STRAY LEAVES OF SCIENCE

AND

FOLK-LORE.

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FOLK-LORE.

BY

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STRAND.

1870.

TO THE

RIGHT HONOURABLE THE EARL OF DERBY.

My Lord,

Dedications, I am informed by critical people versed in the study of fashion, are out of date. To one like myself, who never professed to move with fashion, that does not signify much. I dedicate these Stray Leaves to your Lordship out of respect for the advanced and generous sentiments conveyed by your Lordship's public utterances, and in recognition of some trouble your Lordship willingly undertook in a matter concerning myself.

I have the honour to be,

My Lord,

Your Lordship's most obedient Servant,

JOHN SCOFFERN, M.B. Lond.

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PREFACE.

If any reader of these 'Stray Leaves' has ever been in a wine-merchant's office, when wines were tasted in quick succession, sample after sample, he will have seen a dry biscuit, and perhaps a bit of cheese, interposed, to blunt one distinctive flavour before judging of the next.

A similar office has been performed by my contributions on folk-lore and science, to various magazines; in which judicious editors are wont to interpose small condimentary fragments of distinctive taste, to freshen the literary palate for deeper and more important subjects of mental culture.

When an individual accepts without murmur his destiny, not envying his betters, but honestly striving to do his duty in the position to which it has pleased God to call him, criticism should stand disarmed. I ask an indulgent public to take the following *Stray Leaves of Science and Folk-Lore* for what they are. Preadamite man, extinct species, spectrum analysis, and such-like minor topics, can advance no just claim to equality of interest or utility with fictional renderings of murder, bigamy, and divorce-trials: of that no one better than myself is aware. I doubt whether they can even claim equality with a well-idealised record of petty larceny. Things small and mean have their uses in God's coördination, notwithstanding. My 'Stray Leaves' have done some service on the biscuit-and-cheese principle when serially published in magazines. Their author craves permission for the modest hope that in this collected and corrected form their utility may not be less.

Mainly selected from the *Leisure Hour* (in which my papers have taken substantive rank, scientific instruction being one of the specialities of that periodical), from the *Dublin University Magazine*, from *Belgravia*, *Temple Bar*, *Tinsleys'*, *St. James's*, and *Chambers's Journal*, my 'Stray Leaves,' in this their present form, have been grouped under appropriate headings, and the scientific points brought up to the cognisance of the times. In this way the attempt has been made to give a continuity and a solidity to the theses, which the exigencies of periodical appearance sometimes do not admit of. That the science is correct, so far as it goes, I know; that the folk-lore has the warranty of authentic records, I also know, having collated it from accredited documents. The idea of giving authorities in foot-notes did once suggest itself, but was abandoned for two reasons. It might have seemed pedantic, for the first reason; and secondly, the volume would have expanded into inconvenient bulk.

Were I conceited enough to think the memory of these papers might linger in the public mind, I should expect some benevolent critic to remind me of the fact, that certain of them have appeared under names and initials not my own. They are mine not the less. On some occasions it may be prudent to escape at once the enmity of enemies—and what is still more important, the friendship of friends—by the innocent device of feigned signatures; of which, were this a day of confession, I should have to acknowledge many.

Stray Leaves of Science & Folk-Lore.

POPULAR SCIENCE.

Many circumstances prove that a taste has arisen for scientific information, if not scientific study, beyond that of any antecedent period. Popular magazines, the standard matter of which is assumed to be fiction, nevertheless find room occasionally for scientific papers. Scientific lectures are generally well attended, if only the lecturer be competent; and here the fact should be heeded, that in proportion as a lecturer is more deeply versed in the subject on which he treats, so does he commend himself to an audience. It is worth while to investigate the causes of this change; for undoubtedly it is a change, and it is rather sudden. Not by all is this change accepted at one even value. Whilst some persons deprecate the scientific spirit, associating it with some notion of irreligion, or at the least free-thinking, others foster the spirit as one calculated to elevate the mind to conceptions of the Deity such as the mind of an individual unacquainted with science can never aspire to. Meantime science advances, drawing within its ranks men of pure minds and high theological training. The time has come when, if members of the clergy be sought to deprecate scientific culture, they cannot be found in the very highest clerical ranks. Upon the laity science has imposed a yet stronger hold. Oxford and Cambridge, abandoning their ancient principle of exclusive devotion to the dead languages and pure mathematics, have fallen in with the sentiment of the day. Both Oxford and Cambridge have established good chemical laboratories, and the collateral science of geology has been studied at Cambridge with a devotion and freedom from theological bias eminently characteristic of the spirit of the times. Some explanation may be found for the scientific tendencies of the age in practical utilitarianism—men being induced to study science for what it may bring; and much as it is the custom to deprecate this incentive, still the concession must be granted that practical utility is one not unworthy the aspiration of mankind. Some confusion exists as to the meaning of this word 'utility,' and a loose way of expression in respect to it has become usual;—one it may be worth while to dispose of.

If a man could bring himself to believe that any specified branch of knowledge, acquired through scientific inquiry, was actually useless, and ever must be—then, I apprehend, he would not be justified in giving time to its study. The fact is, he does *not* believe this: he cannot believe this; the assumption would be wholly adverse to every teaching of periods gone by. No words are, perhaps, more ill-applied than 'practical' and 'unpractical' in respect to science. The history of science shows that facts, the utility of which could not only not be seen at the time, but not for long ages after the time in some cases, have at length been turned to the most material account. No science is more rich in these examples than chemistry, understanding that science, as is usual in England, to comprehend electricity and certain other branches of physics as well. The example of the electric telegraph has been so frequently adduced in support of this, that I almost hesitate to adduce it; still, to omit that illustration would be a mistake in such an argument as we are upon. When the Danish philosopher Œrsted, in 1819, proved that an electric current travelling in any one direction deflected a magnetic needle at right angles to itself, no sort of use for this discovery was at the time apparent. It seemed to be in the list of things popularly called useless. Nevertheless, in time—and, for a discovery to take effect, no long time—it culminated in one form of the electric telegraph. Then, again, when Faraday proved, that by winding an insulated wire around an iron bar, and transmitting electricity through the wire, the bar was instantaneously converted into a powerful magnet, he laid the foundation of other varieties of the electric telegraph; and the electricians who, before his time, proved that electricity could be made to develop colour in a chemical salt furnished a principle on which is based a third variety. Up to this day all the electric telegraphs made or proposed—whether to indicate by bell-ringing, dial-work, actual printing in ordinary letters, printing by accepted signs, or telling their tale by change of colour (and electric telegraphs can do all this)—are but developments of three electrical functions that, when discovered, seemed as far from useful application as well might be. Take electrotype, again; the beautiful process whereby a thin layer of gold, silver, or other metal may be deposited on a conducting surface; consider the numerous practical applications of this art, the manifold ways in which it conduces to the utilities of life: the principle on which it depends was known some time before any practical application became apparent.

A very remarkable application of science, that seemed remote from any human need, is even now taking place to most utilitarian purposes. After the decisive proof offered by Dr. Tyndall at a Friday-evening Royal-Institution lecture, that air can be mechanically purified from dust by transmission through a filter of cotton-wool, it is impossible the demonstration can stop short of effecting a rational means of ventilation. Hitherto, ventilative contrivances of whatever kind have merely had the end in view of admitting to apartments atmospheric air *as* pure, but *no* purer than the atmosphere without, or, at the very utmost, separating the gross fuliginous particles due to smoke by a rude contrivance of filtration, as was accomplished by Dr. Reid in the new Houses of Parliament. It is impossible after recent discoveries that ventilation can remain at that point of immature development. When certain facts in the history of atmospheric physical analysis shall have been laid before the reader in something like the order of their succession, the practical bearing of Dr. Tyndall's late illustrations will become apparent. There is a certain class of phenomena known to experimentalists by the general name of 'catalysis;' a word of indefinite meaning, almost equivalent to an admission that the so-called catalytic function was not understood at all. Some catalytic agencies refer to the inorganic, others to the organic, kingdom; but the time seems almost come, if it is not already come, for abandoning the idea of organic catalysis altogether.

Not many years ago the change of sugar to alcohol under the action of yeast was said to be a catalytic change; in other words, that the yeast acted as a ferment by mere contact in some inscrutable way. About the year 1836, however, the discovery was made that the transmutation was an organic change due to the growth of certain minute fungi, none the less real because they were minute. Proceeding from this starting-point, microscopists soon found that whenever any sort of fermentation or decay occurred, myriads of small living beings—in some cases vegetable, in others animal, in yet others indeterminate—were to be found. Thus, if beef-tea be set aside in the open air, it soon turns sour; and if, when in this condition, it be microscopically examined, it teems with animalcules. Again, the paste of wheaten flour, if set aside for a while in the open air, also becomes the abode of living beings. These are two instances out of many; the generalisation being, that every fermenting or putrefying body is the abode of some form or forms of organic life. It was found that great diversity of type was discoverable in the living beings that pervaded different substances, and that each class of body revealed its own forms of life. For example, the yeast fungus has been so frequently observed and drawn, that microscopists now speak of it with the same confident familiarity a botanist does of any variety of the large field mushrooms. Again, the special form of animal life to be met with in sour paste is that of an eel, and under the guise of something like river eels they are to be found depicted. Parallel cases need not be adduced to make comprehensible the philosophic boundary we are arriving at.

Out of revelations like these the question naturally evolves itself: How came these things there? How came the yeast fungus in yeast, the paste eels in paste? and so on for the rest. One of two hypotheses must be adopted as a necessity. Either these living things must have been spontaneously generated, or must have been developed from some kind of ovum, seed, or germ. As for the spontaneous-generation hypothesis, any general reader would most likely abandon it as absurd; but this word 'absurdity' is not lightly adopted by the philosopher, whose usual and only legitimate way of dealing with a disputed proposition is to take measures by experiment, the issue of which shall be to show the truth or falsehood of the disputed phenomenon in question. Now, improbable as the thing may seem, the idea of spontaneous generation had, some few years ago, won to its side many advocates amongst philosophers on the Continent, especially in France; the evidence on which they based their hypothesis being gathered from the fact that, notwithstanding all care they had been enabled to take to insure fair conditions of experiment, the living forms of decomposition, as, to generalise, we may call them, would and did present themselves. It was found that the passage of air through such destructive agents as oil of vitriol and potash solution did not interfere with the development of these small forms of life. Flour-paste, enclosed under a glass bell and exposed to air thus treated, soon became pervaded with its family of animalcules; and similarly in respect to other bodies in which the phenomena of organic life would under ordinary circumstances be seen. In trying other forms of air-purification, however, cotton-wool pressed hard was at length alighted upon as being wholly efficient. More than one experimenter proved that certain things naturally prone to decompose suffered no decomposition when exposed to air that had been carefully filtered through cotton-wool. The inference was inevitable: the cotton-wool must have filtered away the floating germs of organic life.

There was no spontaneous generation. In the cotton-wool these things must be, if one could only discover them. But how? how reveal and make manifest those microscopic forms of life? The task might well have seemed hopeless; but it has been accomplished. Proof having been made, as already stated, that filtration of atmospheric air through a pledget of cotton-wool effectually separated the organic germs naturally pervading the atmosphere, a French experimenter hit upon the following ingenious modification of the experiment. Instead of using ordinary cotton-wool, he employed gun-cotton wool, which, not differing from ordinary cotton in texture, of course had the same physical effect. But the power accruing to the experimenter was this. Gun-cotton is easily soluble in ether, the glutinous fluid known as collodion being the result. So, having taken gun-cotton, M. Pasteur —for this was the ingenious experimenter—used it as a filter; next dissolving the materials of his filter, he liberated into the transparent collodion whatever germs of organic life might be present. Being liberated, he subjected them to microscopic examination, and then what he had been in quest of was found.

Hitherto the group of experiments I have been describing seems far enough away from any practical application. To the philosopher it might be very interesting that the question of spontaneous generation was settled in the negative—that the axiom *omne ex ovo* was upheld; but what use, the utilitarian might still inquire, were all these proofs? This we shall presently see. Few of us who are old enough can have forgotten the discovery which the cholera visitation occasioned in 1849-50. Asiatic cholera was, comparatively speaking, a new disease. Until this century had some way advanced, it had never been seen or heard of even in India; whence, having gone forth, its origin was traced back to a localised region corresponding with the delta of the Ganges; and numerous investigations, conducted by many persons working independently, associated it in some way with a detrimental crop of rice. It was natural that microscopists should apply themselves to this rice. They did so; and with the curious, though not unexpected, result of actually discovering a minute fungus. Analogies came in aid. Rice is a grass, and the fruit ordinarily called the seed of grasses was already known as being prone to the growth of fungi. The so-called smut of wheat is of this sort, as in like manner is rye ergot, a material used as medicine by the physician. In this country a medical man, now deceased—the late Dr. Snow—first called attention to the fact that the incidence of cholera was, in every case known to him, traceable either to the eating or drinking of things which in some way had been associated with previous cholera patients, or else to the eating and drinking of articles of food in which certain processes of decomposition were going on. The late Mr. Warington of the Apothecaries' Hall, though not a medical man, came to the conclusion that Asiatic cholera depended in some way on the incidence of a certain sort of fermentation; which was equivalent to expressing the belief, in other words, that it depended on the growth of microscopic fungi.

Collateral evidence was soon forthcoming. The immunity of copper smelting-works from cholera had become noticed; and here young physicians, led away by false indications, began to administer copper as a cholera remedy, but without success. Reasoning on the matter, the fact was remembered that copper was not, under the ordinary circumstances of copper-smelting, volatile. The cholera preventive, whatever it might be, must have been volatile—must have wrought its preventive agency through the air-passages, being absorbed by the lungs. Explanation must be sought, not in the copper itself, but in some collateral product or products. These were sulphurous acid and arsenic; could the prevention of cholera be due to either of these?

Evidence on this point soon came to hand. It was found that men engaged in certain other operations involving the dispersion of sulphurous acid had also been free from cholera; and accordingly a large amount of evidence was in favour of the probability that sulphurous acid or its compounds would be valuable agents in the treatment of cholera, or rather to secure its prevention. All this accorded with previous knowledge as to this agent. The fact had long been known that sulphurous acid absolutely prevented the fermentation of ordinarily fermentible things. In the year 1849 a considerable amount of sugar-cane juice, charged in Barbadoes with sulphurous acid, was brought to this country uncharged, and its full complement of sugar extracted. The Devonshire cider-maker, wishing to produce sweet cider for the London market, had long been in the habit of sulphuring his casks, as he called the process, *i.e.* burning a sulphur-match inside the bung-hole before turning in his yet unfermented cider. What he wished to effect was thus actually effected—the sugar yet present, but which under the ordinary march of fermentation would have been changed to alcohol, remained sugar, the cider kept sweet. Another illustration. Certain makers of fruit-preserves in the City had discovered, whether by reasoning or practice I know not, that by rinsing-out their preserve-vessels with the soluble bisulphite of lime, fermentation of the preserves was obviated. Gradually we see an accumulation of evidence leading up to more than one practical point. Next followed the announcement by a member of the medical profession that sulphite of lime was, so far as his experience went, an almost absolute cure for choleraic diarrhœa—a symptom that in times when cholera prevails runs on to cholera itself. Other medical men tried this agent in their practice; and having established its character, sulphite of lime is now sold for that purpose by most dispensing chemists. Next dawned the idea that sulphurous acid used in some form might be probably efficacious in the preservation of meat. Professor Gamgee devoted himself to the necessary experiments, which, so far as they have gone, are wholly successful. By the adoption of his process, the details of which it is unnecessary here to give, carcasses of animals home-killed have been rendered, so to speak, incorruptible. It remains yet to be seen whether the process be efficient to protect carcasses packed in the hold of a ship during a voyage of Australian sea transit. If it be, then the problem of feeding our starving millions on good cheap animal food will have been solved.

Let us pause to reflect on some of the remarkable, even stupendous, developments which have resulted from the seemingly abstruse and unpractical experiment of the German philosopher, who proved that filtered air would not prevent the development of living beings in his beef-broth. Whether the germs of these living beings be filtered away mechanically, or whether they are killed by the operation of sulphurous acid, the practical result is identical. It cannot be said that the curious group of experiments detailed has culminated to its full practical issue; but Dr. Tyndall has drawn them to a focus, so to speak—has popularised them to his audiences, and is working in the new field with all his known energy, and employing all his manifold resources. Although he is not a medical man, yet the belief in the germ-theory of disease is so strongly fixed in his mind, that he has expressed himself ready to be the subject of experiment, by breathing a diseased atmosphere, armed with no farther protection than a mouth-and-nose filter of cotton-wool.

Perhaps the utilitarian in a perfect sense will cavil at the enunciation of spectrum analysis as a case in illustration of the point I wish to illustrate—namely, the practical application, time being given, of the most seemingly useless discoveries. He may tell me, that although it may be very interesting to know what the sun and stars are made of, and though spectrum analysis would seem to have taught us this, yet such knowledge is of no use to us. Looking at utility from his point of view, we must perhaps give way to the practical man, and say, 'Agreed.' Responding to this considerate deference, will the practical man kindly meet us half-way? Will he please to remember, that by aid of this spectral analysis Mr. Crooke discovered the new metal thallium? Will he admit that the discovery of any new metal belongs to his utilities? No, he says; thallium is not a useful metal. Well, I do not feel inclined to argue that point, the practical man and I viewing the evidence under lights so totally diverse. Not getting up a contest with him, I will proceed to describe the facts and the general line of evidence on which this spectral analysis is based.

Everybody knows that when a sunbeam is passed through a triangular prism, the beam is decomposed into three primary colours: red, yellow, and blue. Newton described as many as seven colours; but more modern experimenters have proved all, save three, to be secondary—mere mixed tints. So much for colour; but the solar rays are not composed of light alone. They have heat rays too, and another set of rays termed 'actinic,' to the operation of which latter chemical changes are referable—all the changes of daguerreotype and other sun-painting, wrongly called 'photography,' for example. It is with the luminous part of the spectrum we have now to do.

If the luminous portion of a prism-decomposed solar beam be looked at, certain black bands will be seen to traverse it, some broader than others, but each one of invariable relative dimensions and in one invariable place. Having been first pointed out by Frauenhofer, they were known, and are still known, by the name of Frauenhofer's lines. They remained a mystery until Bunsen and Kirschoff solved it; and out of their solution came the modern spectrum analysis, which depends upon the following essential facts.

