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The Importance of Dust: A Source of Beauty and Essential to Life (1898)

Alfred Russel Wallace

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By Alfred Russel Wallace

Transcribed and Edited by Charles H. Smith, Ph.D.

This essay, incongruously slipped into his book The Wonderful Century in 1898, represents one of the best examples of Wallace's talent as a popular expositor. Transcribed from the Swan Sonnenschein & Co. edition of 1898. Original pagination indicated within double brackets. See more information on Wallace at The Alfred Russel Wallace Page, at: http://web2.wku.edu/~smithch/index1.htm

[[p. 69]] When the lamp is shattered,
The light in the dust lies dead;
When the cloud is scattered,
The rainbow's glory is shed.
—*Shelley.*

How beautiful is the rain!
After the dust and heat,
In the broad and fiery street,
In the narrow lane,
How beautiful is the rain!
—*Longfellow.*

The majority of persons, if asked what were the uses of dust, would reply that they did not know it had any, but they were sure it was a great nuisance. It is true that dust, in our towns and in our houses is often not only a nuisance but a serious source of disease; while in many countries it produces ophthalmia, often resulting in total blindness. Dust, however, as it is usually perceived by us, is, like dirt, only matter in the wrong place, and whatever injurious or disagreeable effects it produces are largely due to our own dealings with nature. So soon as we dispense with horse-power and adopt purely mechanical means of traction and conveyance, we can almost wholly abolish disease-bearing dust from our streets, and ultimately from all our highways; while another kind of dust, that caused by the imperfect combustion of coal, may be got rid of with equal facility so [[p. 70]] soon as we consider pure air, sunlight, and natural beauty to be of more importance to the population as a whole than are the prejudices or the vested interests of those who produce the smoke.

But though we can thus minimize the dangers and the inconveniences arising from the grosser forms of dust, we cannot wholly abolish it; and it is, indeed, fortunate we cannot do so, since it has now been discovered that it is to the presence of dust we owe much of the beauty, and perhaps even the very habitability, of the earth we live upon. Few of the fairy tales of science are more marvellous than these recent discoveries as to the varied effects and important uses of dust in the economy of nature.

The question why the sky and the deep ocean are both blue did not much concern the earlier physicists. It was thought to be the natural color of pure air and water, so pale as not to be visible when small quantities were seen, and only exhibiting its true tint when we looked through great depths of atmosphere or of organic water. But this theory did not explain the familiar facts of the gorgeous tints seen at sunset and sunrise, not only in the atmosphere and on the clouds near the horizon, but also in equally resplendent hues when the invisible sun shines upon Alpine peaks and snowfields. A true theory should explain all these colors, which comprise almost every tint of the rainbow.

The explanation was found through experiments on the visibility or non-visibility of air, which were made by the late Professor Tyndall about the year 1868. Everyone has seen the floating dust in a sunbeam when sunshine enters a partially darkened room; but it is not [[p. 71]] generally known that if there was absolutely no dust in the air the path of the sunbeam would be totally black and invisible, while if only very little dust was present in very minute particles the air would be as blue as a summer sky.

This was proved by passing a ray of electric light lengthways through a long glass cylinder filled with air of varying degrees of purity as regards dust. In the air of an ordinary room, however clean and well ventilated, the interior of the cylinder appears brilliantly illuminated. But if the cylinder is exhausted and then filled with air which has passed slowly through a fine gauze of intensely heated platinum wire, so as to burn up all the floating dust particles, which are mainly organic, the light will pass through the cylinder without illuminating the interior, which, viewed laterally, will appear as if filled with a dense black cloud. If, now, more air is passed into the cylinder through the heated gauze, but so rapidly that the dust particles are not wholly consumed, a slight blue haze will begin to appear, which will gradually become a pure blue, equal to that of a summer sky. If more and more dust particles are allowed to enter, the blue becomes paler, and gradually changes to the colorless illumination of the ordinary air.

The explanation of these phenomena is that the number of dust particles in ordinary air is so great that they reflect abundance of light of all wave-lengths, and thus cause the interior of the vessel containing them to appear illuminated with white light. The air which has passed slowly over white-hot platinum has had the dust particles destroyed, thus showing that they were almost wholly of organic origin, which is also indicated by their [[p. 72]] extreme lightness, causing them to float permanently in the atmosphere. The dust being thus got rid of, and pure air being entirely transparent, there is nothing in the cylinder to reflect the light which is sent through its centre in a beam of parallel rays, so that none of it strikes against the sides; hence the inside of the cylinder appears absolutely dark. But when all the larger dust particles are wholly or partially burnt, so that only the very smallest fragments remain, a blue light appears, because these are so minute as to reflect chiefly the more refrangible rays, which are of shorter wave-length—those at the blue end of the spectrum, which are thus scattered in all directions, while the red and yellow rays pass straight on as before.

