Thomson's, that some life germs may have been carried to the earth by a meteor, and you are probably equally well acquainted with the cheap ridicule the statement met with at the hands of newspaper article writers and the general public. It was derided as an absurd attempt to explain the origin of life. It was nothing of the kind. Nothing at all was said about the origin of life; it was a sober matter-of-fact statement that it was a scientific possibility for some organic germs or seeds to be conveyed to the earth by a meteor, to be rubbed off it at its first entrance into the atmosphere without getting overheated, and thence to slowly settle down as dust, and germinate. Well, it is a possibility, and it may before now have happened, and it may happen again, and very interesting it would be to be able to point to a case of its happening. But what then? If you account for the presence of a cherry-tree in your orchard by saying that it sprang from a cherry-stone dropped by a passing balloon, are you to be assailed as a full-blown explainer of the origin of all cherry-trees and of all forms of life?

You may take it as a fairly safe rule that when a statement is made by the highest living scientific authority, the statement may or may not be true, but it is not likely to be such abject nonsense that any newspaper article writer, in the interval between ten o'clock and midnight, can see all through it, detect its follies, and serve them up exposed for your breakfast edification.

Leaving the subject of meteoric dust now, and of the possibility of future discovery which may be wrapped up in it, let us proceed to ask, What is dust for—what purpose does it serve? We shall not enter upon the teleological inquiry, what was it intended to do; we shall simply ask what it does—a plainer, and for the most part a more instructive, question.

First, what is the function of human dust, such as is made in towns? One of its functions is to choke up the breathing organs, both of plants and animals; another is to propagate disease from place to place. It is one of the most important discoveries of this century, that infectious disease is due to the growth of a specific vegetable organism in the system, propagating itself like yeast in dough, or ferments in alcoholic liquors. The germs of these organisms float about in the air from place to place, and gain positions enabling them to enter the blood of some animal organism, say man, where they can grow and flourish, provided they are able to successfully encounter their mortal foes, the white corpuscles of the blood. If these white corpuscles are strong and vigorous, they will overpower the foreign growth, and kill it. If, on the other hand, they are weak and feeble, and the germs are very numerous, the foreign growth may get a secure footing and spread luxuriantly, changing the character of the fluids of the body, coagulating, it may be, the albumen, and otherwise setting up the unnatural and abnormal display of functions which we call disease. I have only to indicate thus much to exhibit to you the enormous field of knowledge and of inquiry which is involved in the discussion of the function of dust from this point of view.

But it is not my province to discuss this, and I must hasten on to more purely physical considerations, and must ask, What is the function of the fine impalpable dust or ultra-microscopic particles in the upper regions of the air? First of all, it is this which causes the blue of the sky and the diffusedness of daylight. I have not time to go into this. I will only state it, and pass on. You will find the rudiments of it beautifully expressed by Dr. Tyndall in his Lectures on Light, but it will take Lord Rayleigh to explain it to you completely.[1]

If the atmosphere were purely gaseous, and held no minute foreign bodies in suspension, the aspect of the sky would be utterly different from what it now is. The sun would glare down directly with blinding intensity, and objects not in direct sunlight would be in almost complete shadow. A room facing north would be in something like darkness; at least, it would be only illuminated by reflection from illuminated objects outside. The sun would be set in a black firmament, and if its direct light were screened off it would be easy to see the stars at noonday. (Through dust-free air light passes on without loss by scattering, and is quite invisible except to any eye placed directly in its course. [Tyndall's optically empty tube was here shown.] There is nothing remarkable in seeing nothing, when no dust or other reflecting body is present. When you see motes dancing in a sunbeam, it is not the motes which render the sunbeam visible, but the sunbeam the motes; and of course light is invisible which does not enter the eye.)