Every metal can be burned, and heat sufficient being employed, the burning mass can be made to evolve a vapour. Every metal burns with a certain invariable colour, and the light of these colours can be projected through a prism. If so projected, a line across the spectral image results, of certain specific size and also colour; but if the light of a burning mass of metal be transmitted through its own vapours, then the band of colour it would have yielded on the spectrum is quenched as to colour, and the result is not colour, but black. An indication of the nature and meaning of spectral analysis was only aimed at in this place and at this time, and the outlines given will be sufficient to the end.

Whatever cavil the typical man of practice might raise against the utility of spectrum analysis, he will not object to the case now to follow. It is surely of some use to abolish a manufacture that produces horrible disease, mostly fatal, and at the same time to diminish the chances of fire. Amorphous or allotropic phosphorus has accomplished this, or rather might accomplish this. What, then, is allotropic or amorphous phosphorus? Amorphous means devoid of form; in the present example, crystalline form is alone referred to. Ordinary phosphorus crystallises, the amorphous variety does not; hence the name 'amorphous.' As for the word 'allotropic,' it is a very puzzling word to have any discourse about. Philosophers, of whatever kind, have long been used to employ certain words to comprehend certain phenomena which they cannot explain. It was said of Cuvier, that when he got hold of a living creature he did not know how to classify by any certain assemblage of analogical signs, he put it in radiata. Similarly we may affirm of chemists, that catalysis and allotropism are two cupboards wherein they have been wont to stow away certain facts undigested or unexplained. I have said something about catalysis, so let that pass; allotropism needs more attention. Literally, allotropism or allotropicity, when translated into plain English, is a very startling thing indeed; meaning little else than expression of the fact, or rather belief, that some one thing may be some other thing, and yet remain the same thing. I will give an illustration. Everybody knows that the diamond to look at is very different from a lump of charcoal to look at, and both different from a piece of black-lead. This is physically evident; yet chemistry, apply it as we may, only proves that the diamond, charcoal, and black-lead are one and all carbon. If a diamond be actually burned in oxygen gas, carbonic acid results; the very same gas we obtain by the combustion of charcoal in a stove. More evidence: by exposing diamonds to heat in a certain way, they can be changed to coke; but unfortunately for the practical man, and happily for ladies who have invested in diamonds, proud of the investment, no means have yet been discovered for effecting the backward change of coke into diamonds. Enough for our purpose. Here, then, we have an agent, an element—that element carbon, assuming three forms. Chemically, the element carbon *is* the same; physically it is *not* the same. How shall the puzzled chemist describe the sameness and unsameness? He has invented the words allotropism, allotropic, allotropicity, to this end. A man who has done his best should not be blamed because the best is imperfect.

Carbon is not the only element that can assume allotropic changes. Oxygen is in the same category, allotropic oxygen having the specific name ozone—a name that I am surprised to see is so much popularised. Hundreds of individuals using English, but wholly void of science, talk and write about the luxury of going into the country to breathe pure ozone. Unhappy individuals! they little know what they bargain for. A little ozone will go a long way. Pure ozone entering the lungs would be surely fatal; one might as well breathe pure chlorine. The popular use of the word ozone is in the 'fiery element' and 'subtle fluid' category. Certain persons can only describe a conflagration by using the first, a lightning flash by the second. We have no concern with ozone or allotropic oxygen now, neither with allotropic sulphur; for this also may take on a second form wholly dissimilar to ordinary brimstone. Allotropic phosphorus is what we have to do with, and the following particulars relate to it.

In the year 1849 a Viennese chemist, Professor Schrötter, surprised and rather amused the staid members of our British Association by announcing that in his waistcoat-pocket he had brought a sample of phosphorus simply enveloped in a fold of paper. Now the particular circumstance has to be borne in mind, that phosphorus, as everybody knew phosphorus up to the time of the Viennese professor, was an element so prone to burn, that it had to be kept under water, and, when removed from water, handled with the utmost caution, inasmuch as a degree of heat little exceeding that of the human body caused it to burst into flame. Sure enough the Viennese chemist had brought in his pocket a certain puce-coloured material, and he called it phosphorus; but no such phosphorus had ever been seen. Philosophers tried to smell it. The thing had no smell. Ordinary phosphorus smells strongly. Philosophers shook their heads and demurred; but the Viennese chemist, using means unnecessary to describe here, changed his puce-coloured powder into ordinary phosphorus without adding anything to it or taking anything away. This evidence was of course irresistible. The Viennesé phosphorus had assumed some second form, just as carbon may assume a second and third form: it was allotropic phosphorus; accordingly, by the names allotropic or amorphous phosphorus it has ever since been known.

Ordinary phosphorus is a very deadly and insidious poison. If swallowed, a small portion soon kills; but swallowing is not most to be apprehended. Rats and mice indeed are fond of the phosphorus flavour, and eat phosphorus readily, to their own destruction, when occasions permit; but to human beings the smell of phosphorus is abominable. Children have been killed through putting lucifer-matches into their mouths; but that sort of accident could hardly occur to grown-up people. The poison danger of phosphorus most to be apprehended does not come in this way, but through inadvertently breathing air pervaded with phosphorus fumes. The result is slow, but it is deadly and most horrible. If an individual breathing phosphorus fumes continuously have an unsound tooth—and how rare is a set of teeth wholly sound!—absorption takes place, the jawbone decays, and in the end the patient dies in excruciating torture. Allotropic phosphorus is wholly devoid of poisonous quality. It is not volatile, hence it has no vapour to be breathed; and if swallowed, it does no more harm than so much chalk would have done. Now phosphorus is much used in the manufacture of matches; and a very deadly operation match-making was and is under the original system of using common phosphorus. Allotropic phosphorus answers every need if used in a particular way; that is, not as an ingredient of the match itself, but of the tablet upon which the match is rubbed. Thus Schrötter's discovery enables the manufacturer not only to guard his workmen against the chance of poisoning, but to guard the public against the chance of setting their premises on fire, inasmuch as the sort of matches now under consideration will ignite when rubbed upon their own peculiar tablet, but not otherwise.

The general history of phosphorus affords a good instance of knowledge once abstract, ultimately applied to popular utility. The discovery of phosphorus is one of many which have been evolved from labours of the alchemist. It was discovered by Kunkel, and by chance. But for the incentive of the philosopher's stone and universal elixir, phosphorus might not perhaps have been discovered until our own days. It was first obtained from animal fluids, next from bones; ultimately, when the supply of bones ran short, attention was turned to the mineral phosphate of lime of Estremadura, from which substance nearly all the phosphorus of commerce is now extracted.

A valuable essay illustrating our topic might be composed on the subject of the discoveries to which alchemy, or the belief in metallic transmutation, gave rise. At different epochs of human advancement the mind of man is ruled by different incentives; but one—the love of immediate gain—pervades all epochs. Experimental science has now attained such development, that it affords ample scope for intellectual exercise. Day by day it more nearly approaches to the exactness of mathematical science, in the study of which numerous men of high intellectual endowments, from the time of Euclid and Archimedes down to the time when we live, have found solace. It was not thus in respect to chemistry and other experimental sciences until lately. Even going back a century, chemistry barely afforded any field for rigid intellectual study at all; but now, owing to the formularisation of its known laws, much advance in the science may be achieved by book-work alone, without the need of actual experiment. The question indeed arises, whether the next great chemical discovery will not appertain to him who, having competent mathematical knowledge, applies himself to generalise the weighings and measurings already done and recorded, rather than to the industrious laboratory-worker. It takes long in the education of the human mind before men come to put faith in the belief that the unravelling of truth is valuable for its own sake alone; and the belief once created, the number of men to whom the unravelling of truth for its own sake is possible will be comparatively few. The number, however, will be probably commensurate with the number of intellects strong enough to be turned advantageously in this direction. The belief is very common, that discovery and invention are only two developments of one and the same faculty, but in inferior degree. An opinion prevails that discoverers are by necessity inventors; men who, looking down on human needs, might, if they would only condescend, turn their discoveries to profitable use. This opinion does not appear to be borne out by facts. The faculty of invention would appear to be different from that of discovery, and few experimental discoverers could be predicated to their utilitarian issues by aid of theory alone. Of this some remarkable instances may be cited. The theoretical prediction made by Dr. Lardner, that ships steam-propelled would never be able to cross the Atlantic, has been often quoted, and is popularly known. Not so well known is the fact that a lecture was once delivered at the Royal Institution to prove that electricity could never be used for telegraphic purposes save for very inconsiderable distances, the maximum specified distance being, I believe, no more than eighteen miles.

It is curious to reflect on cases in which Science has frequently come to the aid of utilitarian man just when wanted —so soon, indeed, as utilitarian man has deliberately sought her aid. Some remarkable examples of this are afforded by the history of the great French Revolution. Much fighting had then to be done, as readers need not be informed; but fighting needs gunpowder, gunpowder needs saltpetre, and up to the period of the revolution almost all the saltpetre of commerce had been imported from India. True, the Italians were aware that saltpetre occasionally forms in caves and tombs; the fact is stated by the Italian writer Tartalea. This does not invalidate the fact, that before the French Revolution nearly all the saltpetre of commerce was brought from

India. To have recognised small home specimens as a natural product was one thing; to have mastered the conditions of its formation, and generated it at pleasure in quantities large enough to supply the needs of French revolutionary armies, was another. Very soon after the pressure of the need, the thing was done, and for many years every pound of saltpetre entering into French gunpowder was home-made.

The importance of this discovery became apparent to other continental nations. Remembering that they might be subject by fortune of war to conditions of exclusion, just as the French had been, they took measures to insure a home supply. The government of Sweden to this day imposes a saltpetre tax, payable in kind, on every Swedish farmer. A certain specified amount of this sinew of war must be rendered periodically to the collector. The Swedish government will accept no money-equivalent—the saltpetre must be paid in kind. Another chemical manufacture to spring out of the revolution under the pressure of the times was that of sugar from beetroot. The French are, and always have been, a sugar-eating people; but English command of the ocean was so vigilant, that during a period of the revolutionary war no sugar from the colonies could be obtained. Some years previously it happened that a Prussian chemist had demonstrated the presence of sugar in white Silesian beetroot, but the discovery had been turned to no practical account. The French applied themselves to the commercial problem, and ultimately with complete success—as the large importation to this country of beetroot-sugar testifies. At first, however, they were unsuccessful. And here again we find an instance of inventors—men of practice—correcting a doctrinal error. A commission of French philosophers came to the conclusion that, although sugar did exist in beetroot, it could not be extracted at a commercial profit. The doctrinaires were wrong. Less connected with the revolutionary pressure, but associated with it to some extent, was the manufacture of soda from sea-salt.

Some of us are old enough to remember the time when washing-soda was not so common and so cheap as now—when pearl-ash was habitually used for washing and other domestic purposes, for which washing-soda is now universal. Well might washing-soda be dearer than it now is, seeing that the whole of this useful substance was got by a tedious process out of the ashes either of actual sea-weeds, or from the ashes of certain plants that grow on the sea-coast. At length a chemist bethought himself that the sea—the ocean—held illimitable quantities of the material of washing-soda, only it chanced to be in the form of common salt. The proposition, then, was to convert salt into washing-soda. A chemical process suitable to the occasion was soon devised; and now almost all the soda that enters into commerce is made from sea-salt either taken from the ocean or from salt-mines.

When Mr. Woods, an assay-master in Jamaica, discovered amongst his gold a metal that caused him much trouble, and to which the name of 'platinum' is now given, he little knew that it was destined to work a revolution in the whole range of chemical manufactures. Thus indeed it was to be, and in this way: Few chemical manufactures can be efficiently carried on without the aid of oil of vitriol, directly or indirectly; and before the discovery of platinum, every drop of oil of vitriol had to be distilled from vessels of glass. The danger, the labour, the expense of this may easily be imagined. Platinum retorts have made the case easy. Oil of vitriol can now be bought at considerably less than a penny the pound. To specify a tithe of the manufacturing utilities of oil of vitriol would fill a volume. Amongst other applications, we are not to forget its use in agriculture. Most artificial manures involve the use of oil of vitriol in one way or another. When the reader is informed that mummy bones are exported from Egypt to be half dissolved in oil of vitriol, and in this condition applied to English land, he may come to realise the curious connection between a precious metal, the bones of some two-thousand-year-dead-and-buried Egyptian Pharaoh, and our daily bread.

What I set myself to do is done; not to give the full rationale of processes indicated, but to foreshadow some examples of the modern application of science to the wants of man. In view of these cases, and others like them, we need no longer wonder that science has taken such fast hold on the minds of men. The pure life and reverent belief of that great philosopher Faraday, who has passed away from us, is in itself a standing proof and disclaimer to all who profess to fear the influence of science on the holy mysteries of man's present and to come. One addicted to science, be it in ever so humble a way, must fain derive pleasure from contemplating the scientific movement that now pervades the whole of English society. Independently of the direct pleasures and material advantages of scientific culture, both very great, it may possibly be that its indirect consequences as a mental discipline may be very applicable to English minds. Owing to our free institutions, our free press, and the license accorded by our government to full political debate, it may be fairly questioned whether the science of politics, if one may so dignify it, has not been carried to a point incompatible with a purity of mind or tranquillity of thought which human beings might rise to by following other trains of contemplation whither they tend. It *may* be that the proper study of mankind is man; but the time at length arrives for human beings to grieve over human imperfections—to long for some purer field of intellect, within the realms of which the soul may expand, and reach, ideally at least, the sacred throne of truth. Science presents such a field. There we absolve ourselves from human passions. There the elements speak to us in their never-changing, never-erring language:—teachings the same for all, though their higher mysteries only a favoured few in each generation can understand.

A CHEMICAL TRIAD.

CAVENDISH.

It is the biographer's privilege to be present at the hearth and home of the subject of his memoir, to see his every-day performances, to chronicle his acts, without explaining to the world how the home was invaded, how the observing eye found means to cross the barrier, or the recording pen to write. I ask the reader, then, by force of will, to annihilate the last sixty years, and to imagine himself the world's denizen in 1810, and follow me.

We go to witness a death-bed scene. Clapham is the locality; the house is, at the period of this narrative, known as Cavendish House. We enter: the domicile has all the aspect of a gentleman's mansion; but its interior arrangement is so peculiar that one wonders what the owner's avocation can be. One chamber we see fitted up like a blacksmith's shop. Here are anvils, forges, tempering troughs, files, hammers, and in short almost everything that a blacksmith could require; but there are other things too, which a blacksmith would not have. Philosophical apparatus lie about in confusion. Here an air-pump taken to pieces, there a transit instrument, yonder the compensation pendulum of a clock. Vainly we look for the artificer—he is not there. Wending our way through a long corridor we open a door, and pass into a suite of noble apartments. Their aspect is equally strange with the last, but quite different. They are devoid of furniture, but filled with all sorts of chemical instruments. In one corner is a furnace, the embers of which still glow; proving that the operator has recently been there. On a large table in the centre of the room is an electrical machine; by the side of it a Leyden battery, and a curious instrument of thick glass, known at this present time by the designation of 'Cavendish's eudiometer.' But the most striking feature in the apartments is the large number of thermometers which hang upon the walls. Examining the thermometers more narrowly, we discover in them a peculiarity of construction. Their frames bear traces of home manufacture. We see none of the neatly cut figures that appear on the thermometer scales of philosophical-instrument makers, but their scales are roughly engraved. Evidently no mere amateur has done this, but one who, desirous of having his instruments correct, has known how to make them for himself. *This* is evidently a chemist's domain; but we look in vain for the chemist. No one is there.

Wandering along in our visit of exploration, we ascend a flight of stairs, and at length witness some signs of human habitation. One sitting-room, meagrely furnished, and one bed-room—no more. But perhaps the owner of the mansion, whoever he may be, prefers to live one flight higher. We ascend again, to find ourselves mistaken. All this portion of the house has been converted into an astronomical observatory, two rooms only excepted, the furniture of which sufficiently indicates their use. They belong respectively to the family domestics, a female housekeeper and a footman. Softly! we hear a noise in the observatory, and return. In our hurry, we did not thoroughly explore it. Looking more attentively, we see, half hidden behind the stand of a large telescope, a pale infirm old man. He is intently gazing on the stars, for twilight has almost passed away. Let us not disturb him, but note his appearance and costume before the night sets in. In stature he is below the middle height; his countenance thin and very pale. His forehead is broad and intellectual. His eyes are bright and shining, but his features display no trace of sentiment or passion. He might be likened to a sculptured block of marble, were it not for the radiant intelligence of his eyes; but that radiance is peculiar. It has in it nothing of human sentiment. It is the light of the moonbeam, cold and cheerless. Our strange individual is evidently stricken in years, and his attire is that which was fashionable in his youth. Perukes even in 1810 were not *quite* unknown, but the peruke of our strange philosopher is of very antique shape. Its curls are very tight, and the queue is of the obsolete form known as the 'knocker pattern.' His wrists are enveloped in lace ruffles, and he wears a frill of similar material. His coat is of velvet. Its colour was originally violet, but time and use have faded it down into a sober neutral tint. Its cut is antique, but we are familiarised with it in the court-dress of the present day.

Thus much for the appearance of our illustrious stranger, for he is indeed such—illustrious even in the sense of heraldry, coming as he does of one of our most noble families. He is the grandson of a duke. He is celebrated, too, in another sense. The Honourable Henry Cavendish is one of England's most renowned philosophers: great as a chemist, great as a mathematician, great as an astronomer. No science was too expansive for the grasp of that master-mind, none too minute for the limit of its scrutiny. To weigh the earth, to unveil the mysteries of the stars, to solve the most complex lunar problems—these were the occupations of him we look upon. Henry Cavendish seems to have been born for the purpose of demonstrating the power of the human mind as a calculating machine, and of proving how little the possession of that power implies the coexistence of those sympathies which ennoble human life, rendering man, when he rightly directs them, that which poets have termed him, God's noblest work.