We have seen that the air near the earth's surface is full of rather coarse particles which reflect all the rays, and which therefore produce no one color. But higher up the particles necessarily become smaller and smaller, since the comparatively rare atmosphere will only support the very smallest and lightest. These exist throughout a great thickness of air, perhaps from one mile to ten miles high or even more, and blue or violet rays being reflected from the innumerable particles in this great mass of air, which is nearly uniform in all parts of the world as regards the presence of minute dust particles, produces the constant and nearly uniform tint we call sky-blue. A certain amount of white or yellow light is no doubt reflected from the coarser dust in the lower atmosphere, and slightly dilutes the blue and renders it not quite so deep and pure as it otherwise would be. This is shown by the increasing depth of the sky-color when seen from the tops of lofty

mountains, [[p. 73]] while from the still greater heights attained in balloons the sky appears of a blue-black color, the blue reflected from the comparatively small amount of dust particles being seen against the intense black of stellar space. It is for the same reason that the "Italian skies" are of so rich a blue, because the Mediterranean Sea on one side and the snowy Alps on the other do not furnish so large a quantity of atmospheric dust in the lower strata of air as in less favorably situated countries, thus leaving the blue reflected by the more uniformly distributed fine dust of the higher strata undiluted. But these Mediterranean skies are surpassed by those of the central Pacific ocean, where, owing to the small area of land, the lower atmosphere is more free from coarse dust than any other part of the world.

If we look at the sky on a perfectly fine summer's day, we shall find that the blue color is the most pure and intense overhead, and when looking high up in a direction opposite to the sun. Near the horizon it is always less bright, while in the region immediately round the sun it is more or less yellow. The reason of this is that near the horizon we look through a very great thickness of the lower atmosphere, which is full of the larger dust particles reflecting white light, and this dilutes the pure blue of the higher atmosphere seen beyond. And in the vicinity of the sun a good deal of the blue light is reflected back into space by the finer dust, thus giving a yellowish tinge to that which reaches us reflected chiefly from the coarse dust of the lower atmosphere. At sunset and sunrise, however, this last effect is greatly intensified, owing to the great thickness of the strata of air through which the light reaches us. The enormous [[p. 74]] amount of this dust is well shown by the fact that, then only, we can look full at the sun, even when the whole sky is free from clouds and there is no apparent mist. But the sun's rays then reach us after having passed, first, through an enormous thickness of the higher strata of the air, the minute dust of which reflects most of the blue rays away from us, leaving the complementary yellow light to pass on. Then, the somewhat coarser dust reflects the green rays, leaving a more orange colored light to pass on; and finally some of the yellow is reflected, leaving almost pure red. But owing to the constant presence of air currents, arranging both the dust and vapor in strata of varying extent and density, and of high or low clouds, which both absorb and reflect the light in varying degrees, we see produced all those wondrous combinations of tints and those gorgeous ever-changing colors, which are a constant source of admiration and delight to all who have the advantage of an uninterrupted view to the west, and who are accustomed to watch for these not unfrequent exhibitions of nature's kaleidoscopic color-painting. With every change in the altitude of the sun the display changes its character; and most of all when it has sunk below the horizon, and, owing to the more favorable angles, a larger quantity of the colored light is reflected toward us. Especially when there is a certain amount of cloud is this the case. These, so long as the sun was above the horizon, intercepted much of the light and color; but, when the great luminary has passed away from our direct vision, his light shines more directly on the under sides of all the clouds and air strata of different densities; a new and more brilliant light flushes the western sky, and a dis- [[p. 75]] play of gorgeous ever-changing tints occurs which are at once the delight of the beholder and the despair of the artist. And all this unsurpassable glory we owe to—dust!

A remarkable confirmation of this theory was given during the two or three years after the great eruption of Krakatoa, near Java. The volcanic *débris* was shot up from the crater many miles high, and the heavier portion of it fell upon the sea for several hundred miles around, and was found to be mainly composed of very thin flakes of volcanic glass. Much of this was of course ground to impalpable dust by the violence of the discharge, and was carried up to a height of many miles. Here it was caught by the return current of air continually flowing northward and southward above the equatorial zone; and as these currents reach the temperate zone where the surface rotation of the earth is less rapid they continually flow eastward, and the fine dust was thus carried at a great altitude completely round the earth. Its effects were traced some months after the eruption in the appearance of brilliant sunset glows of an exceptional character, often flushing with crimson the whole western half of the visible sky. These glows continued in diminishing

splendor for about three years; they were seen all over the temperate zone, and it was calculated that, before they finally disappeared, some of this fine dust must have travelled three times round the globe.