What is the actual state of things as contrasted with this? The sun's rays on reaching our atmosphere are partially intercepted, diffused, and scattered by myriads of most minute particles, so minute as to be even smaller than the light-waves themselves, and to act on the smallest of these waves more powerfully than on the largest. The light thus scattered is the diffuse daylight so entirely satisfactory and pleasant to the eye, and so inimitable by artificial systems of illumination. The light thus scattered has a preponderance of small waves, owing to the minute size of the scattering particles, and hence it affects our sight organ with the sensation of blue. By this scattered light shadows are mellowed, the intensity of direct sunlight is mitigated, and the whole expanse of sky glows with a perfect lustre, effectually drowning the light from the more distant celestial bodies. Above the top of a high mountain dust is almost absent, and there the sky has been observed at times to look almost black, and stars are sometimes visible in sunlight.

But besides the blue of the sky, we owe to this dust the possibility of clouds, which still further intercept and scatter the solar beams. "Cloud is visible vapour of water floating at a certain height in the air," says Mr. Ruskin[2]; but he is not quite right in his language. True vapour of water is invisible, and that which is visible is no longer vapour, but condensed vapour. It is vapour which has condensed to liquid—not to great masses of liquid, but to minute globules or spherules of liquid, so small as only to sink very slowly through the air. What makes the vapour condense into this water-dust form? Why does it not condense at once into great masses or sheets of water? Something there must be to start the condensation at multitudes of separate points, so that the vapour shall condense the instant it is saturated, without ever becoming supersaturated. Things that act in this way are called nuclei. Without a nucleus, it is as easy for a phenomenon to begin at one place as at another, and when that is the case it does not begin anywhere: there is no preponderating cause. Wherever there is a nucleus, however, there the action can begin; and in order that action may commence at an infinity of points at once, it is necessary that an infinity of nuclei exist. The action of nuclei is readily illustrated by the well-known experiment of a supersaturated solution of Glauber's salts. The solution remains liquid until a nucleus is introduced, when it becomes suddenly converted into a solid. (I don't say that it is clear *why* nuclei are able to start the action. What is there at the surface of discontinuity to make change of state easier there than anywhere else? It will take a bigger man than me to tell you that.[3])

[1] *Phil. Mag.*, August 1881. [2] "Storm Cloud" lecture, p. 12.

[3] Sir W. Thomson has partially indicated a reason for it in his theory of the effect of curvature of surface on vapour-tension. See Maxwell's "Heat," chap. xx. p. 268.

Now this sudden conversion is just what might happen in the case of the atmosphere, only the change of state would be from vapour to liquid. Picture to yourselves aqueous vapour accumulating and increasing in quantity in dust-free air, saturated, over-saturated, nothing to start the condensation; it goes on accumulating; the atmosphere becomes unbearably damp, soaking into and through everything. At length at some point something causes it to give way, and condensation takes place. Instantly it spreads from this point as from a centre, volumes of liquid are produced, and fall not as a shower but as a splash, deadly and destructive by the mere weight and impetus of its fall.

Instead of this, what really happens? The moisture, on becoming saturated, finds myriads of minute dust particles or nuclei, round which it condenses; the more numerous the nuclei, the more minute may be the globules of mist formed; it never becomes supersaturated at all. The instant it is saturated it begins to condense, and we have the mist or visible cloud, and in this form it may last for any length of time. Under certain influences, however, not yet fully understood, but which I wish in part to illustrate to-day, these minute globules may congregate into larger ones. Too large to remain slowly falling through the air, they begin to fall more quickly as their size increases, and we get the fine shower; or, if the aggregation goes on further, and the drops do not evaporate much as they fall, we have the heavy downpour, the thunderstorm, or the tropical deluge—all varieties of rainfall caused by the different size of the aggregated water globules.

Were there no nuclei, condensation would not begin, and were there but few nuclei, condensation could only begin at a few points, and a quite different kind of mist might present itself; one which would consist of comparatively large and rapidly sinking globules—small for raindrops, but large for mist globules, a kind intermediate between mist and rain, such a mist as is met with in clear moist climates, and known in England as a Scotch mist.