The old philosopher, whom we see gazing at the orbs of heaven, has numbered more than seventy-nine years. He who for so many years has studied the decomposition of bodies, and predicted the advent of eclipses, who has calculated the time when comets should reappear, knows the hour of death is at hand. The mystery of death is only unveiled to those on whom eternity has dawned, to such as have stood face to face before the great Omnipotent. There is, besides, a cognate mystery, one little discussed, but the existence of which is real: the sentiment of death approaching. What that sentiment, that vague prescience may be, who knows save those who have experienced it? Who, at all conversant with death-bed scenes, especially those of aged people, can doubt that a vague sentiment of approaching dissolution is sometimes a reality—a sentiment which, though vague and undefinable, is often justified by the resnlt, death itself speedily following, so surely as thunder succeeds the lightning? The old philosopher trembles, the telescope drops from his hand, he utters a faint scream. He feels he is about to die. His mental disturbance is but instantaneous. He gets up haggard and bleeding, for one of the telescope glasses has broken in falling, and has slightly cut him. He slowly descends from his observatory to the sitting-room, where, sinking into an arm-chair, he lays his hand upon a bell and rings it gently. A male domestic appears.

'Listen!' said Cavendish, addressing him by name. 'Have I ever commanded you to do an unreasonable thing?'

The man heard this question without much astonishment, for his master had the character (not without reason) of being an eccentric person. He replied in the negative.

'And that being the case,' continned his master, 'I believe I have a right to be obeyed.'

The domestic bowed assent.

'I shall now give you my last command,' said Cavendish. 'I am going to die. I shall now retire to my chamber. There let me be alone, for I have matters to arrange. Let me be eight hours alone. Tell no one: let no one come near. When eight hours have passed, come and see if I am dead. If dead, let Lord George Cavendish know. This is my last command. Now go!'

The servant knew, from long experience, he might not dispute his master's will. He turned to go away.

'Stay—one word,' interrupted Cavendish; 'stay—one word. Repeat your orders *exactly*.' And thereupon he caused the servant to repeat the directions previously given. Obedience was promised once more.

But the directions, even though given by an eccentric man, were too mysterious to be implicitly followed. They seemed to point to suicide; for who, not intending this, could foretell so closely the period of the great event? One, two, three hours passed away. Cavendish had retired to his apartment, and all was still. Was he dead, or still living? The man durst not ascertain; but, feeling anxious, as well he might, hurried away to London, and made the particulars of his situation known to Sir Everard Home, the celebrated medical practitioner. Cavendish was personally known to Sir Everard —known as a mere acquaintance, no more; Cavendish had neither enemies nor friends. The intimation was so alarming that neither Sir Everard nor the man could banish entirely the idea that the philosopher's brain had become turned; that a too arduous devotion to philosophical pursuits had caused insanity. The will of Henry Cavendish, too, was noted for a certain inflexibility which nothing could swerve from a purpose once formed. If, therefore, he had set his mind on the commission of suicide at some premeditated hour, he would probably do so if not interrupted. Such were the reflections which occurred to both the servant and Sir Everard as they hurried away to Clapham.

They arrived considerably before the expiration of the appointed eight hours, and, proceeding at once to the bedroom in which Cavendish lay, listened for an instant outside the door. Not the most acute hearing could discover the slightest sound: all within was silent. They entered, the man keeping well in the back-ground, not caring to encounter his master's gaze, after breaking the promise so solemnly given. Sir Everard approached the bed. The curtains were not drawn; Cavendish was not dead, neither was he asleep. His eyes were still open; but they appeared not like the eyes of a living man. They gazed abstractedly into space, as if the world had no longer any object upon which their glances might fall. His lips were quivering, but voiceless. Cavendish was seemingly in communion with some invisible being.

Sir Everard, approaching still nearer, gently removed the coverlet, and took Cavendish by the hand. The philosopher, thus disturbed in his last reveries, remembered that the sanctity of his retirement had been infringed. He started, but made no remark. Looking round the chamber, he presently recognised the servant: frowning sternly, he beckoned him away.

'Do you feel ill?' inquired Sir Everard.

'I am not ill,' replied Cavendish; 'but I am about to die. Don't you think a man of more than seventy-nine has lived long enough? Why am I disturbed? I had matters to arrange. Give me a glass of water.'

The glass of water was handed to him; he drank it, turned on his back, closed his eyes, and died!

Such was the end of the Honourable Henry Cavendish. Imagination has not been drawn upon for a death-bed scene; the most daring writer of fiction would scarcely have been guilty of such temerity, so improbable are the incidents. But the mental constitution of this great philosopher was a puzzle to those who knew him best. It defied all their acumen to fathom it, and remove its shroud of mystery. Even had he not been one of England's greatest philosophers, his biography would have been interesting; but when his numerous discoveries in the walks of science are considered, a double interest is thrown around his career. A sketch of his biography I shall therefore proceed to give.

Henry Cavendish was elder son of Lord Charles Cavendish, third son of the second duke. His mother was born Lady Ann Grey, fourth daughter of Henry, duke of Kent. Nice was the place of his birth, in the year 1731, his mother having retired thither for the benefit of her health. Of his infancy and early childhood very little is known. We hear of him, almost for the first time after his birth, in the year 1742, when he was therefore eleven years old, at which period of his life he was sent to the school of the Rev. Dr. Newcome at Hackney—a seminary then celebrated for the education of aristocratic youths. He remained at this academy seven years, making himself no way remarkable, so far as we can learn, either by talents or peculiarities. One circumstance in relation to his scholastic career deserves comment, as proving that the extraordinary reserve which characterised him in after years, making him shun the society of his fellows, was only an extreme development of a youthful feeling. The records of Dr. Newcome's school state that Henry Cavendish never took part in certain entertainments got up by the boys for their amusement. And here, before accompanying Cavendish in his university career, a circumstance should be mentioned, which is not—as should seem—without significance as connected with the morbid peculiarities of the subject of this memoir. He lost his mother when only two years old. This, though a circumstance usual enough, and which has occurred frequently without generating misanthropic feelings in the child subjected to the privation, was not, some have thought, without an influence on the subsequent character of Henry Cavendish.

In 1749, he matriculated at St. Peter's College, Cambridge. There he remained until 1753, and left without taking a degree. The latter remark also applies to his brother, who was studying at Cambridge at the same time. In explanation of his leaving without a degree, various conjectures have been made. The reason advanced by some—that he feared the test of examination—is scarcely consistent with the circumstance of his profound scientific acquirements, more especially in the mathematics, as evidenced in his future career. Perhaps the extreme dislike which he manifested throughout life at being the subject of public remark, even in the way of commendation, may have influenced him; or, still more likely, the existence of certain religious scruples—scruples not accordant with the university tests, at that time very stringently observed. Even in his early youth he had been suspected of entertaining unitarian doctrines; and though his religious opinions were veiled throughout life in extreme mystery, there is reason to believe that the distinguished subject of this memoir died as he had lived.

Those who have traced his career through life, with all the minuteness that his aversion to human society and his extreme habits of retirement permit, assure us that from the day of his baptism he never entered a place of worship of any kind, and that, when he felt the hour of death to be approaching, he retired to his chamber, as already described, commanding that no one might interrupt him. What the matters were that—to employ his own phrase—'*he wished to arrange*' in this solemn hour, of course stand unrevealed. The most probable supposition is, that he desired to pass these last moments in silent contemplation. It is not satisfactory to have to record such facts. How different would have been his career, had his love of knowledge been chastened and elevated by acquaintance with Him who of all others is the object most worthy of being known! Experience has shown, by many a bright example, that it is possible to be a man of profound science, and yet to sit with humility at the feet of the Saviour.

It is not proposed in this short memoir to enter upon the scientific discoveries of Cavendish; these would cover too wide a field, and would involve points of discussion not suited to general scrutiny. Perhaps the most remarkable investigation associated with his name is that respecting the composition of water; which fluid, hitherto regarded as an element or simple body, was proved by his experiments to be the result of combination between oxygen and hydrogen. I am aware that the merit of Cavendish, as sole discoverer of this interesting fact, has been disputed. There is no space here to mention the reasons which could be adduced in favour of the scientific claims for or against. Let it suffice to say, that Cavendish is recognised to have been the sole discoverer of the composition of water, by those who have gone into the question most deeply; and he is acknowledged by all to have contributed the major points of the discovery.

It is not with the question of the scientific grade of recognition to which Cavendish is entitled, that we have to concern ourselves in the course of these remarks. That award has long since been made by impartial judges, and needs no amplification. It is with Cavendish here, regarded as a strange moral phenomenon, that we have to deal; and his biographer will best acquit himself of that by relating some well-attested anecdotes.

Up to the age of forty, Cavendish was poor—his total annual income (being an allowance from his father) not exceeding 200*l.*; indeed, according to some authorities, falling short of that sum. This was indeed a small stipend for the son of a noble family; and popular rumour was not slow to attribute the restricted amount to the displeasure of Lord Charles Cavendish at the peculiarities and impracticable disposition of his son. The truth of this explanation, however, is by no means apparent. When about the age of forty, a very large fortune came into the possession of Henry Cavendish—left him, it is believed, by some distant relative; but concerning this there is again some doubt. Our philosopher had so long been obliged to cultivate habits of economy, that, without being parsimonious, these habits had become engrafted in his system; and after indulging in the purchase of books and instruments to the extent of his fullest wishes, he still found that the interest of money accumulated faster than he could spend it. He therefore presented an example of that *very* rare phenomenon—a man whose pecuniary means were so large as to be troublesome. A curious instance of one of these singular troubles is as follows.

On one occasion, his bankers in the City finding that a very large sum of money had accumulated in their tills to his account, and thinking that it had better not lie idly there, determined to wait on him and receive his instructions in the matter.

Accordingly, one of the principals hied away to Clapham with the intention of seeking our philosopher in his lair. *That* was no such easy matter; for once committed to the recesses of his *den*, Henry Cavendish never liked to be disturbed.

The banker knocked; the subject of his visit was delicate; it of course could only be communicated personally.

To the interrogatories of the footman as to who he was, and what his desires might be, the only answer was that he wished *personally* to communicate with Mr. Cavendish.

'At any rate, sir,' replied the footman, 'it would be as much as my place is worth to disturb him now. You must wait until he rings his bell.'

The banker had waited for more than an hour when the long-expected bell rang. The footman announced the man of business.

'What does he want with me?' Cavendish was heard to say.

The footman explained the banker's desire to have a personal interview.

'Tell him I cannot see him. I am very busy,' was the reply.

The footman bowed and retired.

'Stay,' interrupted his master; 'how long has Mr. —— been waiting?'

'For more than an hour, sir.'

'O, very well, very well. Send him up.'

'I am come, sir,' remarked the banker, 'to ascertain your wishes concerning a sum of eighty thousand pounds now placed to your account.'

'Does it inconvenience you?' demanded Cavendish. 'If so, I can transfer it elsewhere.'

'Inconvenience, sir? by no means,' replied the banker; 'but pardon me for suggesting that it is too large a sum to remain unproductive; would you not like to invest it?'

'Invest it, eh? yes, invest, if you like; do as you please with it; but don't interrupt me about such things again. I have other matters to think about.'

Though not a philanthropist in any sense of the term, few persons have contributed more liberally towards the accomplishment of philanthropic objects than Cavendish. Subscription-lists—if not the bearers of them—found ready access, and Cavendish dealt with them in a way peculiarly his own. Glancing over the list of subscribers, he would notice the largest amount subscribed, then contribute a like sum. This peculiarity became so well known, that it was frequently abused, a fictitious subscription being announced for the purpose of misleading our philosopher. Although in early life Cavendish must have exercised no little amount of frugality in making his slender income suffice, yet a certain ignorance of the value of money characterised him throughout life: in proof of this, the following anecdotes may be cited. At a time when the funds of the Royal Institution were far less ample than at present, Sir Humphry Davy, then attached to that society, had opened a subscription-list in order to purchase an expensive voltaic battery, an instrument necessary for the prosecution of some discoveries which have since immortalised his name, and in which Cavendish was largely interested. People hoped that the philosophic millionaire would come down for a good round sum; but he did not contribute one penny, notwithstanding the various hints thrown out in the proper direction. If this be construed into penuriousness, contrast it with the following: A scientific gentleman having fallen into pecuniary embarrassments, some friends managed to procure for him the situation of temporary librarian to Cavendish, whose books were as much confused as the pecuniary matters of the librarian. The task was executed satisfactorily, and the gentleman took his departure, having received the stipulated salary, but nothing more. A short time subsequently, Cavendish happened to be present at a dinner of the Royal Society, and some friends of the quondam librarian thought it a good opportunity for turning the conversation on the subject of their protégé. His name accordingly was brought up.

'Ah! how *is* he? what is he about?' inquired Cavendish.

'Poor fellow! he is in the country, very badly off,' was the reply.

'I am very sorry, *very*,' said Cavendish.

'We were hoping that you would have done something for him,' the friends ventured to remark.

'I—I—I? what *could* I do?'

'We were hoping that you would have settled a small annuity upon him.'

A dawn of light seemed to have irradiated the brain of Cavendish; the thought, apparently so obvious, had only then occurred to him for the first time. 'True,' replied he hurriedly; '*would a cheque for fifteen thousand pounds be of use?*'

Would a cheque for 15,000*l.* be of use?—what a question! The cheque was drawn, and the needy man of science made comfortable for life.

If the subject of our memoir did not possess that active, searching, and, what is equally important, that discriminating benevolence which seeks out the hidden recesses of misery, and cheers them with timely assistance, we have at least seen that he was open to suggestions, and that, when he did unclasp his cheque-book, it was after the manner of a prince. He had no hatred of *man*kind; but of *woman*kind that much cannot with truth be stated. If a female servant chanced to meet him in his own house, however inadvertently, it was the certain prelude to her dismissal; and the whole neighbourhood of Clapham was once lost in astonishment at a most remarkable phenomenon—no less than this: Our philosopher, in one of his rural strolls, interposed to save a lady from the attacks of an infuriated bull. According to all the preconceived notions entertained respecting our friend, he would more probably have taken sides with the bull against the lady.

On one occasion, when dining with the associated fellows of the Royal Society, some of the philosophers, after the dinner was over, happened, when looking out of the window, to be attracted by the appearance of some young lady on the opposite side of the street, whom curiosity had led to glance in the direction of the apartment where so many philosophers were dining. 'How lovely she is!' said one. 'What a beauty!' whispered another. The moon had risen, but the fellows were *not* apostrophising the moon. Cavendish, however, thought they were, and went to the window to participate in their delight. No sooner did he discover his mistake than he uttered a faint scream, as was his wont when disturbed or annoyed, hobbled back to the table, and showed his disgust by one single ejaculation: it was 'Pshaw!'

Though not much addicted to conviviality, Cavendish was sometimes known to invite a few friends to dinner. On these occasions everybody knew beforehand the bill of fare: a leg of mutton with trimmings; in other words, a due accompaniment of vegetables and sauce. Now a leg of mutton—pleasant eating enough in itself—is not expensive; the number of a dinner-party, when nothing else is provided, must be limited by imperious laws. Once Cavendish appeared to have forgotten this idea of a limit; he invited more guests than a leg of mutton could possibly suffice for. The result was an epistolary communication to that effect from his cook (direct verbal communication, we have seen, was never permitted): 'The leg of mutton will not be enough.' 'In that case provide *two*,' replied Cavendish.

But I must draw this memoir of a celebrated man to a close, and shall do so by quoting the words of his biographer, Dr. Angus Smith:

'Such, then, was Cavendish in life and death, as he appeared to those who knew him best. Morally, his character was a blank, and can be described only by a series of negations. He did not love, he did not hate, he did not hope, he did not fear, he did not worship as others do. He separated himself from his fellow-men, and apparently from God. There was nothing earnest, enthusiastic, heroic, or chivalrous in his nature, and as little was there anything mean, grovelling, or ignoble. He was almost passionless. All that needed for its apprehension more than the pure intellect, or required the exercise of fancy, imagination, affection, or faith, was distasteful to Cavendish. An intellectual head thinking, a pair of wonderfully acute eyes observing, and a pair of very skilful hands experimenting or recording, are all that I realise in reading his memorials. His brain seems to have been but a calculating engine; his eyes inlets of vision, not fountains of tears; his hands instruments of manipulation, which never trembled with emotion, or were clasped together in adoration, thanksgiving, or despair; his heart only an anatomical organ, necessary for the circulation of the blood. Yet if such a being, who reversed the maxim, *Nihil humani me alienum puto*, cannot be loved, as little can he be abhorred or despised. He was, in spite of the atrophy or non-development of many of the faculties which are found in those in whom the "elements are kindly mixed," as truly a genius as the *mere* poets, painters, and musicians, with small intellects and hearts, and large imaginations, to whom the world is so willing to bend the knee. Cavendish did not stand aloof from other men in a proud or supercilious spirit, refusing to count them as fellows. He felt himself separated from them by a great gulf, which neither they nor he could bridge over, and across which it was vain to extend hands or exchange greetings. A sense of isolation from his brethren made him shrink from their society and avoid their presence; but he did so as one conscious of an infirmity, not boasting of an excellence. He was like a deaf-mute sitting apart from a circle, whose looks and gestures show that they are uttering and listening to music and eloquence, in producing or welcoming which he can be no sharer. He dwelt apart, and, bidding the world farewell, took the self-imposed vows of a scientific anchorite, and, like the monks of old, shut himself up within his cell. It was a kingdom sufficient for him, and from its narrow window he saw as much of the universe as he cared to see. It had a throne also, and from it he dispensed royal gifts to his brethren. He was one of the unthanked benefactors of his race, who was patiently teaching and serving mankind, whilst they were shrinking from his coldness, or mocking his peculiarities. He could not sing for them a sweet song, or create a "thing of beauty," which should be a "joy for ever," or touch their hearts, or fire their spirits, or deepen their reverence or their fervour. He was not a poet, a priest, or a prophet; but only a cold clear intelligence, laying down pure white light, which brightened everything on which it fell, but warmed nothing—a star of at least the second, if not of the first, magnitude in the intellectual firmament.' How mournful to think that a man with so many excellences stood aloof from that generous and ennobling faith which would have quickened his dormant affections, and superadded to his intellectual eminence the attractiveness of Christian love!

LAVOISIER.

Antoine Laurent Lavoisier, the philosopher who gave the final *coup de grâce* to the wild mysticism of alchemy, and laid the foundation of modern chemistry as we find it, was an extraordinary character. He was also an unfortunate man. He lost his head by a stroke of the guillotine in the stormiest part of the first French republic, and because of a tobacco question! Yes, it was even so. For this cause, ostensibly, the wise, the generous, the benevolent Antoine Laurent Lavoisier died. He was said by his enemies to have watered his tobacco!