The same principle is thought to explain the exquisite blue color of the deep seas and oceans and of many lakes and springs. Absolutely pure water, like pure air, is colorless, but all seas and lakes, however clear and [[p. 76]] translucent, contain abundance of very finely divided matter, organic or inorganic, which, as in the atmosphere, reflects the blue rays in such quantity as to overpower the white or colored light reflected from the fewer and more rapidly sinking particles of larger size. The oceanic dust is derived from many sources. Minute organisms are constantly dying near the surface, and their skeletons, or fragments of them, fall slowly to the bottom. The mud brought down by rivers, though it cannot be traced on the ocean floor more than about 150 miles from land, yet no doubt furnishes many particles of organic matter which are carried by surface currents to enormous distances and are ultimately dissolved before they reach the bottom. A more important source of finely divided matter is to be found in volcanic dust which, as in the case of Krakatoa, may remain for years in the atmosphere, but which must ultimately fall upon the surface of the earth and ocean. This can be traced in all the deep-sea oozes. Finally there is meteoric dust, which is continually falling to the surface of the earth, but in such minute quantities and in such a finely-divided state that it can only be detected in the oozes of the deepest oceans, where both inorganic and organic *débris* is almost absent.

The blue of the ocean varies in different parts from a pure blue somewhat lighter than that of the sky, as seen about the northern tropic in the Atlantic, to a deep indigo tint, as seen in the north temperate portions of the same ocean: due, probably, to differences in the nature, quantity, and distribution of the solid matter which causes the color. The Mediterranean, and the deeper Swiss lakes are also blue of various tints, due [[p. 77]] also to the presence of suspended matter, which Professor Tyndall thought might be so fine that it would require ages of quiet subsidence to reach the bottom. All the evidence goes to show, therefore, that the exquisite blue tints of sky and ocean, as well as all the sunset hues of sky and cloud, of mountain peak and alpine snows, are due to the finer particles of that very dust which, in its coarser forms, we find so annoying and even dangerous.

But if this production of color and beauty were the only useful function of dust, some persons might be disposed to dispense with it in order to escape its less agreeable effects. It has, however, been recently discovered that dust has another part to play in nature; a part so important that it is doubtful whether we could even live without it. To the presence of dust in the higher atmosphere we owe the formation of mists, clouds, and gentle beneficial rains, instead of waterspouts and destructive torrents.

It is barely twenty years ago since the discovery was made, first in France by Coulier and Mascart, but more thoroughly worked out by Mr. John Aitken in 1880. He found that if a jet of steam is admitted into two large glass receivers,—one filled with ordinary air, the other with air which has been filtered through cotton wool so as to keep back all particles of solid matter,—the first will be instantly filled with condensed vapor in the usual cloudy form, while the other vessel will remain quite transparent. Another experiment was made, more nearly reproducing what occurs in nature. Some water was placed in the two vessels prepared as before. When [[p. 78]] the water had evaporated sufficiently to saturate the air the vessels were slightly cooled, when a dense cloud was at once formed in the one while the other remained quite clear. These experiments, and many others, showed that the mere cooling of vapor in air will not condense it into mist clouds or rain, unless *particles of solid matter* are present to form *nuclei* upon which condensation can begin. The density of the cloud is proportionate to the number of the particles; hence the fact that the steam issuing from the safety-valve or the chimney of a locomotive forms a

dense white cloud shows that the air is really full of dust particles, most of which are microscopic but none the less serving as centres of condensation for the vapor. Hence, if there were no dust in the air, escaping steam would remain invisible; there would be no clouds in the sky; and the vapor in the atmosphere, constantly accumulating through evaporation from seas and oceans and from the earth's surface, would have to find some other means of returning to its source.