Note this, that to get a fine permanent fog, you must have an enormous number of centres of condensation. Mr. Aitken (*Trans. Roy. Soc. Edin.*, about 1879) established this fact, that every spherule of mist must have condensed itself round a minute solid dust particle, a nucleus, and that without such nuclei condensation could not go on. The minuteness of the nuclei able to act in this way is extreme, an almost immeasurably small quantity of matter being sufficient to precipitate a copious cloud. Their size is quite beyond a microscope.

[Mr. Aitken's experiment was here shown with apparatus from the Royal Institution. A long glass tube is filled with moist air, carefully filtered through cotton wool and glycerine, after Tyndall, and is then suddenly exhausted by an air-pump. It is thus cooled far below the dew point, but no precipitation occurs; and the tube, well illuminated, is seen to remain clear. Now ignite a platinum wire inside it with a few Grove cells, and let more filtered air enter. As soon as this is done exhaust again; instantly a thick cloud is precipitated, condensation occurring round myriads of nuclei given off from the platinum wire—which, however, has not appreciably lost weight. I wonder if this experiment could not give Sir Wm. Thomson a fifth limit to the size of atoms by estimating the loss of weight of the platinum spiral and the number of globules in the resulting mist.]

A familar illustration of the effect of nuclei on vapour is given by the simple experiment of writing on a pane of glass with a stick, and then breathing on it. Where the writing has wiped away the dust, the moisture condenses less easily and in much fewer and larger globules than where nuclei are abundant; consequently the writing becomes visible.

In studying the properties of any physical agent, it is essential to be able to employ it or exclude it at pleasure. One must have insulators to investigate electricity; one must perform optical experiments in a dark room; and to study the properties and functions of dust it is important to be able to remove it, and to obtain dust-free spaces.

Methods of removing dust from air are:—

(1) Filtration through cotton-wool, or cotton-wool and glycerine, packed tightly. Tyndall has shown how effective this can be made with proper management.

(2) Allowing it to settle. In a few days or a week most of the dust has settled out of stagnant air. Prof. Noel Hartley employed atmospheres of hydrogen in his old and careful experiments on "spontaneous generation," because it was too rare for germs to float in.

(3) Condensing vapour in the air several times. Mr. Aitken has shown that successive condensations of vapour gradually purify air by removal of nuclei, until it is quite clear. He shows that the ability of vapour to condense is an extremely delicate test of the presence of such nuclei, and that when the dust particles are very few, condensation takes place not as cloud but as fine rain or Scotch mist. Doubtless, the cause of actual Scotch mist is the clearness and purity of the Highland air induced by frequent and continued rains.

(4) Keeping a hot body in air for some time. This, Tyndall calls "calcining" the air.

(5) Discharging electricity into it from a point.

I must say a few words about the two last methods. When a hot body is held under a sunbeam, a dark stream of dust-free air is seen rising above it. This was discovered by Dr. Tyndall, and investigated by Lord Rayleigh, as well as by Mr. Clark and myself.[1] A hot spiral of platinum wire in a bell-jar produces this dust-free stream, and so gradually clarifies the air in the jar. That this is not due to combustion or evaporation we proved by using the smoke of burnt magnesium, which answers perfectly. Lord Rayleigh has shown that a cold body is similarly effective, and causes a *descending* dust-free stream.

We have found that the dust-free streamer is only a prolongation of a dust-free *coat* which surrounds all warm bodies. The dust is kept away from them by molecular bombardment. It has been shown by Tait and Dewar, and by Osborne Reynolds, that a Crookes bombardment is effective at even ordinary pressures provided the bodies bombarded are small. Dust particles are very small, and so they get driven by molecular impact away from hot surfaces and towards cold ones: the distance through which they are so driven away being easily measured by observing the thickness of the dust-free coat round an illuminated body at known temperature.[2] Two black tin vessels or glass flasks can be put under a bell-jar, one of the flasks full of warm water, the other of cold. On now burning magnesium, or otherwise filling the jar with smoke, the cold one will presently be found thickly covered with a deposit, the warm one will be nearly free. What Tyndall calls "calcining" the air, then, is really bombarding the dust out of it on to the cool wall surfaces. The deposition of lamp-black on a cold body held in a flame is thus explained. Whenever the air is warmer than bodies it deposits its dust and smoke upon them; whenever bodies are warmer than the air they keep the dust off, except when the weight of some of the larger particles is sufficient to overcome the bombardment; a thing which is very likely to happen on a horizontal and slightly warm surface.