It was in the year 1794, when the notorious triumvirate of public safety were committing their atrocities—when to be good, or well-born, or rich, was each a sufficient cause to be held in suspicion by the triumvirate—that Antoine Laurent Lavoisier and his friend Berthollet were engaged in making some of those discoveries which have rendered them both so celebrated. The house of Lavoisier was where they prosecuted their experiments. That house was in Paris. Men engaged in any deep pursuit usually take little heed of political strife. They live in a world of abstraction all their own, and are not usually much influenced or affected by what is taking place outside their own sphere.

Lavoisier was like our own Cavendish in one respect—he was a scientific man, and he inherited riches. His family had for many generations held the post of Fermier-Général—an office, I need hardly say, abolished before the time of which I write, because the terrible revolution swept all those posts of the old *régime* away. Would that all the crimes to be laid to the charge of the French revolutionists were so venial as this!

The office of Fermier-Général was of this kind. A responsible individual agreed, for a consideration, to pay into the exchequer a fixed sum on behalf of certain things—tobacco being one. The Fermier-Général then, whoever he might be, held the monopoly of the sale of tobacco for his own district. For many generations the post in question had been held by the family of Lavoisier. They grew wealthy upon it, which may be taken as a proof that they found it a good thing. No flagrant charge of impropriety was ever brought against the Lavoisiers. People shook their heads sometimes, smiled, and remarked that farmer-generalship was a fine trade—they wished they had the like; but if the old Lavoisier had been a little close, young Antoine Laurent, when the office devolved on him, was so generous—thought so little of amassing wealth, and did so much good—that it would have been difficult to find a rich government official with fewer enemies. Then, finally, when the storm of revolution came, and the lucrative sinecure, with others of its stamp, was swept away, Lavoisier treated the matter so lightly—speaking of it as a positive gain, and as giving him more time to cultivate philosophy—that the few who had been envious of him were constrained to admit Antoine Laurent Lavoisier to be—what his friends and the world knew long before—*a philosopher.*

At the period to which these remarks apply, Lavoisier was living at Paris, whither he had come some years before, the better to follow out, in the society of congenial minds, some experiments in which he was engaged. Being himself rich, he threw open his house and his laboratory to those who, with similar tastes to his own, had fewer means of gratifying them. One great disadvantage under which a chemist is placed, in comparison with workers in other branches of philosophy, is the expense of the instruments with which he has to work. Many a student of pure mathematics has positively no instruments. If he have practically to apply his mathematics, a few fixed unchanging instruments are all he requires. Give the botanist a pocket lens, and, if he be luxurious, a microscope, and he is well provided; and though the instruments necessary to the astronomer are costly, they too are for the most part unchanging. But men who devote themselves to new lines of chemical investigation frequently require instruments to be devised, and, what is still more difficult, the wherewithal to pay for them.

Lavoisier, at the period to which this brings me, was engaged in proving what has since become a truth in the mouth of every moderately educated person, namely, that the diamond and charcoal are in composition identical. An investigation so curious made great stir at the time. Our countryman Priestley, and the celebrated French chemist Berthollet, were appointed to come to the laboratory of Lavoisier, and see the experiments. Berthollet had already arrived, as I have said, but Priestley was yet absent.

It was evening. A large argand lamp, having its rays cast downwards by a shade, played upon some diamonds laid on a piece of black paper, ready to be sacrificed to Lavoisier's splendid though expensive discovery.

'It is well Robespierre does not know of this,' said Berthollet, a smile lighting up his large features, which seemed as if they had been chiselled out of a rock; 'or it would make work for the Louisette.'*

'We chemists are not high game enough for the monsters,' replied Lavoisier. 'These are indeed fearful times! Ugh!' continued he, shuddering; 'what the end will be, I know not.'

'It seems,' replied Berthollet, smiling, 'that some sort of revolutionary infection is in the air: even you, my friend, are struck with the malady.'

Indeed, few persons have been more revolutionary than

* The instrument of death invented by Dr. Guillotin, and now universally known as the *guillotine*, was for a time denominated the Louisette, because it was the deputy Louis who first made himself acquainted with its capabilities, and furnished a report upon them to the National Assembly.

Lavoisier in his own way. He revolutionised the whole domains of chemistry; he reduced the nomenclature of that science to a system, and gave us most of the names by which chemical substances are at the present time known.

'I shall not wait longer for Priestley,' at length said Lavoisier; 'I am impatient to show you my experiment:' and, saying this, he made arrangements for burning a piece of iron wire in oxygen gas. Every itinerant chemical lecturer performs the experiment now, because it is so brilliant. The performance of it by Lavoisier, in the presence of his friend Berthollet, marked the downfall of a theory. It was one of the capital discoveries of Lavoisier, that when a body was burned and the results of combustion collected, they were invariably heavier than the body consumed; from which it is quite clear that combustion cannot depend upon the *loss* of a something which philosophers called 'phlogiston,' but that it is attended with the *gain* of something. So Lavoisier proceeded to weigh his iron wire; he then burned it, and weighed the result of combustion; no difficult matter in this case, inasmuch as that result is a solid.

I shall not entrap the reader against his knowledge, giving him a chemical lecture in the place of a biographical incident; but it will be at least worth while to make him aware of some of the great points of philosophy developed by the subject of this sketch.

Whilst Lavoisier and Berthollet were thus engaged, the bell rang, and immediately afterwards Priestley was introduced.

'Mon ami,' said Lavoisier, going to meet him, and grasping his hand, 'why so late?'

Priestley trembled, and was pale; his coat, too, was torn; he sank into a chair, and for a time could find no words. When at last he spoke, Priestley explained that he had been lost in a crowd of revolutionary miscreants, who were parading the streets with a model of the guillotine. Such wild revels were frequent at the time. Bands of savage creatures, after glutting their eyes with the sanguinary scenes of a wholesale execution, would parade the streets of an evening, calling at the guinguettes, and quaffing strong drinks; carrying with them a model of the guillotine, which every now and then they would set down, and display its mechanism to all who contributed a sou. It was dangerous for a well-dressed person to be in the streets at this time. Rags and drunkenness were the only claims on the respect of these depraved wretches, the 'sans culottes,' as they gloried in being called.

Whilst Priestley was yet explaining the cause of his absence, the ignoble throng surged by. Hoarsely they yelled the revolutionary street-cries of the day: 'A bas les rois,' 'A bas les aristocrats,' 'Vive la Louisette,' 'A bas les philosophes.'

'Ah! is it come to this?' ejaculated Lavoisier faintly, as he heard the latter exclamation—a new one to the revolutionary vocabulary.

Apparently, a sufficiently large crowd had now come together to give hopes of a plentiful harvest of sous to the bearers of the guillotine. The crowd stopped near where the philosophers were assembled. The hateful machine was placed on the ground; the mock executioner raised the knife, and, instead of letting it fall immediately, gave out the first line of a revolutionary song, whilst one of the party went round for contributions, as the proprietor of a punch raree-show does in our own streets. Amid shouts of wild laughter, and abuse of all that is great and good, the words of a song written in honour of the guillotine fell on the ear.

'I wish those ruffians would pass on,' remarked Lavoisier, losing his patience, as they continued the revolutionary air. But the men had other ends in view.

The cry of 'Farmer-General—Diamond philosopher!' rose on the breeze, and the crowd surged on.

So, by some means or another, the outside myrmidons of

Robespierre had made themselves acquainted with what Lavoisier was about. The three philosophers exchanged glances ominously. To have the reputation of riches was, at the times of which I write, a cause of political suspicion. Lavoisier saw that he was compromised.

'Escape whilst you may,' said Berthollet, addressing him.

'What matter?' replied Lavoisier. 'If they set their minds on having my poor fortune, have it they will, whether I escape or not. I have never heeded riches, save for the power they gave me of aiding others. I have used them to accumulate facts. Now in future, if God will, I can earn my bread as an apothecary, and work out theories by reflection.'

Poor Lavoisier! So soon as he perceived himself to be compromised, he took it as a matter of course that he should lose all the wealth he had, and be obliged to recommence the world at the age of fifty. He anticipated nothing worse: why should he? What wrong had he done? Many days, however, had not passed before a different train of feelings came across him. It was the custom of the myrmidons of Robespierre, at that period, to circulate prejudicial reports against those whom they had already doomed to destruction. Vague rumours came to Lavoisier's ear of malversations committed whilst he was Fermier-Général. Conscience acquitted him of the charge; but what mattered whether true or false, provided Robespierre and his confederates had resolved to have him? In an evil moment, Lavoisier escaped and hid himself, which only seemed to give probability to the charges brought against him. The minions of Robespierre were still on his track, but could not discover him. Lavoisier might have escaped; but, actuated by a noble and generous sentiment, he determined to give himself up—not to the officers of justice, for justice was not then in the French dominions—but to the officers of Robespierre the monster.

His wife's father, M. Paulzé, happened to be in the power of Robespierre at the time when Lavoisier escaped. The latter, so soon as he became acquainted with this circumstance, determined to surrender at once, lest his absence might give colour to the charge against him and his father-in-law, and lest the latter might be unduly prejudiced.

Revealing the place of his concealment, Lavoisier was seized by the triumvirate, along with twenty-seven others, all of whom had been Fermiers-Général before the revolution. A great cry was now being made against the peculation of these same officials; and notwithstanding the office had been abolished by the revolution, and that none but an unprincipled tyrant would have judged people for retrospective offences in a case like this, Robespierre was not a man to be restrained by such scruples. The Fermiers-Général were rich; that was enough.

So Lavoisier was sent to prison, in company with the other twenty-seven. He was brought to a mock trial, and condemned; but the frivolous charge on which he was to die proclaims, better than a whole treatise, the integrity of his previous life. If the reader of this can divest himself of the knowledge for one moment of the fact that the axe of the guillotine is poised aloft, waiting for a victim; if he can drive out from the recesses of memory recollections of this fearful time, and carry himself ideally back into the council-chamber of the horrid triumvirate, where the nature of Lavoisier's derelictions were gravely set forth, he may indulge a passing smile. Fancy a man, retired from business many years, gravely brought to trial in Westminster Hall for having watered his tobacco and snuff *some ten years ago!* Yet so it was; no graver charge could be brought against Lavoisier by those who, depend upon it, said the worst they could about him. For this he died, on the 8th of May 1794.

It was dangerous to stand up and speak well of a man in those days; nevertheless, the citizen Hallé did so. He boldly impugned the right of trying a man on a retrospective charge; but he did it unavailingly. He then, when the trial was over and the sentence passed, invoked the mercy of the triumvirate! Alas! they had none. He set forth Lavoisier's discoveries, his many acts of benevolence, his charity, his other excellent qualities: all in vain—Lavoisier was to die.

The philosopher did not murmur; meekly he submitted himself to the impending fate. One request he made, and only one; any individual a shade less vile than Robespierre would have granted it.

'Let me live a few more days,' said he, 'to see the result of some experiments now going on.'

'Bah!' replied Coffinhall, the president of the judicial conclave, who had been sitting on the mock trial; 'the republic doesn't want philosophers. Away with him!'

Thus mournfully ended the mortal career of Antoine Laurent Lavoisier.

I have already adverted to the revolution which this great man accomplished in the science of chemistry. Two great truths, made known by him, I have already related. He made several other discoveries; but Lavoisier is chiefly known by the nomenclature which he devised, and which, somewhat modified to suit advancing necessities, is still retained by chemists. Before the time of Lavoisier, chemical substances were known by arbitrary names. Thus, the chemist Glauber, having discovered a certain salt, called it after his own name, 'Glauber's salt'—a name which conveys no knowledge of its composition. According to the nomenclature of Lavoisier, it is called 'sulphate of soda,'* a compound term, indicative of its being made up of sulphuric acid (oil of vitriol) and soda. Again, before his time, a certain gas—the gas which maintains vitality when breathed—was called by one of several vague names. Lavoisier, finding this gas a constituent of some acids—all that were known to him—and imagining that it was the universal acidifying principle, called

* Now more generally *sodium sulphate*, on the assumption that not sulphuric acid, but a *function* of sulphuric acid, unites with—*not* soda, but *sodium*.

it 'oxygen,' or the 'acid-former.' A true creature of revolution, the Lavoisierian nomenclature was arrogant. It set out on the basis that theories then adopted were true theories, and for all time must be true. It so happens, for instance, that many acids are devoid of oxygen, which therefore ought not to have been endowed with the universal name of acid-former. All true acids are now considered to have hydrogen as a necessary constituent. But I promised not to entrap the reader into the infliction of a chemical lecture. I wished to give a biographical sketch of Antoine Laurent Lavoisier; and it is done.

DALTON.

It was a cold December morning, and the snow lay deep, when a man, already somewhat advanced in years, and carrying a lantern, might have been seen to emerge from the house of the Rev. W. Johns, in George-street, Manchester, and proceed towards the Literary and Scientific Institution of that city. He was rather above the middle size, tall and bony. His features were hard, though not harsh; his eyes deeply set and thoughtful. His body was slightly bent—not conveying an idea of infirmity, but rather that sort of bending forward sometimes met with in pedestrians, and which creates the notion of a desire to hurry along. He wore the dress of a member of the Society of Friends, somewhat the worse for wear, but still not shabby from age. The sun had barely dawned; but, guided by the beams of his lantern, you might see, if observant, that his habiliments were spotted and stained. A closer inspection would prove that not a few stains had become holes; as if burned by sparks of fire, or some corrosive fluid.

The active life of Manchester is not like ocean's flood, which ebbs and flows, but like the current of an impetuous river, which ever hurries on. It was difficult to regard the tall factory-chimneys belching forth their smoke that morning, to gaze on the crowded streets, and to hear the busy click of machinery mingling with the hum of men, without feeling convinced that Manchester was a city of action, not of contemplation—that the worker-out of abstractions could find no place there. Silently, amidst this din and throng, the tall hard-featured lantern-bearer moves on. He goes towards the Literary and Philosophic Institution. Suppose we follow.

Is the man a lunatic? Unmoved by the hum of passing wayfarers, the lantern-bearer talks to himself. He talks of Plato, of Pythagoras, and Thales; he mentions also Lucretius; then whimsically mixes up those antique names with others of modern date. No, he is no lunatic, but a thinker aloud, a reverist. Arrived at the door of the Institution, he gives his lantern a shake, as much as to say, 'I have it now,' then opens the door and enters. He next proceeds to the laboratory, and deposits his lantern on the table. He then lays and lights the fire, according to the most approved rules of fuel economy—a perfect model of a servant in the matter of saving firewood; for, of course, a servant he must be.

Manchester has long been celebrated for her resident chemists. Calico-printing involves some of the highest branches of applied chemistry. Every new colour, almost every new pattern which may appear from time to time on a piece of Manchester printed goods, is the fruit of some new chemical discovery. In our curiosity, we wait. We like to see clever men at work in their retreats. We are in no hurry: the chemical professor will by and by walk in. But that lantern-bearing Plato and Lucretius-quoting fire-lighter, we are getting tired of *him*. There, he will go soon. He sweeps the laboratory clean, and dusts the bottles. He goes, but not away. He proceeds to an adjoining room, and taking his stand in front of a wall, whereon hang several barometers, thermometers, and hygrometers, he opens a book. He now enters particulars of temperature, atmospheric moisture, and barometric height, like a philosophic painstaking observer. He does not work like one unacquainted with his tools. He is an adept. Looking at the barometric mercury, for instance, no chronicling of mere inches, or quarters, or even eighths of inches serves his turn. He estimates the variation from yesterday by a Vernier scale, as an accurate philosopher would have done. He compares the barometers one with another, and finding that the mercury contained in one stands lower than the mercury of the others, he says (for he appears to be in the habit of talking to himself), 'Bad, bad!' Then referring to a memorandum-book in which the date of the construction of that barometer stands recorded, he finds the tube was neither dried nor was the mercury boiled. He makes a note of these facts. If the Professor's servant be thus wise, how much wiser must the Professor himself be!

A knock—a double knock! Does the Professor come at last? The lantern-bearer opened the door without delay, and an old gentleman entered. His face was radiant with joy, and he seemed to be out of breath. The lantern-bearer had no time to say a word, before the stranger seized him rapturously by the hand, and shook it heartily. 'Friend,' said he, 'I bring you good news. Good-morning, DOCTOR *Dalton*.'

The lantern-bearer opened his eyes as if arousing from a reverie, but he made no remark; his ideas were apparently in another channel.

'Good-morning, *Doctor* Dalton,' repeated the stranger, laying peculiar stress on the word 'doctor.'

If his object had been to surprise the lantern-bearer he was disappointed. The word 'doctor,' though strongly emphasised, seemed to have made no impression. The lantern-bearer was apparently thinking too much about his barometers, for, having bid his friend good-morrow, he turned towards his instruments again.

'I call you *doctor*,' repeated the new-comer. 'Do you hear me?'

'Did you indeed?' replied Dalton.

The stranger laughed.

'On some people,' said he, 'honours fall unthankfully, like drops of water into a thankless sea; whilst others would give their ears for honours. The Oxford people are going to make you D.C.L.'

'D.C.L.,' said Dalton; 'and what is that?'

'Doctor of Civil Law,' replied the friend.

'Doctor of Civil Law!' repeated Dalton, musingly, in a falsetto pitch of a naturally gruff voice; and he burst into an incipient laugh, not loud, roistering laughter, but a subdued cackling laugh—a proper laugh for a philosopher. 'What do I know about law, friend?' demanded he, as soon as he could speak—'law civil or law criminal?'

'Pshaw! it is a very great honour,' replied the friend—'the highest that can be given by the University.'

'Honour! but I say I know nothing about civil law; and if I don't know it, how can I teach it? and if I can't teach it, why am I to be called doctor?'

'It is simply a compliment,' repeated the stranger, smiling.

'Well, I could call it something else, if I liked,' was Dalton's sly remark. 'Doctor of Civil Law! Well, that *is* odd. If they would call me doctor of the laws of atomic combinations, there would be sense and truth in it; but doctor of civil law is neither sense nor truth.'

'Now I have it,' was the friend's remark. 'The Oxonians are determined to have you; and I have no doubt, as a special favour, they will allow the initials D.C.L. to stand for Doctor of Combination Laws. There, will that suit you?'

Perhaps by this time the fact will be evident that the elderly lantern-bearer, who came forth so early in the morning to light the laboratory fire, was no other than the illustrious Dalton himself, the philosopher whose name is associated with one of the most remarkable scientific discoveries of modern times—one second only in importance perhaps to the discovery of gravitation. Yes, it was Dalton who thus, day by day, lighted his laboratory fire. That great man would perform an analysis for half-a-crown, or give a lesson for eighteenpence, and thank you, in either case, for the trifle; whilst many an inferior chemist would have thought himself dishonoured by touching any but a golden fee. So little connection is there between self-respect and self-conceit.