One of these modes would be the deposition of dew, which is itself an illustration of the principle that vapor requires solid or liquid surfaces to condense upon; hence dew forms more readily and more abundantly on grass, on account of the numerous centres of condensation it affords. Dew, however, is now formed only on clear cold nights after warm or moist days. The air near the surface is warm and contains much vapor, though below the point of saturation. But the innumerable points and extensive surfaces of grass radiate heat quickly, and becoming cool, lower the temperature of the adjacent air, which then reaches saturation point and condenses the contained vapor on the grass. Hence, if the atmosphere at [[p. 79]] the earth's surface became super-saturated with aqueous vapor, dew would be continuously deposited, especially on every form of vegetation, the result being that everything, including our clothing, would be constantly dripping wet. If there were absolutely no particles of solid matter in the upper atmosphere, all the moisture would be returned to the earth in the form of dense mists, and frequent and copious dews, which in forests would form torrents of rain by the rapid condensation on the leaves. But if we suppose that solid particles were occasionally carried higher up through violent winds or tornadoes, then on those occasions the super-saturated atmosphere would condense rapidly upon them, and while falling would gather almost all the moisture in the atmosphere in that locality, resulting in masses or sheets of water, which would be so ruinously destructive by the mere weight and impetus of their fall that it is doubtful whether they would not render the earth almost wholly uninhabitable.

The chief mode of discharging the atmospheric vapor in the absence of dust would, however, be by contact with the higher slopes of all mountain ranges. Atmospheric vapor, being lighter than air, would accumulate in enormous quantities in the upper strata of the atmosphere, which would be always super-saturated and ready to condense upon any solid or liquid surfaces. But the quantity of land comprised in the upper half of all the mountains of the world is a very small fraction of the total surface of the globe, and this would lead to very disastrous results. The air in contact with the higher mountain slopes would rapidly discharge its water, which would run down the mountain sides in torrents. This [[p. 80]] condensation on every side of the mountains would leave a partial vacuum which would set up currents from every direction to restore the equilibrium, thus bringing in more super-saturated air to suffer condensation and add its supply of water, again increasing the in-draught of more air. The result would be that winds would be constantly blowing toward every mountain range from all directions, keeping up the condensation and discharging, day and night and from one year's end to another, an amount of water equal to that which falls during the heaviest tropical rains. The whole of the rain that now falls over the whole surface of the earth and ocean, with the exception of a few desert areas, would then fall only on rather high mountains or steep isolated hills, tearing down their sides in huge torrents, cutting deep ravines, and rendering all growth of vegetation impossible. The mountains would therefore be so devastated as to be uninhabitable, and would be equally incapable of supporting either vegetable or animal life.

But this constant condensation on the mountains would probably check the deposit on the lowlands in the form of dew, because the continual up-draught toward the higher slopes would withdraw almost the whole of the vapor as it rose from the oceans and other water-surfaces, and thus leave the lower strata over the plains almost or quite dry. And if this were the case there would be no vegetation, and therefore no animal life, on the plains and lowlands, which would thus be all arid deserts cut through by the great rivers formed by the meeting together of the

innumerable torrents from the mountains.

Now, although it may not be possible to determine [[p. 81]] with perfect accuracy what would happen under the supposed condition of the atmosphere, it is certain that the total absence of dust would so fundamentally change the meteorology of our globe as, not improbably, to render it uninhabitable by man, and equally unsuitable for the larger portion of its existing animal and vegetable life.

Let us now briefly summarize what we owe to the universality of dust, and especially to that most finely divided portion of if which is constantly present in the atmosphere up to the height of many miles. First of all it gives us the pure blue of the sky, one of the most exquisitely beautiful colors in nature. It gives us also the glories of the sunset and the sunrise, and all those brilliant hues seen in high mountain regions. Half the beauty of the world would vanish with the absence of dust. But, what is far more important than the color of sky and beauty of sunset, dust gives us also diffused daylight, or skylight, that most equable, and soothing, and useful, of all illuminating agencies. Without dust the sky would appear absolutely black, and the stars would be visible even at noonday. The sky itself would therefore give us no light. We should have bright glaring sunlight or intensely dark shadows, with hardly any half-tones. From this cause alone the world would be so totally different from what it is that all vegetable and animal life would probably have developed into very different forms, and even our own organization would have been modified in order that we might enjoy life in a world of such harsh and violent contrasts.

In our houses we should have little light except when the sun shone directly into them, and even then every [[p. 82]] spot out of its direct rays would be completely dark, except for light reflected from the walls. It would be necessary to have windows all round and the walls all white; and on the north side of every house a high white wall would have to be built to reflect the light and prevent that side from being in total darkness. Even then we should have to live in a perpetual glare, or shut out the sun altogether and use artificial light as being a far superior article.

Much more important would be the effects of a dust-free atmosphere in banishing clouds, or mist, or the “gentle rain of heaven,” and in giving us in their place perpetual sunshine, desert lowlands, and mountains devastated by unceasing floods and raging torrents, so as, apparently, to render all life on the earth impossible.