[1] Mr. Aitken commenced the same investigation after reading my preliminary note of July 1883 in NATURE, and has followed it up in much the same way as we have, obtaining very similar results. I have just seen Mr. Aitken's paper in the *Trans. Roy. Soc. Edin.*, vol. xxxii. Part II. He therein criticises one or two of the views I somewhat hastily expressed in the preliminary note referred to. But our views were naturally modified by further experience, and in the complete paper in the *Phil. Mag.*, March 1884, they are more carefully expressed. It would have been better if I had not written to NATURE until the investigation was complete.

[2] See Lodge and Clark, *Phil. Mag.*, March 1884; also NATURE, July 26, 1883, vol. xxviii. p. 297, and April 24, 1884, vol. xxix. p. 612.

So we learn that the things in a room warmed by radiation (sunlight or open fire), because they are warmer than the air of the room, do not tend to get very dusty. But in a room warmed by hot piping or stoves, things are liable to get very dusty because the air is warmer than they are.

Finally, let us turn to electrical phenomena in dusty air. Just as a magnet polarises iron filings, and makes them attract each other and point out the lines of force, so an electrified body polarises dust particles, and makes them point out the lines of electrostatic force. It is therefore very interesting to watch electrical phenomena in illuminated smoky air.

The pyroelectric behaviour of tourmaline for instance is beautifully shown by the aggregation of dust in little bushes at the opposite poles of the crystal. Mica often exhibits strong electrical actions But perhaps the most curious thing of all is what happens when a brush discharge begins in such air. The violent and tumultuous action must be witnessed—it can hardly be described; but it does not last long, for in a few seconds every particle of dust has disappeared, condensed on the walls and floor of the vessel.

[An experiment of discharging from a point connected with one pole of a Voss machine into a bell-jar of illuminated magnesium smoke was then shown. It is a very easy experiment, and rather a striking one. A potential able to give quarter-inch or even one-tenth-inch spark is ample, and better than a higher one. The smoke particles very quickly aggregate into long filaments which point along the lines of force, and which drop by their own weight when the electrification is removed. A higher potential tears them asunder and drives them against the sides of the jar. A knob polarises the particles as well as a point, but does not clear the air of them so soon. If the bell-jar be filled with steam, electrification rapidly aggregates the globules into Scotch mist and fine rain.[1]]

This experiment shows how quickly air may be cleared of its solid constituents by a continuous electrical discharge. The fact may perhaps admit of practical application in clearing smoke-rooms, or disinfecting hospital air. It also must have a close bearing on the way in which "thunder clears the air," on thunder-showers, and perhaps on rain in general. Sir Wm. Thomson's "effect of curvature on vapour-tension" shows that large cloud globules increase at the expense of small ones, and so may gradually grow into raindrops; but under electrical influence rapid aggregation of drops must occur. The large drops so formed may be upheld by the electrical attraction of a strongly charged thunder-cloud, but as soon as the flash occurs, down they must come. Lord Rayleigh made some interesting observations on the effect of a feeble electrical charge in inducing a spreading water-jet to gather itself together (*Proc. Roy. Soc.*, No. 221, 1882); and Prof. Tait has pointed out in his lecture on Thunderstorms (NATURE, vol. xxii. pp. 339, 436) that aggregation of feebly charged drops into larger ones is of itself sufficient to raise their potential. One strongly charged cloud would thus act on another, aggregating its drops, and so raising its potential until a flash is a necessity.[2]