When it is affirmed of a philosopher that he has a world-wide reputation, the words must ever be received in a qualified sense. To say that the scope of his reputation is as extensive as that of the poet, the historian, or the narrator of fiction, is simply untrue, because all persons have in them the faculty, more or less developed, of being able to appreciate history, poetry, and fiction. The remark is truer still when extended to those who achieve reputation by the fine arts. The scope of their reputation is nearly universal. Far different is it with him whose fame depends on discoveries in science. A chemist's labours, for example, can only be appreciated by chemists, for the most part; an astronomer's, for the most part only by those who have cultivated astronomy, and so on for other sciences. Pity this! Science has its bits of poetry, equal, at least in all that makes poetry attractive, to anything the poetry of language and sentiment can boast. The flights of the poetry of science, too, are more daring; and, though often wilder than the wildest rapture of the poetry of words and sentiment, they have the rare merit of being as true as they are wild. Here, then, is a beautiful field for the mind to career upon, like a steed from harness released—a field all covered with gems and flowers, the gems and flowers of truth. But around that pleasant field is a thorny fence, bristling with technicalities. The philosopher alone can penetrate that hedge, and enter within. All who are not philosophers must be content to remain outside. Nevertheless, little gaps can be found, here and there, through which inquisitive folks may peep; and I think it may be possible to give the reader who is no chemist a peep into the enchanted domains of the atomic theory and doctrine of definite proportionals—to unravel the secrets of which was the aim of Dalton's life-long labour. Yes, there *is* an opening, and you shall have a satisfactory peep, but on one condition only—you must not be frightened by names. If people would only make up their minds not to be frightened by names, they would not find science so difficult. The 'atomic theory' is the name, or rather one of the names, you are not to be frightened at; the 'doctrine of definite proportions,' or 'equivalents,' these are other names. Forget the existence of all these names, however, at present.

The philosophers of ancient Greece and Rome were fond of arguing about philosophic beliefs—matters which they could neither prove nor disprove, because they were not experimental people. Amongst the chief topics of argumentation, the following was one: whether a thing having weight, and cognisable to the senses (matter), could or could not be divided without end. Epicurus and Pythagoras imagined that matter could be thus divided *ad infinitum*, and Lucretius sets forth the views of these philosophers. Other ancients, too numerous for mention here, adopted the other side of the argument; and so they continued to argue away, proving nothing, until both sides got tired.

And what do *you* say about the argument? Don't fear giving an opinion. You have common sense, and that goes a long way in philosophy. What do *you* think about it? Can *a* substance—*any* substance—a potato, for instance—can that potato, I ask, be indefinitely divided, or is such indefinite division impossible? Evidently the potato may be cut into two halves, and each of the two halves may be halved again and again and again, and so on, until our eyes are not sharp enough to see the little pieces. If instruments be now had recourse to—a microscope and a delicate knife—the division may be carried still further; and it thus seems proved that the subdivision of the potato *ad infinitum* is conceivable, if our instruments were delicate enough to effect the subdivisions, and our eyes to make them discernible. Thus argued Epicurus and his followers.

Let us now look at the other side of the argument, illustrating it by an assumption. Suppose that amongst the unknown things existing in parts of the earth yet unexplored, there should be a lump of new matter found (we may not say a particle)—a lump of some definite size—as big as a potato, for example. Suppose that lump of new matter should be so very hard that no human means could break, or cut, or otherwise divide it. What then? It would be indivisible, of course, 'uncuttable;' or, if we choose to adopt a Greek expression, it would be 'atomic,' this word being a modification of α (*not*) and τεμνειν (*to cut*)—not cuttable, or not divisible—in short, 'atomic.'

So it appears, then, that our ordinary notion of an atom, as being something necessarily small, is only, after all, an indirect notion. That atoms *must* be small, if they really do exist, is demonstrable, since all matter can be divided to the furthest limits permitted by our means; and the division might be carried further still, if our means and our senses permitted. But, for anything one knows to the contrary, the potato *may* be composed of amazingly small indivisible parts; and the hard indivisible parts might each have been tangibly large—as large, say, as a potato, as assumed to be the case with the new mineral invoked by hypothesis. Whether large or small, such palpable indivisible masses would have been to all intents and purposes *atoms*.

Mark, then! There lurked a fallacy in the argument of those who denied the possibility of atoms, because a substance (a potato, say) might, as they said, be conceived to be infinitely divisible. This line of illustration by no means proves that the potato could be infinitely divided, were it not for the imperfection of our senses and our tools, but merely (which is quite another thing) that the *space* occupied by that potato might be thus divided.

If atoms of matter be so inconceivably small, how then could people expect to see them? and if not seen, how could their existence be demonstrated? The ancients could get no proof; so they allowed the discussion to drop. Even in later times, our own illustrious Newton, though a believer in the existence of atoms, could not prove them to exist. He hoped they might hereafter be rendered visible by high microscopic power, but that hope has never been realised, and no one at this time believes that it ever will be realised. After Newton's time, the discussion dropped once more; and may be said to have remained in abeyance until the celebrated labours of Dalton proved the existence of atoms by every testimony short of rendering them visible. We can never hope to see them, they are so very, very small.

I must now, reader, find a tangible illustration, else you will not get your promised peep into the enchanted regions of the atomic theory.

You and I, we will assume, are schoolboys for the nonce. We have a bag before us, that bag containing leaden bullets. Dipping my hand into the bag, I withdraw a handful of leaden bullets, throw them into the scale-pan, and weigh them; their weight we find to be (say) *three* ounces. We take another dip, and proceed exactly as before; but the weight is now (say) *five* ounces. Once more, *six* ounces. Once more, *four* ounces; and yet again, *two* ounces. That will do. Let us now see what comes of it:

		oz.
Experiment	V.	2
„	I.	3
„	IV.	4
„	II.	5
„	III.	6

We perceive that, although our dippings have been quite at random, we get no fractions of an ounce—no halves and quarters, and so forth. Moreover, the results of the five weighings seem to prove that each of the bullets weighs exactly one ounce; and if similar results accrued from any number of weighings, that which was at first a notion would grow into an irresistible conviction. Observe what comes of this. There are sixty and more known kinds of matter, in respect of which Dalton perceived that, weigh them, torture them, analyse them as he might, his weighings, torturings, and analyses disclosed no fractions. How can this fact be explained, except on the assumption that matter is composed of ultimate atoms?

If we now assume, in place of the existence of one set of bullets of one weight and one substance, the existence of sixty and more* different kinds of bullets, differing from each other in weight; so that, calling the weight of the lightest 1, the weight of the heaviest would be 213, we arrive at a still nearer idea of the conditions of the atomic theory.

It so happens that each kind of matter has its own appointed work to do; and that one kind of matter can do the work, or fill the place of another kind. Thus, to give an example in the language of chemistry, chlorine can unite with hydrogen, and so can oxygen; but whereas exactly eight parts by weight of oxygen are required by exactly one part by weight of hydrogen to generate water, it takes thirty-six parts by weight of chlorine to be equivalent *for*, or take the place *of*, the aforesaid eight parts by weight of oxygen, and, by combining with the one part by weight of hydrogen, to form hydrochloric acid. So 1, 8, and 36, are said† to be the equivalents or atomic numbers of hydrogen, oxygen, and chlorine

* The exact number of elementary bodies is still undetermined: sixty-three is usually accepted.

† Or *were* said. It is usual now to regard the atomic weight of oxygen as 16, on which assumption water is composed of two hydrogen combined with one oxygen.

respectively. In like manner, each of the sixty and more kinds of matter has its own combining, or equivalent, or atomic number: for instance, the atomic number of the metal copper is 32, and that of silver 110; by which we mean to say, that if one part of hydrogen can do a certain amount of work, it will require eight parts of oxygen, thirty-six of chlorine, one hundred and eight of silver, and thirty-two of copper, to do the same amount of work.

But of what are these numbers the respective weights? grains, ounces, pounds, or, in short, *what?* Just whatever you please. Atoms being inconceivably small, we are unable to weigh them absolutely: we can only ascertain the relation subsisting between their weights; the ratio according to which is lighter or heavier than its neighbours.

Cui bono? What's the advantage? It is universal. Everything truthful and reliable in analytical and operative chemistry depends upon an application of the facts above mentioned. Take an example. If silver be thrown into aquafortis, the metal dissolves and disappears, but it still exists in the aquafortis. The piece of silver, we will assume, weighed 110 grains. A chemist wishes to get this silver, but the aquafortis will not let him have it until it receives a *quid pro quo.* The greedy solvent will be content with copper, and so the chemist determines to give it copper; but he wishes to give it the exact quantity required, neither more nor less. Dalton's law teaches the chemist that 32* grains of copper will be the exact quantity. He adds that amount, and down goes the silver. It was a great thing, even practically speaking, to have made this discovery.

Dalton furnishes a rare example of what a strong will and a vigorous intellect, when they co-exist, can do. He was the son of a Cumberland weaver — a very poor weaver, earning

* In the language of present chemical nomenclature, copper is said to be a di-valent, and its combining weight 63·5—say, in round numbers, 64: double the formerly received atomic weight as given above. Study the two concluding paragraphs at p. 63.

only a scanty subsistence by making common country goods, while his wife eked out the scanty income by selling paper, ink, and quills. The poor weaver, however, did not neglect the education of his son. He taught him at first himself, paying to mathematics especial attention. Subsequently young John Dalton was sent to school, under the charge of Mr. Fletcher, a member of the Society of Friends, to which community the Dalton family belonged. John Dalton here remained until about twelve years old, when he set up as schoolmaster on his own account, furnishing an early proof of that energy and self-reliance so conspicuously brought out hereafter. But it was a winter school only. His father, at this time, had given up weaving, and become farmer. He was poor, and the dutiful schoolmaster helped him during summer time to labour in the fields. Many Cumberland boys were situated like the Daltons, learning in winter time, and working during the remaining portions of the year on their respective farms. A boy of twelve years may have the materials for teaching in him, but he will find it hard work to maintain order amongst boys of his own age. John Dalton experienced this; some of his pupils, it is affirmed, would neither be silenced nor commanded, but challenged the schoolmaster out to have a stand-up fight. The great man's biographers do not say whether he accepted the challenge.

Our philosopher occupied himself in this winter school for about three years, which brought him to the age of fifteen. This period is marked by Dalton, in a letter to a friend, as constituting an era in his life; for then occurred what seemed to him a remarkable event. Dalton, when on a visit at Cockermouth, saw an umbrella. He bought it, and felt himself (to adopt his own words) 'becoming a gentleman.' This little incident ought not to be omitted from a biographical sketch of Dalton's life. It shadows forth two traits of character ever conspicuous in him — dry quaint humour and simplicity of tastes. He now, at the age of fifteen, began to act as the usher of his cousin, George Bewley, who kept a school at Kendal; and here his own real education commenced. Providence threw him in the way of the blind mathematician Gougb, to whom Dr. Whewell and other great mathematicians are indebted for their early training, and whom the poet Southey has commemorated in the following beautiful lines:

> 'Methinks I see him, how his eyeballs rolled
> Beneath his ample brow, in darkness pained,
> But each instinct with spirit, and the frame
> Of the whole countenance alive with thought,
> Fancy, and understanding; whilst the voice
> Discoursed of natural or moral truth,
> With eloquence, and such authentic power,
> That in his presence humbler knowledge stood
> Abashed, and tender pity overawed.'

Ultimately, Mr. Bewley gave up the school, which was continued by the two brothers Dalton, John and George. To begin housekeeping was hard work for the brothers. Their means were small, and the necessities of furnishing pressed hard upon them. Nevertheless, what with the assistance of Mr. Bewley, and seven guineas lent them by the old people, to be repaid '9 mo. 29,' and which *was* paid only a week after time, and thirteen shillings and sixpence thrown into the common fund by kind sister Mary, who acted as housekeeper, and in respect of whom our philosopher's journal bears the expressive testimony of 'Mary, in part, 0*l*. 0*s*. 6*d*.'—the first difficulties of housekeeping were overcome. The brothers Dalton may be said to have succeeded in their school, notwithstanding that the average income derived from tuition was only 70*l*. per annum. This scanty pittance was eked out by drawing conditions, collecting rents, making wills, and searching registers; all which brought them, on an average, about 5*l*. per annum more.

But the life of a village schoolmaster afforded a scope too restricted for a gigantic intellect like that of John Dalton. He yearned for a profession more congenial to his tastes, and thought of either becoming a barrister or entering the medical profession. Happily for science, and for himself too, he did neither. What is erroneously called a casualty proved the turning-point of his scientific destiny. In the year 1793, Mr. Barnes asked Mr. Gough to recommend a suitable teacher for mathematics in the New College of Manchester. He recommended Dalton, who was accordingly elected. He lived in the establishment, and taught mathematics for six years; publishing during this time his *Meteorological Observations and Essays.*

In 1794, Dalton became a member of the Literary and Philosophic Society of Manchester, inaugurating his connection with that learned body by reading a paper on 'Extraordinary Facts relating to the Vision of Colours.' The fact is, Dalton was a subject of the peculiar visual defect to which the term of *colour blindness* has subsequently been given. He did not see colours as people usually see them. 'I can,' says he, 'see two, or at the utmost three, distinctions in the solar spectrum; these I should call yellow and blue, or yellow, blue, and purple. Yellow and blue make a contrast to my eyes; blue and purple differ more in degree than in kind. Pink appears by daylight to be sky-blue, a little faded; by candle-light it assumes an orange or yellowish appearance. Crimson appears muddy blue by day; and crimson woollen yarn is much about the same as dark blue. Red and scarlet have a more vivid and flaming appearance by candle-light than by day-light. To me there is not much difference of colour between a stick of red sealing-wax and grass by day. Dark green woollen cloth seems a muddy red, much darker than grass, and of a very different colour. Coats, gowns, &c. appear to me frequently to be badly matched with linings when others say they are not. On the other hand, I should match crimson with claret or mud; pinks with light blues; browns with reds, and drabs with greens. The colour of a florid complexion is dusky blue.' Dusky blue for a lady's face!

The affection of colour blindness has been noticed by Dalton's biographer, Dr. Angus Smith, as perhaps supplying a key to some of that great philosopher's traits or peculiarities, especially the dogged persistence wherewith he advocated views based on evidence unperceived or incomplete to other people.

Dalton's character was deficient in idealism. He was an indefatigable hunter after facts—*truths*. Adopting these as a basis, he arrived at deductions which had been heretofore mere poetic dreams begotten of ardent fancies; thus affording another example of the frequently noticed fact, that the fictions of poets and ideal speculations, however wild they seem, are often the shadows of truth unseen as yet, but slowly advancing towards the goal of discovery. An engraver on copper, affected with colour blindness still more completely than Dalton—only being able to distinguish in the varying tints of colour, gradations of white and black—testified that he considered the affection an advantage. He was not subject to the difficulty of being able to decide on the amount of whiteness or blackness of which each tint of colour should be rendered in the engraving. May not the colour blindness of Dalton have imparted increased tranquillity and power of concentration of other faculties? May not the field of his intellectual excursions have been rendered more free from obstacles, in proportion as his sense of vision was narrowed? Might not the sum of intelligence remaining to him have been increased by the extent of the amount taken away? 'It would probably explain many strange occurrences,' writes Dalton's biographer, 'if we were to consider that there are really persons in the world who see all crimsons as "dark blue" or "a muddy blue," and who would match crimsons with claret or mud, pinks with light blues, browns with reds, and drabs with greens; who see the healthful tints of a florid complexion to be like "dilute black ink on white paper," or "a dull opaque blackish blue upon a white ground." How many strange mistakes and visions might be accounted for by this defect of sight! A fair face with glowing veins would be to Dalton as a corrupting corpse!'

Nevertheless, Dalton was not insensible to human, to *female*, beauty. Though he never married and never courted society, he was not, like Cavendish, a misanthrope. If he did not court society, he did not flee from it; and if he did not shine in general conversation, he was a good listener. His letters are a fount of kindly sentiment and droll humour. He has been called penurious, but during the greater part of his life he worked hard and remained poor. He gave 50*l.* towards building a chapel at a time when he had little to spare; and he held forth the helping hand of charity on many proper occasions. He was awkward in manner, and his voice was harsh; perhaps, conscious of these defects, he did not court society. But is not courting social intercourse to be imputed as a fault to one who felt the span of life already too short for the maturing of his researches—one who made upwards of two hundred thousand meteorological observations, and experiments innumerable—one who taught much, wrote much, and worked in the fields—one whose mind must have been roaming amidst the atoms, who penetrated into the immensity of created particles and weighed them as in the scales, though he could not see them?

The desire to become and remain independent was a fine trait in the character of Dalton. His becoming schoolmaster at the early age of twelve was a proof of it, in boyhood. In manhood, he gave still further proof, by refusing an offer which many in his position would have readily accepted. A gentleman, who entertained sincere respect for Dalton's scientific talents, and fearing lest the *res angustæ* would impede his pursuits, offered him apartments, complete independence of action, a laboratory, and 400*l.* per annum. The philosopher respectfully declined. He feared to compromise his independence.

In the year 1804, the fame of Dalton as a philosopher had become so widely spread, that he accepted an invitation to deliver a course of lectures in the Royal Institution of Great Britain. Davy (then Mr. Davy) was professor of chemistry there at the time—a young man of elegant manners, and somewhat vain. Dalton was the reverse of all this. Davy, fearing that the unstudied manners of the great philosopher would leave a disagreeable impression on the minds of an audience so fastidious as that of the Royal Institution, advised him to write his first lecture carefully. What followed shall now be told in Dalton's own words. 'I studied and wrote,' said he, in a letter to Mr. Johns, 'for nearly two days; then calculated to a minute how long it would take me reading, endeavouring to make my discourse about fifty minutes. The evening before the lecture, Davy and I went into the theatre; he made me read the whole of it, and he went into the farthest corner; then *he* read it, and *I* was the audience.' Who would not like to have seen the two great philosophers thus engaged? The first lecture went off satisfactorily; and Dalton's self-confidence was complete.