There are a few other phenomena, apparently due to the same general causes, which may here be referred to. Everyone must have noticed the difference in the atmospheric effects and general character of the light in spring and autumn, at times when the days are of the same length, and consequently when the sun has the same altitude at corresponding hours. In spring we have a bluer sky and greater transparency of the atmosphere; in autumn, even on very fine days, there is always a kind of yellowish haze, resulting in a want of clearness in the air and purity of color in the sky. These phenomena are quite intelligible when we consider that during winter less dust is formed, and more is brought down to the earth by rain and snow, resulting in the transparent atmosphere of spring, while exactly opposite conditions during summer bring about the mellow autumnal light. Again, the well-known beneficial [[p. 83]] effects of rain on vegetation, as compared with any amount of artificial watering, though, no doubt, largely due to the minute quantity of ammonia which the rain brings down with it from the air, must yet be partly derived from the organic or mineral particles which serve as the nuclei of every raindrop, and which, being so minute, are more readily dissolved in the soil and appropriated as nourishment by the roots of plants.

It will be observed that all these beneficial effects of dust are due to its presence in such quantities as are produced by natural causes, since both gentle showers as well as ample rains and

deep blue skies are present throughout the vast equatorial forest districts, where dust-forming agencies seem to be at a minimum. But in all densely-populated countries there is an enormous artificial production of dust—from our ploughed fields, from our roads and streets, where dust is continually formed by the iron-shod hoofs of innumerable horses, but chiefly from our enormous combustion of fuel pouring into the air volumes of smoke charged with unconsumed particles of carbon. This superabundance of dust, probably many times greater than that which would be produced under the more natural conditions which prevailed when our country was more thinly populated, must almost certainly produce some effect on our climate; and the particular effect it seems calculated to produce is the increase of cloud and fog, but not necessarily any increase of rain. Rain depends on the supply of aqueous vapor by evaporation; on temperature, which determines the dew point; and on changes in barometric pressure, which determine the winds. There is probably always and everywhere enough atmospheric dust [[p. 84]] to serve as centres of condensation at considerable altitudes, and thus to initiate rainfall when the other conditions are favorable; but the presence of increased quantities of dust at the lower levels must lead to the formation of denser clouds, although the minute water-vesicles cannot descend as rain, because, as they pass down into warmer and dryer strata of air, they are again evaporated.

Now, there is much evidence to show that there has been a considerable increase in the amount of cloud, and consequent decrease in the amount of sunshine, in all parts of our country. It is an undoubted fact that in the Middle Ages England was a wine-producing country, and this implies more sunshine than we have now. Sunshine has a double effect, in heating the surface soil and thus causing more rapid growth, besides its direct effect in ripening the fruit. This is well seen in Canada, where, notwithstanding a six months' winter of extreme severity, vines are grown as bushes in the open ground, and produce fruit equal to that of our ordinary greenhouses. Some years back one of our gardening periodicals obtained from gardeners of forty or fifty years' experience a body of facts clearly indicating a comparatively recent change of climate. It was stated that in many parts of the country, especially in the north, fruits were formerly grown successfully and of good quality in gardens where they cannot be grown now; and this occurred in places sufficiently removed from manufacturing centres to be unaffected by any direct deleterious influence of smoke. But an increase of cloud, and consequent diminution of sunshine, would produce just such a result; and this increase is almost certain to have [[p. 85]] occurred, owing to the enormously increased amount of dust thrown into the atmosphere as our country has become more densely populated, and especially owing to the vast increase of our smoke-producing manufactories. It seems highly probable, therefore, that to increase the wealth of our capitalist-manufacturers we are allowing the climate of our whole country to be greatly deteriorated in a way which diminishes both its productiveness and its beauty, thus injuriously affecting the enjoyment and the health of the whole population, since sunshine is itself an essential condition of healthy life. When this fact is thoroughly realized we shall surely put a stop to such a reckless and wholly unnecessary production of injurious smoke and dust.

In conclusion, we find that the much-abused and all-pervading dust, which, when too freely produced, deteriorates our climate and brings us dirt, discomfort, and even disease, is, nevertheless, under natural conditions, an essential portion of the economy of nature. It gives us much of the beauty of natural scenery as due to varying atmospheric effects of sky, and cloud, and sunset tints, and thus renders life more enjoyable; while, as an essential condition of diffused daylight and of moderate rainfalls combined with a dry atmosphere, it appears to be absolutely necessary for our existence upon the earth, perhaps even for the very development of terrestrial, as opposed to aquatic life. The overwhelming importance of the small things, and even of the despised things, of our world has never, perhaps, been so strikingly brought home to us as in these recent investigations into the widespread and far-reaching beneficial influences of Atmospheric Dust.