It seems not impossible that some use may be made of this aggregating power of electricity on small bodies, such as smoke particles and mist globules. In coming to this country we lay for some hours outside the Straits of Belle Isle in the midst of icebergs mingled with fog. Icebergs alone are not dangerous but beautiful. Fog is an unmitigated nuisance. Electric light is powerless to penetrate it; and it was impossible, as we lay there idle, not to be struck with the advisability of dissipating it. It is rash to predict what can be done, it is still rasher to predict what can not. I would merely point out that on board a steamer are donkey-engines, and that these engines can drive a very powerful Holtz or Wimshurst machine, one pole of which may be led to points on the masts. When electricity is discharged into fog on a small scale, it coagulates into globules and falls as rain—perhaps it will on a large scale too. Oil stills the ripples of a pond, and it has an effect on ocean billows; just so an electric discharge, which certainly coagulates and precipitates smoke or steam in a bell-jar, may possibly have an effect on an Atlantic fog. I am not too sanguine, but it would not cost much to try, and even if it only kept a fairly clear space near the ship, it would be useful. There are other possible applications of this electrical clearing or deposition of dust, but I am not here to talk of practical applications but of science itself. A homely proverb may be paraphrased into a useful motto for young investigators. Stick to the pure science and the applications will take care of themselves. I am not one to decry the applications of science for the benefit of mankind, far from it, but while the rewards of industrial applications are obvious and material, and such as will always secure an adequate following, the rewards of the pursuit of science for its own sake are transcendental and immaterial, and not to be imagined except by the few called to the work. That call entails labour and self-sacrifice beyond most other, but they who receive it will neglect it at their peril.

[1] I find that unless one claims a lecture experiment it is commonly treated as a *rechauffée*. It is pardonable, therefore, and indeed only due to Mr. Clark, who has been associated with me in the dust research, to state that these observations are original. A small cellar can be cleared of thick turpentine smoke pretty quickly by a point discharge.

[2] If the initial potential of the second cloud were opposite to that of the first, the spark would pass between the two clouds: if it were similar, its rise would raise the potential of the first cloud, and so cause it to spark into something else.

HEREDITARY DEAFNESS[1]

THE startling title of Mr. Graham Bell's admirable memoir is fully justified by its contents. It appears that there are upwards of 33,000 deaf mutes in America, mostly collected in large institutions forming social worlds of their own, whose inmates intermarry or else contract marriages with the hearing relatives of their fellow pupils, who themselves, in many cases, must have an hereditary though latent tendency to deafness. This state of things has been going on increasingly for two or more generations, with the result that congenital deafness, which in other countries appears sporadically, and mostly fails to obtain an hereditary footing, has become artificially preserved in America, and is intensified by inter-marriages, until a deaf variety of the human race may be said to be established. There can be no question, after reading the mass of evidence submitted by Mr. Graham Bell, of the general truth of this summary statement. That precise knowledge that we should be glad to possess, of the strength and peculiarity of the hereditary taint, is unfortunately unattainable owing to the imperfection of the records kept at the institutions of the after history of their pupils; but the data, such as they are, have been handled with great statistical skill by the author, so that he has squeezed all the information out of them that they appear competent to give.

We may now go a little more into details. It appears that out of six asylums, with an aggregate of 5823 pupils, 29·5 per cent. have deaf relatives. Also that nearly half the pupils contract marriages, and that 80 per cent. of those who do so, marry together. This ratio of intermarriage is much greater than it was at the beginning of the century, and it appears to have steadily increased from then up to the present time It is unfortunate that the imperfection of the records kept at the institutions make it difficult to ascertain the exact rate of the increase or the precise fate of the issue of all the marriages. This latter fact may, however, be estimated by working back-

[1] "Upon the Formation of a Deaf Variety of the Human Race," by Alexander Graham Bell, National Academy of Sciences, New Haven, U.S.A., November 13, 1883.