Dalton's lectures at the Royal Institution were much admired for their philosophy; but the philosopher's manner gave rise to comments and pleasantries. Among other things, a laugh was raised against him for calling the elementary bodies, oxygen, hydrogen, &c., 'these articles,' speaking of them, it is said, with far less enthusiasm than a linen-draper would have spoken of the articles on his shelves. Dalton was now for a time absorbed in the vortex of fashionable club-life. This was not to his taste, but it was kindly meant, and he did not avoid it. Too often his abstractions caused him to forget the time, and to arrive when dinner was over. On this he would repair to the nearest eating-house and supply his wants, duly recording what he had for dinner and what he paid for it. The boiled-beef shops, which furnished him with a dinner and beer for 11½*d.*, were his admiration; but he complains harshly of having had to pay, on one occasion, eighteenpence for a basin of soup—no more than a pint.

In many respects the stamp of Dalton's character was like that of Cavendish. The same mathematical turn was common to both; the same unpolished manners and uneasy address. Both were self-reliant; each trusting more to his own deductions than to the opinions of others. But Dalton possessed a genial love of humanity which Cavendish had not, and a fund of quiet humour to which the latter was a stranger. Neither married: Cavendish because he hated womankind; Dalton, as he playfully observed, because he could never find time. But Dalton was, nevertheless, fond of the society of ladies. The memory of a lady, too, was painfully blended with thoughts of his early life. He held a letter written in a female hand. It had been addressed to him as a youth, but he often read it when stricken in years. He never told its contents, nor allowed any strange eye to gaze upon them: but as often as he read the letter, he would shed tears. The coryphæus of atomic philosophy was not moved to tears by a trifle, depend upon it. Even when in London, delivering lectures at the Royal Institution, he could unbend enough to furnish Mrs. Johns with a notion of London fashions. 'I should tell Mrs. J. something of the fashions here,' he writes to Mr. Johns; 'but it is so much out of my province, that I feel rather awkward. I see the *belles* of New Bond-street every day, but I am more taken up with their faces than their dresses! I think blue and red are the favourite colours. Some of the ladies seem to have their dresses as tight round them as a drum, others throw them round them like a blanket. I do not know how it happens, but I fancy pretty women look well anyhow.' When we reflect that a lady's face must have seemed to Dalton sky-blue, and her ruby lips purple or mud colour, he must have been very far from a woman-hater to have thought them pretty!

This sketch of Dalton's life would not be complete without stating the circumstances which first led him to be intimate with the Johns family. In early life Dalton had been acquainted with Mr. Johns, but not intimately. Mr. Johns having married, happened to be living in Manchester when Dalton came to that city. Dalton passed the house of the former daily. In the autumn of 1804, Mrs. Johns casually meeting Dalton, asked him why he never called.

'I really don't know,' was Dalton's reply; 'I will come and live with you if you will let me.'

He *did* come, occupying the only spare bedroom, and sitting with the family. In this new home Dalton remained in the greatest amity for six-and-twenty years. This brings us up to the period at which our sketch commenced. Honours now flowed in on him apace, always unsolicited. He was not insensible to them; but they always remained external to him, never altering his simple tastes, or otherwise affecting his manner. In 1834, he was presented at court. He did not seek that honour, neither did he churlishly retire from it. On this occasion, as formerly when Dalton lectured at the Royal Institution, his friends thought he would require training and rehearsal, the better to enable him to act and move with grace in the presence of majesty. He was therefore taken under discipline, like one who had to accomplish a feat. A question now arose of some importance. In what costume was Dalton to be presented? A Quaker decked in court dress, and girded with a sword! Horrible! A friend suggested that the presentation had better be made in the scarlet robes of a D.C.L. Fears were still entertained lest Dalton might think that guise too conspicuous; but Mr. Babbage, who seems to have managed the diplomacy of the business, did not find him intractable in matters of innocent form. So it was agreed that he should present himself before royalty in the scarlet doctorial gown, the colour of which, as Dalton was colour blind, would not seem a very demonstrative tint. The man who considered red sealing-wax to be of the colour of grass, a lady's face sky-blue, her lips purple or the colour of mud, would not, after all, be dazzled by the colour of a red robe. In the preliminary course of drilling which Dalton underwent, the friend who personated royalty detained the presentee only for a moment: he had therefore but two points of rehearsal left—to gather up his robes, and retire.

Fortune, it is said, proved treacherously kind to Dalton on presentation day. The trumpet-blast of fame had preceded him. Somebody replying to a royal question, intimated something about the man in red. The king, finding that he had to do with no ordinary individual, contemplated Dalton's face longer than a moment. Provision for this contingency had not been made in rehearsal. Dalton thought, as some people aver, that the king waited to be spoken to; and Dalton is said to have bid the king good-day, and asked him how he did. Another version of the tale is, that Dalton, instead of passing on, stood so long before his majesty, that the latter was embarrassed—wishing to be civil, yet knowing not what to say. This much is clear—Dalton's true place was not in any gay throng of worldly splendour.

Dalton was now growing old, full of honours, and in the enjoyment of comparative wealth. He had been placed on the civil list as a recipient of 300*l.* per annum, and he had succeeded to a small patrimonial estate. His industry had not diminished; but the subtle penetration which characterised his younger days—that genius, in short, of which the atomic doctrine was the fruitage—had paled and dimmed. Industry and energy both remained, but they did not suffice to increase his fame. Dalton had never been a great reader; on the contrary, he objected to book lore, boasting that he could carry on his back all the books he had ever read. This boast was an index of his leading characteristic—self-reliance on individual deductions. In a matter so little handled as the doctrine of atoms, this peculiarity might have been an advantage. In Dalton's own brain, the ideas of atomic constitution were harmonious and defined. External to the domains of his intellect, all on that subject was discordant and chaotic. Perhaps he did well to close his senses against the outer confusion. The composer of music, living in a city where discordant sounds prevail, does well to seclude himself, and trust his own perceptions. But he would be a foolish composer who, living in a grove, amidst the warbling of birds, should close his senses to their influence. Dalton was an honest, bold, and self-reliant man. Whatever he attempted, he preferred to do alone. To be honourably independent was the maxim of his life—its spring, its motive force. This is an honourable sentiment: few men have it in excess. But even a sentiment, good intrinsically, may be unduly developed. Perfection of human character is the result of a balance established *between* faculties, not of the expansion of one. Dalton's negligence, his contempt almost of the labours of others, made him perhaps a greater genius, but a lesser man. His self-reliance partook of the nature of pride; and pride, like other faults, prepares a scourge for itself. Dalton's small reading was the cause of his sometimes appearing in the character of a plagiarist, though quite unwittingly. He accomplished some discoveries which had been discovered before—things great and wonderful, considered as the fruits of mental exercise, but of a bygone age.

The doctrine of atoms which he had given to chemists was an agent of tremendous power—an engine wherewith the rocks of crude knowledge could be moved and shattered, and their gems of truth laid bare. These rocks of knowledge had already been chronicled in books, as rocks and quicksands are depicted on geographic charts. Dalton, like a traveller rich in instruments, but ignorant of geography, knew not where to find them. Other travellers borrowed his tools, shattered the rocks, and unmined the gems. To develop and unravel the laws of atoms was to realise the brightest philosophic day-dream of modern times—a great and memorable work. The later efforts of Dalton were less happy. He failed chiefly because he knew not what others had done; thereby furnishing a proof, were it required, that a single human intellect, even when brightest and clearest, is a weak and limited thing. As Dalton grew older, he overrated his powers. A paper of his, sent to the Royal Society, and rejected, first aroused in him the suspicion of this fact. On the returned paper Dalton wrote a few words, which have the force of an epitaph: 'I sent the account of the Phosphates and Arseniates to the Royal Society. It was rejected. Cavendish, Davy, Wollaston, and Gilbert, are no more!'

On the 18th of April 1837 he was seized with an attack of paralysis, from which he never quite recovered. On February 15th, 1838, he was attacked again; but rallying, he still talked of science; and speaking of a scientific man whom he had seen in France, he said, 'Ah! he was a wreck then, as I am now.' His end was near. On May 27th, attempting to rise from bed, he fell on the floor and died.

It would be injudicious to close this sketch without adverting to some modifications of opinion the atomic theory has undergone and is still undergoing. Just at this time chemists are divided in opinion as to the existence or non-existence of atoms; and for some years past a distinction has been found necessary between *molecules* and *atoms*. The expression *equi-valent* has no longer the universality claimed for it by Dalton. Chemists now speak of mono- di- tri-valents, &c.

The atomicity or non-atomicity of matter will probably never be determined; but the definite proportionality of chemical combination, as established by Dalton, is a fact. *Assume* the existence of atoms, and we find a cause for this definite proportionality; *deny* the existence of atoms, and the result is inexplicable. To quote an expression of Monsieur Dumas: Matter *may* be atomic, or it may *not* be atomic; *but if atomic, its elements must observe definite ratios of combination exactly as they do now.*

COSMETICS.

THE SKIN.

WHAT are we to say about the propriety of painting the skin? The subject is one that would soon lead the inquiring mind into troubled waters; or, if the figure of speech be thought unfitting, would lead it to troublous issues. A lady about to paint, or varnish, or enamel herself, has first, if she be wise, to consider the matter from a hygienic or health-disposing point of view. She has to consider what the skin is, what it has to do, and how the interior economy may resent any violation done to this delicate expansion. Having decided to rouge upon a white ground, she has to consider what the white ground shall be, and what the pink to be laid upon it. Ah, ladies, you do not think of these matters—you never *will* think of these matters! The perfumer, then, must do it for you, as he does for the most part conscientiously. The white pigments used for skin-purposes at the present time are commonly harmless; time was when a verdict so favourable could not have been given. As for rouge, the best is a preparation, by a treatment unnecessary to state here, from the *coccus cacti*, or cochineal insect; an inferior sort is got from safflower, the petals of a flower used in dyeing. White skin-pigments usually go under the name of 'pearl-powder;' though the composition of none of them has anything to do with pearls, and though so-called pearl-powders differ extremely in their nature. I shall treat of their composition by and by; pausing now to note the troubled waters, or troublous issues, as may seem the trope most fitting, to which I adverted.

If skin-powder cosmetics are indeed harmless, as those now used mostly are, then what troubles are we to encounter? Moral troubles—conscience troubles, ladies fair. You know what opinions some people hold in respect to what they call vanity. You know how sinful it is in the estimation of some people to tint the skin. Would you wish me—a man liking peace and quiet—to pronounce opinions on this point, to state whether I approve of skin-painting, regarded from a moral point of view, or disapprove of it? Goodness, no! I hate argument. The morality of the thing, ladies, pray settle among yourselves. Still, perhaps some people may accede to a few general propositions; the first being that any lady whose complexion is good already had better let well alone. It is not within the competence of any art to give the delicate tints which mantle upon a really beautiful female skin. My advice to ladies having delicate complexions, and valuing the gift, would be to keep their complexions good by observance of certain points of discipline. Early hours, not too much dancing, distilled water for the toilet, and low alkalised soap.

If asked to specify the greatest enemy to the duration of a lady's complexion, I would state the London season; recurring again and again, with all its hard work, its mental anxieties and general rigour. Yet there will be London seasons *many*, despite my vaticinations; and belles *must* disport themselves in hot drawing-rooms, and eat ices after the ball's warm glow; and turn night into day. They must do all this and more; all not conducive to good health, and hence not to the maintenance of the highest ideal of skin-beauty. Wherefore, after a certain age, I suppose skin-pigments there must be, as there always have been.

There was a time when the chemical nature of things was not so well known as to-day; when the creamy whiteness of flake-white—none other than superior white-lead—entered into the composition of pearl-powders. I need not pause to reprobate the awful danger of employing this material for such a purpose, seeing that the employment is abandoned. Subsequently to the going-out of white-lead as face or pearl-powder, another metallic preparation—the trisnitrate of bismuth—came in. It is not so decidedly poisonous as a lead compound, but it is poisonous enough to prove injurious to the skin; indeed, I know not of any metallic pigment so innocent that it can be laid-on the skin continuously without incurring serious damage. Such pigments mar the beauty of the skin at least, perhaps lead to evil constitutional effects through absorption.

Even if white-lead and trisnitrate of bismuth were not injurious to the skin and poisonous generally, their use as skin-pigments would be attended with a great disadvantage. They both turn black under the influence of sulphuretted hydrogen — a gas which in small quantities exists pretty largely diffused. The effect of bringing concentrated sulphuretted hydrogen in contact with skin whitened by a lead or bismuth preparation would be to turn the skin suddenly black. Under the usual circumstances of society, no such extreme issue as utter blackness need be contemplated; but a certain darkening of colour would rapidly ensue, destroying the harmony of the work of art perfected with so much care—dissipating the illusion of a beautiful complexion.

The tale is recorded in books of a certain lady who had been whitening her skin with trisnitrate of bismuth—magistery of bismuth our grandmammas and grandpapas called it—and who chanced to bathe whilst whitened thus in the Harrogate waters. Harrogate is celebrated for its sulphurous springs. The water of these springs holds sulphuretted hydrogen dissolved. If it be a fact that the lady in question went into a Harrogate bath of sulphurous water whilst skin-painted with bismuth magistery, then it must have come true what the tale records, viz. that she in one instant turned as black, wherever the pigment was laid on, as any Ethiop.

Pearl-powders, as now used, are variously made. Some are nothing else than powdered talc or French chalk; others, a mixture of the same with common chalk; a third order contains starch-grains mingled with the preceding one, or both. By starch-grains I would be meant to signify the preparation known as 'violet-powder,' which really has no more to do with violets than it has with cabbages or cucumbers; being really nothing else than starch-grains odorised by orris-root—*iris florentina*, sweet-smelling iris—a root that smells not unlike violets.

Much discrimination is used by perfumers in selecting a proper sort of starch-grain. Whencesoever starch comes, it has the general characteristic of being in grains. These are readily made manifest under microscopic examination, and are then found to be different, not merely as to size, but as to shape. Hence it is that the investigator can tell whether one kind of starch be mingled or adulterated with another. For example, arrowroot—genuine arrowroot—is starch obtained from the *Maranta arundinacea.* It happens to have an agreeable taste, and hence is so valuable for dietetic uses. It is more expensive than the starch of wheat or of potatoes; than starch indeed generally, hence it is often contaminated.

The grains of wheaten starch happen to be large and coarse; hence the material, although it will do very well for hair-powder, is not satisfactory when used as a complexion-powder; the grains are too staring. Horse-chestnut starch has been much employed for this purpose; so in like manner the starch of ordinary chestnuts; in short, perfumers have, or pretend to have, each a speciality. Nothing whatever can be alleged against any starch pure and simple when used for toilet purposes; on the contrary, it imparts a softness and a freshness both salutary and delightful.

Violet-powder hardly comes under the definition of a cosmetic. When made-up with other ingredients to constitute the so-called pearl-powder, is it injurious then? That will depend on the character of the materials with which it is compounded. On white-lead I have already pronounced.

It may well be called fatal; not only to beauty, but in certain cases to life also, and to health in all cases.

In ordinary domestic usage, thus to write, in the ordinary employment of skin-cosmetics by ladies themselves, violet-powder, the so-called pearl-powder, and rouge, usually complete the list. When female charms have so much waned that higher artistic resources are needed, or are thought to be needed, the case is one for out-of-door practice. Then come the operations of enamelling and blue-veining,—operations that are kept a secret, but in performing which the chemist, if he so pleased, could beat the professed artists who make ladies 'beautiful for ever' out of the field.

I have already adverted to collodion as being a material that may be used to give the appearance of artificial skin, and I have indicated some limitations to its employment. As then stated, I have no doubt that a human individual, man or woman, might be killed by the laying-on of an investiture of collodion all over the body. Death would be induced by occluding the cutaneous pores, checking exhalation, perspiration, and skin-respiration. It does not thence follow, however, that a layer of collodion may not be deposited over limited surfaces of the skin with impunity, nay in some cases with advantage. Suppose, for instance, that a finger has been cut or scalded, and the cuticle removed. The immediate injury may not be grave, but it becomes irritating through collateral circumstances. Not only does the part look ugly—something to be regarded in a pretty hand—but every touch of salt, vinegar, soap, and a thousand other things that might be mentioned, and that we are obliged to touch, induce and keep-up a troublesome irritation. The wound thus perpetually worried, so to speak, gets worse and worse, and all for want of covering. In such a case, collodion is a real boon. I mean true collodion, or solution of gun-cotton in ether. There is a spurious collodion, which is made by dissolving gutta-percha, he effect of which is by no means so good.

The use that might be made of collodion for cosmetic purposes happened to be brought under my notice casually during medical attendance on a case in my own practice. A blister having been applied to the chest of a girl whilst in the condition known to physicians as that of anæmia, or deficient blood, the blistered part, instead of healing kindly, as it should have done, mortified. The patient being supported by administration of stimulants, the mortified part in time came away, leaving a frightful wound extending all over the chest, and up into the visible part of the neck. At a certain stage of treatment collodion was had recourse to, for encroaching on this wound around the edges,—imparting a ring of artificial skin, in point of fact. The practice had no reference to beauty at that time, but I could not fail to be struck with the beauty of the work in addition to its surgical efficacy. Wherever the collodion had deposited and dried, there was not only a protective surface, but a very satisfactory-looking skin,—a little too white and glazed for nature, but yet satisfactory. When my patient got better, and wished to appear in society, the suggestion came from her that I would perform the office of Madame Rachel,—that I would enamel her neck, and make it presentable. I did my best, and, for one who took-up extemporaneously a new art, the success was encouraging. With the artificial skin to begin upon, touched-up with now a rub, now a stipple, of rouge and pearl-powder, and finished-off with violet-powder, I turned-out a work of art beautiful to look at from afar, and not contemptible on nearer scrutiny.

Having no intention to devote myself to this branch of practice for my own immediate emolument, and as little intending to patent the process for acquiring wealth in an indirect way, it would be a useless and a churlish thing for me to hide my knowledge under a bushel. I throw it open for the benefit of science, of beauty, and Madame Rachel. To one conclusion I have come, *videlicet*, the real artistic want I felt was the absence of those short downy hairs which, growing all over the skin, impart a look of such delicacy and softness. The absence of this down is very conspicuous on a waxwork presentment of the human face divine. Anybody with true artistic eye, having gazed on a waxwork, even the most admirably finished, must have been struck with a certain ghastly unreality; he perhaps knows not what or why. It may seem strange that it should be, yet so it is. The defect can hardly be due to that merely explicable on the assumption of imperfect colouring; it must be referred to a deeper source. It comes of this, namely, the wax surface is wholly devoid of *those* small hairs—of *that* soft down; hence the unreality. Now to the point. Whenever, if ever, and perhaps it will be sooner than I think—whenever some artist in female-charm rejuvenation, commencing where I left off, takes up this collodionising treatment of the fair, I counsel him or her to devise some means of imparting the much-desiderated downy finish. I think it could be effected in the same way that the manufacture of plush-enamelled paper is effected. This, however, is a point to be investigated by any one who, profiting by the indications herein set down, may think proper to work-out the process to his or her own profit.

Consideration of the skin naturally leads on to the hair and nails, between both which and the cuticle there is a close similarity. The hair claims cosmetic priority. What can be more beautiful than it, when copious, soft, and delicately tended? what more hateful, more destructive of the charm of loveliness, when allowed to degenerate into savagery by some inappropriate treatment?

A hair consists of three parts—the root, which is fixed in the skin, the shaft or stem, and the point. The usual shape of the stem is a cylinder; it may be flattened, or even grooved. Hair, we all know, varies much as to size. What a difference, for example, between the whiskers of a cat and the hairs of the sleek coat of her tiny victim! Even for one and the same species, and one and the same part of growth, there may be much variety as to the fineness of hair, as the human head exemplifies. As to the further structure of hairs, it is more complex than those people may imagine who abuse it by hair-dye so remorselessly. The stem of each hair is covered with a coating of scales overlapping each other like those on the skin of a fish. Hence comes the property of *felting*, which only consists in beating a layer of hairs, laid upon a flat surface, sharply until they interlace and hold tight one to the other, held by their rough external surfaces. Inside this scaly covering comes a fibrous substance, making up the chief part of the stem; and in the very middle of it, running like a streak of alder-pith along a branch, is often a sort of marrow. This central pith, however, does not exist in all hairs. It is wanting in the fine hairs over the general surface of the body, and is not commonly met with in those of the head. The special pigment that constitutes the difference of colour between different hairs resides in this pith when present, also in the fibrous matter.

We now come to the hair-root. It is lighter in colour and softer than the stem, swelling out at its lower end into a bulbous knot, lying in a special recess called the *hair-follicle*, which may reach down to the subadjacent fat. It is known that women more rarely grow bald than men, and it is accounted for by the circumstance that women have more fat underneath their head-skin, thus furnishing a richer soil, so to speak, for the feminine tresses to spring from.

Usually hair is wholly devoid of sensation, else it would go hard with us when we submit to hair-cutting. There is a certain disease, however, not unusual in Poland, and known as the *plica polonica*, the characteristic of which is that the hair grows sensitive, and when cut bleeds even dangerously. Some physiologists have entertained the belief, that from the insertion of each hair-filament to its extremity a fluid passes, and thence back again. The reality of this circulation, however, has not been demonstrated. The diverse colour of various heads of hair is referable, as we have seen, to the presence of special colouring matters. Hence it follows that if such colouring-matters be absent, the remaining hair is white. Narrations abound of the hair having turned white suddenly after some shock, or fright, or other violent mental emotion. No satisfactory explanation of this has ever been offered, and some physiologists deny the fact wholly. Among the number of these must be mentioned Dr. Davy, who, some years ago (1861), read a paper on the subject at the British Association. It is his opinion that hair never turns gray save under the influence of impaired health, or of age. Much study is popularly considered to turn the hair gray, and long-continued anxiety. The imputation is doubtless true; but then the immediate cause of grayness may still be impaired health.

Haller, in his *Elementa Physiologiæ*, discusses the evidence for and against the sudden change of hair to gray exhaustively. He refers to eight authorities for proof of such change, but, finally summing up the evidence on behalf of himself, he comes to the same conclusion as Dr. Davy. Those who adopt the popular opinion fortify their argument by referring to the colour-mutations certain animals and birds undergo with change of season. Mountain-hares and ermines, *ex. gr.*, acquire white fur towards winter. In like manner so do lemmings. Mr. Blyth the naturalist examined a lemming that was just undergoing this change, and satisfied himself that the whiteness was referable to special *new* hairs, *not* to defect in colouring-matter of the hairs previously growing. For my own part, I confess to a leaning towards the popular belief. If the sudden change of hair from dark to gray be *not* a fact, I am at a loss to account for the belief to the contrary, which is almost universal; finding expression in the traditions and the poetry of so many nations. Of far higher value than any expression of credence on my part is the testimony of the celebrated skin and hair physiologist and practitioner, Mr.

Erasmus Wilson, who has no hesitation in giving credence to the popular belief.

Still, doubtless many of the instances of such change that have found their way into history and narrative are otherwise explicable. Thus, for example, history attests the sudden change of Marie Antoinette's hair from black to gray after her imprisonment. As to this, there now exists little doubt, I believe, that the unfortunate queen's hair had become gray *before* her imprisonment, but that she darkened it assiduously by some sort of hair-dye. When imprisoned she could no longer obtain this hair-dye: hence the natural gray colour of her tresses became apparent. The same explanation awaits the conspirator Orsini, who was executed at Paris some years ago. When he went to the scaffold his hair and beard were gray; when he went into prison they were black. It is well established that Orsini had been in the habit of using hair-dyes. Were it not thus made out, his case, too, would be cited amongst the instances corroborative of popular opinion.

Though the hair be wholly devoid of feeling, it is not devoid of life; it soon resents any discipline founded on the treatment of it as mere dead filaments. It cannot be pinched with hot irons, or crinkled in and out a waver, without causing speedy deterioration; as many ladies have, when too late, discovered to their cost. No style of hair-dressing is so congenial to its well-being as that of arranging it in plain bands. Curling, in whatever way conducted, is injurious; curling by hot irons most injurious of all. Far more prejudicial, however, are some of these crinkling and waving operations, which unfortunately have become fashionable. They are only second in evil to certain operations of dyeing, and, still worse, bleaching, which will be noticed further on. English curls—*boucles Anglaises*—have acquired a civilised-world-wide celebrity. The former predilection of English ladies for ringlets is not to be considered a matter of taste alone, this style of hair-dressing being peculiarly appropriate to English hair and the

English climate. Our fair sex are not celebrated for the profusion of their hair,—in that respect there is hardly a peasant-girl of France, Italy, Spain, or Germany that would not have the advantage; but English ladies' hair is usually of admirable quality—soft and silky,—a condition indispensable to the formation and maintenance of pleasing ringlets. Hair may be easily too long for this style of adornment: foreign women's hair *is* usually too long. Moreover, the moisture of the English climate promotes just that degree of rigidity in the helix twist which is indispensable to beauty. Mostly, when a continental lady emulates the *boucles Anglaises*, the result is not satisfactory. The ringlets are prone to assume a certain corkscrew aspect,—hard, and the reverse of pleasing.

Coming now to the discipline of the hair, the method or methods of keeping it in order, I believe the more it feels the touch of atmospheric air the better for its condition. The magnificent masses of hair to be seen on the heads of foreign peasant-girls, who never wear bonnets or other head-covering, is a standing proof of the soundness of this doctrine. Conversely, again, who can have failed to remark the tendency to baldness which any persistent covering of the head induces? Look at barristers—men whom precedent and tradition compel to smother their pericranium in an investiture of powdered horsehair—see how bald they tend to be, how bald they mostly are. I would advise a barrister entering his profession with a good head of hair, to have it powdered and got-up horsehair-wig fashion.

Is there any cure for baldness when it has become confirmed? Are those elixirs, those balms of Gilead, those rosemary essences, and other things which hair-dressers talk to one about in such bland persuasive tones,—are they fact or are they delusion? And what shall we say about bear's-grease, that was once held in such repute, and the hair-producing character of which still lingers, as did the odour of flowers to Tommy Moore's broken vase? Delusions *all*, I fear; at any rate mostly all. Consideration of the structure and anatomy of individual hairs will prompt to this conclusion, and experience, I think, confirm it. Each hair, as I have already explained, springs from a bulb, and each hair-bulb is naturally bedded in its own socket. The arrangement is one very comparable to that of a tooth in its jaw-socket and membranous investiture. If a hair be broken off, or if, growing weak from one of many causes, it withers down, leaving the root behind, then doubtless much may be done to effect restoration by proper treatment; but if the bulb has wholly gone, and the skin once closed up, then one might as well expect to grow a new tooth from the gap whence a tooth had been extracted, as to evolve a new hair from that particular bulb-socket.

The only effectual way I know of for imparting a new head of hair to a pericranium upon which the blight of actual alopecia has fallen, is *transplantation*. It is a well-established fact that hairs can be transplanted from one head to another, and that when thus transplanted they will grow. I say nothing about the pain such an operation would cause—*that* is a matter to be thought of by the patient. In like manner, feathers and teeth will grow if similarly transplanted. The experiment was tried, and it succeeded, of transplanting a tooth to the comb of a cock. These physiological facts are suggestive of much cranial artistic beauty, whenever fashion may prompt individuals to incur the pain of its infliction. One can readily imagine the imposing beauty that would come of adorning human heads with birds' feathers. It would be some sort of triumph for a lady to boast that she grew her own ostrich-plumes; and it would not be difficult for men of the law to set-off their naturally bald pates with such a resemblance of the conventional horsehair-wig idealised as might satisfy the punctilio of any martinet judge. I have dealt with the proposition, seeing that it comes naturally developed out of the postulate hereinbefore set down. As this thesis is intended to be practical,—intended for the present, moreover, not for posterity,—it would be hardly worth while to bestow more thought on an expedient that, whatever its demonstrable feasibility, is one for the adoption of which people are not yet prepared.

When hairs have withered away down to their respective bulbs, their growth can be promoted by certain applications. Among these, cantharides, or Spanish flies, have acquired a celebrity which, upon the whole, may be pronounced merited. Cantharidine, however, in all its various states, is so powerful an agent that the employment of it should never be trusted to the discretion of a hairdresser. Pernitrate of mercury is another agent that has grown into repute for the same purpose. This also, however, is dangerous when used too strong, and its degree of concentration can only be judged of in respect to each particular case. The repute acquired by bear's-grease for strengthening the hair, and even overcoming alopecia, is wholly unfounded. Bear's-grease first came into vogue through application of what is called *the doctrine of signatures*, whereby it was, in one stage of medical belief, inferred that each particular agent used, or capable of being used, gave evidence by external sign of inward potentiality. Thus inasmuch as bears were seen to grow a strong coat of hair, the signature was adopted as foundation for the belief that *any* scalp to which bear's-grease might be applied should forthwith produce hair in true bearish fashion.

Very conducive to the well-being of hair is assiduous removal of the small cutaneous scales that invest every inch of the skin it grows upon. Brushing accomplishes this well, and the mild friction of the brush is also advantageous by stimulating a proper supply of blood towards the hair-roots. Let no one be led away by the notion that so-called magnetic brushes are of especial use. Magnetic brushes are like any ordinary brushes, in effect neither better nor worse. True, indeed, each of these magnetic brushes *has* a magnet fixed into its reverse; but any person acquainted with magnetism will feel assured that the conditions of arrangement are altogether incompatible with the exercise of any magnetic influence.

Beyond combing and brushing, what are the best expedients for hair-cleaning? In man there is nothing so good as soap-and-water lather; but the plan cannot be recommended for ladies. The alkali of soap is not congenial to the gloss and beauty of female hair; moreover, to some extent, alkaline contact affects the colouring-matter, and changes its tint. Men are above or beside these considerations, but they should be regarded by ladies.

Glycerine and lime-juice, so called, is not glycerine and lime-juice at all. It is merely scented oil and lime-water. Glycerine and rose-water is much better. The advantage of glycerine is, that it imparts to the hair a soft silky brilliancy; the so-called brilliantine, in point of fact, which gentlemen—vain young ones—use for their whiskers and moustaches is only glycerine scented. For bandoline, nothing is better—perhaps nothing so good—as a very small fragment of gum-tragacanth dissolved in water and perfumed. The fragment must be *very* small, otherwise the solution will turn the *accroche-cœur* into a veritable horn, uncomfortable to wear and ungraceful to look at.

People who use pomades should be very careful that they do not apply injurious colouring-matters to the hair. The fashion these some years past has come in of using yellow or straw-coloured pomades. They are elegant to look at, and so long as the yellow tint is imparted by palm-oil, as it should be, they are, sanitarily considered, unobjectionable. I fear, however, that in many instances the peculiar tint of yellow so much desiderated is given by incorporation with some injurious metallic compound. Roseate pomades are never, on account of their colouring-matter, objectionable, the tint being always imparted by alkanet root, which is wholly innocuous.

The oleaginous composition of pomades varies greatly. Spermaceti, and almost any animal oil or fat—except mutton-fat—may be employed in their composition. I believe the very best oleaginous hair-application consists of a mixture of castor-oil and alcohol, two parts by measure of the former to one of the latter, the whole perfumed according to taste. The circumstance should here be mentioned that castor-oil is the only oil admitting of this treatment; if, for example, it were attempted to combine olive-oil with alcohol, the operator would soon find he had taken trouble in vain. Between the two no union would ensue; and the same remark applies to every oil, with the exception of castor-oil.

The hair of human beings, as well as of animals, holds sulphur in its composition, and retains this element obstinately. Thus, if a scrap of flannel a thousand times, or even ten thousand times, washed be taken and analysed for sulphur, this element will invariably be found. As will be seen hereafter, the theory of the action of a certain class of hair-dyes turns upon this sulphurous presence. It is a property of sulphur—and more especially of a certain sulphur-containing gas—to turn several metallic combinations black. Lead is one of the metals in this category, and accordingly lead has formed the basis of more than one hair-dye. Bismuth is another of these metals, and silver another; the blackening function of silver salts, however, when used as hair-dyes, is not wholly referable to this sulphurous reaction.

Poets have often expatiated on the harmonies of Nature; and whatever has been the theme of poetic thought and diction from the earliest times is almost certain to be true. Nothing can be more adverse to the truth than to regard poetry, after the manner of some, as the wild outpourings in language of lawless day-dreams void of order or coherence or reference to fact. Rather should the poet's lucubrations be looked upon as the crystallised essence of truths made to him apparent by the light within, and demonstrable hereafter by the slower mechanism of reason and induction. Thus has it come about in the fulness of time that the harmonies of

Nature, of which poets sang in days of yore while science yet was not, have been confirmed by investigation and made evident to understanding. Harmony can come through each and every sense, though acoustic harmonies are, to common appreciation, the most evident. In respect to these, study of the science of acoustics has reduced them to order and certainty. Every physiologist knows, so does every musician, that the most perfect of all harmonies is fundamental tone to octave; so perfect indeed, that one desiderated effect of harmony is almost lost, the two or more notes coalescing into one integrate tone; all individuality departed, or rather merged, the general effect being a mere intensification of loudness.

In respect to the acoustics of Nature,—the voices of her streamlets as they murmur past, or the sterner tone of her more impetuous rivers, the seething plash of cataracts, and the wild throb and intermittent bellowing of the mighty sea, —there is nothing inharmonious in all these tones. Swelling together, they come to the ear of man impressed with no quality to shock his acoustic sense. Thus also with the breezy whisper through forest-leaves, or those wild voices that the tempest wakes, even to heaven's artillery, the mighty thunder. Thus too with the voices of birds. Songsters chirp and warble—nay, croak and crow—yet all is harmonious. Birds—ay, think of it, doctors of music and learned maestri and orchestral conductors, each and all whose duty it is to solve the mysteries of acoustic art—birds may sing all together each a different song and in a different key, yet their singing produces no discord. Much has been written of this, but much is still unknown. Ingenious Daines Barrington considered that the reason why birds can establish a Dutch concert, each singing his own tune, each in a different key, is because the *timbre* of bird-music is pitched so high as to lie beyond the range of human acoustic—let me say—'vision.'

Then the harmonies of Nature's colouring, how beautiful they are! Every physicist knows that white light is a compound of three primitive lights,—blue, red, and yellow. Into these separate tints a ray of white light may be analysed by the prism, but in different measured proportions. Looking at the prismatic spectrum, we soon perceive that there is less of blue light than either of red or yellow; wherefore it follows that if in any picture the blue light should predominate, a sense of discord would be suggested, violating perfect harmony. Mark, then, how Nature ordains her colour harmonies. Regard the flowers we see in any one tableau of nature, and observe how the red and yellow and white ones predominate; thus preserving the balance between the three tints that should obtain in order to make-up harmonious colouring.

In regard to the harmony of taste, Brillat Savarin would not have thought that individual worth argument who should have seriously doubted the reality of it. Why should apple-sauce have come to be accepted as the proper accompaniment for goose and duck, mint-sauce for lamb? Why do we eat mustard with beef and pork and duck and goose, not with lamb or mutton, chicken or game, if not guided and regulated by a sense of this sort of harmony?

And of smell; how is it that certain odorous things go well together, whilst other odorous things go ill together, but for the existence of the functions of gustatory harmony and discord?

To demonstrate the harmonies of touch is not so easy; but instances can be adduced making it evident. If ice felt warm to the touch, or feathers cool, the sense of tactile harmony would be violated.

What has all this to do with the dyeing and bleaching of human hair? for to that at last I am coming. Much—rather, everything. It has soon to be explained that Nature does not give hair tints at random, any more than she gives blue corn-flowers to harmonise with yellow corn, or red poppies to mingle with the green corn-stalks yet immature. The tint of hair has been arranged according to the fixed canon of colour-harmony. We cannot alter that tint without destroying the balance of that harmony. The real amount of power the chemical hairdresser has of changing the colour of hair, or even of dyeing white hair—which represents the simplest case of all—is very limited. If, however, the whole chromatic range were available, the result would not be harmonious to any artistic eye. To make the work perfect, the operator would have to alter the entire tint of skin in order that it might harmonise with the changeling. Nevertheless, hair is sometimes dyed, ay bleached in order to be dyed; and I—recording events as they are, not palliating them—am bound to explain the manner of doing it.

The simplest case that can arise is that of gray, or, better, white hair. The operator wishes to change it to a darker colour—that is easy enough; but wishing to change it to some particular colour, the artist soon finds himself hampered and shackled in his resources. We will first take the case of black, that being the most simple. Orientalists, Turks, Persians, and Egyptians set great store on having black beards; and when these are not naturally black, they are frequently made so by dyeing. The Persians, who affect a blue-black, are said to use indigo extensively for this purpose; but the Turks and Egyptians more affect a sort of pasty writing-ink, made of pyrogallic acid and the powder of a native ore of iron. Amongst the people of the West these hair-dyes are wholly unused. They mostly employ certain metallic bodies, to be presently noticed; but some are content with the colour given by the juice of walnuts.

In countries where the use of nitrate of silver prevails for any purpose, whether fused and solid, as in surgery, or in solution, as marking-ink, or for photography, the idea must speedily have been suggested of its employment as a hair-dye. Not only solution of nitrate of silver, indeed, but every preparation of silver, blackens when exposed to air and light; accordingly the number of silver preparations which from first to last have been employed as indelible inks and as hair-dyes is very great. I need not specify them here. To one and all the defect attaches of not only dyeing the hair, but everything they come in contact with. The nails, the skin, even the teeth if it should happen to touch them, are dyed black by nitrate of silver, and other silver solutions. This is a serious defect, but it does not stand alone. If the surface of a piece of bone or ivory—the handle of a tooth-brush, for example—be dyed black with nitrate of silver, and continuously exposed to light, a coat of metallic splendour will at length become apparent, mingled with iridescent hues like the tints on the neck of a dove. This chromatic play of tints is very beautiful, in suitable places and under proper circumstances. It is out of place when seen in the human hair; yet I could specify the moustache and whiskers of certain old gentlemen known to me, whereon that silvery splendour and those dove-like tints may be seen in much perfection.

Accordingly, notwithstanding the convenience of its application, solutions of silver cannot be recommended as hair-dyes, and consequently they have much gone out of vogue. A hair-dye, to be as good as it can be, should have the property of dyeing the hair alone, leaving the skin untouched. This can be accomplished by the use of some one amongst many metallic solutions, and the rationale is explicable on grounds of physiological chemistry. First, it is needful to state that nearly all the ordinary or calcigenous metals when dissolved yield solutions that are blackened by the contact of sulphuretted hydrogen gas, a compound holding sulphur. Secondly, it is needful to state that the element sulphur is a constituent of hair, which continually evolves, but more especially during sleep, the gas in question. We now begin to perceive what must come to pass if we moisten hair with the solution of one of the metals capable of blackening under the touch of sulphuretted hydrogen gas. The solution, having found its way into each filament of hair by absorption, there remains; and subsequently, the gas during evolution coming into contact with it, change of colour to darkness results. Long before the theory of this action was understood, leaden combs had acquired a celebrity for the change of colour they effected on red hair after continuous use. It is not that the stain of abraded lead is so black, it is more lustrously metallic. But for the hydrosulphuric acid gas evolved—sulphuretted hydrogen—the use of leaden combs would not be efficient. The explanation of their utility has already been set forth. First, the small particles of abraded lead—the actual lead stain—coming into contact with certain acids present naturally amidst the hair-filaments, is dissolved. Being dissolved it is soon absorbed, when the sulphuretted hydrogen taking effect produces blackness. The change effected by a leaden comb, however, is very slow, the operation needing to be performed again and again before any result is apparent. Hence in process of time a readier mode of operation was devised, having reference to the same theory. It was found that a mixture of litharge, or oxide of lead, and lime, made into a paste with water, furnished a convenient means of effecting the dyeing rapidly. It was seen that if hair were daubed with the paste over-night, and secured in an oilskin bag to retain the blackening gas, then next morning, on brushing away the powder and pomading, the hair would be found to be black. I am told that the discovery of this mode of treatment was made by some British military horse-doctor, whose name has been lost in the efflux of time. This is a pity, seeing that the discovery is ingenious, and does him credit.

I am informed that many of the horses on which our household troops are mounted, notwithstanding the immaculate beauty of their lustrous black coats, are very prone to have tails of less unimpeachable jet. Wherefore again, I am told, the practice still prevails of daubing these defective tails with the lead paste above described, and then enveloping them—not in oilskin bags, but in green cabbage-leaves. Whether applied to skin of horse, or man or woman, any lead compound is objectionable because of its poisonous nature; objectionable in the highest degree, however, in proportion as the seat of its application is nearer to the brain. When this lead blackening has been produced, by whatever modification of the process, what are its advantages and what its defects, to pronounce in an artistic sense? They are many. The blackness is not of that special tint which belongs to any naturally black hair. It is a heavy, harsh sort of blackness, neither begetting reminiscences of the past, nor harmonising with the skin-tints evolved by age. The result is a violation of nature, hateful and odious. The *ars celare artem*, that glorious canon, not being within the artist's reach, he has missed it. What he has accomplished leaves the poor candidate for youthful appearance a mere disguised old man or woman: a phenomenon to be stared at, a butt to be laughed at.

If the problem of dyeing hair black involves the simplest case, and if its accomplishment be so difficult, what have we to say about brown and chestnut in all their delicate varieties? Only that the task is more difficult still, the result more incomplete. To the visual appreciation of such people as are content with a sort of smothered black as the sufficient representation of browns in all their varieties, the effect of ordinary lead dyes used in a particular manner may suffice. We generally find it specified in the directions for using black hair-dyes that they may be caused to impart a brown tint by a little modification of practice. Thus in respect to the ordinary paste of litharge, lime and water; if instead of water, milk be used, the ordinary fulness of the chemical effect is smothered, and there does not result full blackness. The hair-artists call it brown, and it passes for brown; but I pity the chromatic eyesight of anybody who is content to call it brown. It is simply a fusty black, neither more nor less; calling up reminiscences of a grandmamma's black-silk dress treasured from her girlhood; or a black-silk dress of more modern origin that has come across the sea on the back of a deck-passenger.

Lead is not the only metal that has this function of turning black when dissolved and brought into contact with sulphuretted hydrogen. Bismuth preparations are affected with a similar change, though the tint of blackness slightly differs. Gold is in the same category, and indeed most of the ordinary metals. Four, however, are exceptional, and one of them is iron; yet the belief that iron actually imparts dark colouring-matter to certain tints of hair as a natural constituent has suggested the use of iron-salts in the process of artificial dyeing. They can be so used, but not alone. Some second solution must be employed by way of mordant to develop and fix the colour. The Turks use pyrogallic acid to this end, as I have already announced; common gallic acid would not yield black of such unimpeachable colour. British and other west European hair-dyers, when they avail themselves of iron solutions for dyeing hair, employ usually neither gallic nor pyrogallic acid. They use for this purpose a solution of hydrosulphate of ammonia, which will blacken iron solutions, though uncombined hydrosulphuric acid will not. I am not aware that iron dye thus mordanted is used for any more extensive purpose than for the dyeing of whiskers and moustaches, or, at the most, beards. The abominable odour of hydrosulphate of ammonia—compounded of the smell of putrid eggs with hartshorn—would, I should think, make the application of this sort of dye to a full head of hair intolerable; and a fellow who could complacently apply this hateful thing to his moustache must be strong of stomach, and not over delicate as to the sense of smell.

To all hair-dyes one general remark applies, and it is the following: if the illusion of the change of colour effected by them is to last, the dyeing must be gone through continuously. Day by day and, still more, night by night, the hair grows. The root of yesterday is the stem of to-day, and what was underground—to use a metaphor—could not have come under the dyeing influence. No failure of the hair-dyeing art looks more ridiculous than that resulting in a particoloured effect—the body and tips of one colour, the lower part of the stem another. People before committing themselves to the practice of hair-dyeing should well consider this. Let them remember that it must be a practice, not a casualty, or else the deception will stand revealed; let them bear in mind also the precept, that in this affair leaving off is worse than beginning.

It needs a good deal of moral courage to begin to grow a beard. Nothing can well look more disreputable than a beard two days old, except perhaps it be a beard of three days. It takes a week before the scope and design of what the fellow is about becomes apparent, and even then he feels uncomfortable to himself and all about him. The bent and genius of a man's character may be divined by observing the manner in which he begins to grow a beard, having resolved to do so. One man will cultivate the stubble excrescence all over each appointed square inch, suffering resolutely taunts and gibes: the *mens sibi conscia recti*. I like that man: he is an honest man. With my purse I would trust that man—my wife, my daughter. To such a man I incline at once: he is my *beau idéal*. He would tell me my faults at once, and not conceal them, making me morally worse, thinking to please me. Another man, having concluded to grow a beard, will go surreptitiously to work, encroaching a little day by day, thinking you will never discover it. Accursed be that base individual—*carbone notandus!* Even so would he encroach on my landmarks, my purse, my family peace. He would rob a canary-bird of his sugar—the trope is not mine—he would grub-up his grandmamma to make knife-handles out of her leg-bones.

If it be a solemn and a serious thing to grow a beard, then by how much more a solemn and serious thing to dye a beard, or a head of hair for a climax? It comes at once, or at most in a night, the portentous change of colour. White, or carroty, or foxy, as the case may be, you come under the operation of art; then, hey presto! out you go fully metamorphosed. However I may reprobate the act itself, the deed, the thing, I must needs admire the prompting courage of it. Talk of suicide—hanging one's self, drowning one's self, poisoning one's self, or cutting one's throat, the supreme moment is all in all; the deed is done, and your friends shudder, but yourself are out of it. But to dye one's hair, and live! To stand the gibes and staring, the chaff and innuendoes and allusions and questioning, that indeed *is* courage!

This is a digression; we come back again to capillary chromatics. Life is short and art is long; the triumph of hair-dyeing has been reserved for modern time to achieve, and the latter part of this thesis to chronicle. The dyeing of hair black or brown—such as it is—I call mere child's play; to impart the fashionable golden glow is a modern triumph. This achievement resolves itself into one of two cases. Either the hair to be dyed is naturally red, coaxable into golden, or it is actually and unmistakably dark. In the latter case preliminary bleaching will be needed, in the former not. Of red hair there are various tints; the designations cherry, carroty, scorched, and foxy, will mostly comprise them. The two former are colours that generally go together with a rich animal growth; they are accompanied with an exuberance of gloss, and, I think, an exuberance of temper. The two latter seem as though they had grown on poor soil; they want lustre, surface, finish, hot-pressing; they are poor and meagre, suggestive of flocks of dingy oakum untwisted from ropes by convict hands. Out of each and all of such raw materials, then, it were idle to expect the same final amount of artistic golden beauty.

To understand the principles whereon the imparting of this fashionable golden tint to hair is founded, it is necessary to revert to the chemistry of calcigenous metals. Most of the metals in this category, as I have already announced, when in solution yield a black tint by the reaction of hydrosulphuric acid (sulphuretted hydrogen), and still a few others by hydrosulphate of ammonia, iron being amongst the number of the latter. Two metals of this class, however, yield a golden-yellow colour under similar treatment; and this brings us to the point to which we have been tending. The metals in question are arsenic and cadmium; wherefore it should follow from application of the principles already expounded, that whereas a lead component applied to the hair under conditions indicated should cause blackness, an arsenical or cadmium compound should produce yellowness. Now, cadmium is, so far as a metal can be, innocuous; the character of arsenic we all know. It has the evil repute of being a violent poison, and that character it merits. To exaggerate the poisonous danger of arsenic, whether taken internally, or applied to the skin, or its fumes breathed, would be difficult. Yet, terrible to state, solutions of this awful poison are slopped upon ladies' heads when the cherished golden tint of hair is aimed at; and, worse still, sold to ladies for private domestic use. Recklessness could not well farther go, even in the behests of fashion. Many cases of poisoning have already occurred from this cause, the origin unsuspected. What appears to me strange is, that cadmium compounds, though comparatively harmless and yielding a tint hardly less aureate than those evolved by arsenic, have not commonly, if at all, been employed as hair-dyes. The theory of this process of dyeing is identical with that already described under the head of dyeing black by lead compounds. The sulphuretted hydrogen evolved reacts upon arsenic and cadmium, producing yellow, whereas it would have evolved black with a lead compound; in this is all the difference. Evidently this process is inapplicable to hair naturally dark until some preliminary bleaching has been adopted. Several fluids have the property of bleaching hair. Alkaline solutions bleach it to a certain extent; solution of chlorine, and the so-called chlorides of soda and of lime, more effectually. Solution of sulphurous acid will also bleach hair; so will solutions of bisulphite of magnesia and of lime; peroxide of hydrogen has acquired great celebrity under many imaginative names. Whatever process be had recourse to, the subsequent operation of yellow-tinting is prosecuted as already set forth.

Copper solutions are sometimes used for imparting a tint to fair hair not very unlike a tint sometimes seen in natural beards and whiskers. To understand the rationale of this use, we must again refer to our chemistry. If a copper solution be tested with a solution of prussiate of potash (ferrocyanide of potassium), a brown tint, condensing into a precipitate of the same colour if the solution be strong, results. Solutions of three other metals—viz. titanium, uranium, and molybdenum—yield a similar tint under similar treatment; but I am not aware that either metal of the group save copper has been ever employed as the basis of a hair-dye. Our ideal laboratory experiments have shown that the mordant, or second application, must be solution of prussiate of potash. Hair moistened with sulphate-of-copper solution first, and prussiate-of-potash solution to follow immediately, turns brown; as to the precise tint of brown evolved, it is exactly that of old Spanish mahogany. *De gustibus non disputandum:* the process is easy; let those who like use it.

For the dyeing brown of small tufts of hair, such as whiskers, moustachios, and imperials, solution of the chloride of gold might be used, but I am not aware that it ever is used. I have tried it experimentally, and find the result to be more satisfactory than of most hair-dyes. Chloride of gold, however, has the disadvantage of acting as a substantive colour. It needs no second application or mordant, and it dyes both skin and hair alike. Treating of arsenical solutions applied as hair-dyes, I allowed it to be inferred that they acted by virtue of the naturally evolved sulphuretted hydrogen alone, needing no second application. That is, indeed, the fact, if people so like to employ them; but artists using these terrible things have usually the sagacity to employ hydrosulphate of ammonia as a mordant, whereby the effect is sooner gained, and the chances of absorption through prolonged application to the skin diminished.

Any paper on hair cosmetics would be imperfect that should omit to specify certain body paints, not dyes at all, that are frequently used to impart colour to facial hair—beards, moustachios, and whiskers. These things are crude and unphilosophical; they hardly merit our regard. Any possible powder may be mingled with grease and applied to the hair this way—washing-blue, were the aspirant so minded, or chimney-soot, or black-lead, or brickdust. There is actually no limit to this sort of application. The individual's taste is all in all. The repertory is large; he may please himself; and he had better please himself, for that will comprise the sum-total of all the pleasure his art is calculated to beget.

And thus do we conclude the subject of hair-dyes. It is a silly practice, and withal prejudicial. Even the most innocent applications known to this end do some harm, and the use of arsenical hair-dyes is too terrible to think about. Better remain as we are than have recourse to these stupid disfigurements. In respect to the modern whim of imparting golden hues to the brown hair of brunettes, it is strongly to be advised that the brunette pay regard to the unities: let her get into a chlorine bath, and bleach her skin to match, by all means. If a negro can be bleached,* then a brunette *à fortiori*. It would be painful; but what lady heeds pain inflicted at the beck of fashion?

* A dead negro can easily be bleached by immersion in chlorine solution; the process would kill a living one.

THE TEETH.

Civilisation, whatever its defects, is usually conducive to beauty; but in respect to human teeth there is a marked exception. The ugliest savage races—the snail- and snake- and caterpillar-eating Australian savage, the man-eating New Zealander of a past generation, the Fejee cannibals of to-day, the Esquimaux, the Calmuck, whatever the savage or half-savage race we may choose for illustration—have finer teeth than have human beings nursed in luxury, fed delicately, comfortably clad and housed. The fact is plain to sight, but the explanation varies. To say—as many are content with saying—that the deteriorated teeth of civilised races are referable to the habits of civilised life is, in point of fact, to evade explanation; the question being, what *are* the habits and usages of civilised life to teeth so detrimental?

Some hold to the belief that sugar is the cause—an opinion I conceive to be untenable, as in the sequel will more appear; others would refer to vinegar the teeth-deterioration of civilised humanity—a verdict irreconcilable with the subsidiary part fulfilled by vinegar amongst the constituents of human food. I believe that, more than to any other cause, the inferiority of teeth in civilised to those of savage life, is referable to the swallowing of hot food and drink; often in rapid alternation with cold. Be that as it may, failure of teeth seems a part of the price civilised humanity must pay for the boon of civilisation; hence the due economy of teeth becomes of high importance, whether as a matter of beauty or of utility. Childhood past, a natural tooth lost is usually lost for ever.

The cases in which a third set of teeth have been produced are so extremely rare, that the event is looked upon, when occurring, as one of Nature's freaks. The loss of teeth has more than a local meaning: it is a sign in itself of lowered vitality, and is a cause of further constitutional defect.

In the negro slave-market soundness of teeth is relied upon as a sign of sound health and general bodily competence. 'He who has lost a tooth,' wrote Haller, 'may consider that he has begun to die, and already taken possession of the next world with part of his body.'

Although the teeth-economy of human beings is that which especially concerns us here, still, comparative examination of the teeth of different animals has so much of interest that one ought not to pass it by. As a general rule, all animals of the mammalia class have teeth. To this, however, there are some exceptions; thus, the northern or whalebone whale is devoid of teeth, though the warm-sea sperm-whale has tremendous fangs, as those whom he has attacked in his fury could attest. All the ant-eater tribe, again, are devoid of teeth; appendages that would be useless to these animals; even in the way, the habits of their life regarded. A few remaining exceptions might be cited, were one to run the animated kingdom through; the rule being, as common experience makes known, that mammalian animals are all teeth-provided. Not all, however, with teeth on the same pattern and principle. Among mammals the elephant is most peculiar for the mode of teeth formation and development. About the tusks of an elephant little need be written; they are simply long and large teeth, which grow pretty much after the manner of other teeth. It is the short or grinding-teeth of an elephant that are the most peculiar; they are developed in a sort of bony trench, and in growth continually move forwards.

The teeth of rodent animals are, again, peculiar. Thus, for example, if the teeth of a rat be examined, they will be found to terminate each in a cutting, chisel-like edge; and the arrangement of parts is such that, gnaw as much as the creature will or must, the sharpness of these chisel-edges can never be lessened. The result comes to pass in this way: the outside surface of the tooth of a rat contains the hardest materials; wherefore it follows that the inner portion of each tooth is soonest to wear away. From this arrangement, and due to the operation of this cause, it follows that the outer crust of each of a rat's front-teeth will extend in length, and form a cutting edge. In order to make this arrangement effective in rodent animals, the longitudinal growth of these chisel-teeth is very rapid; so rapid that if an opposite corresponding tooth be drawn, whereby no bearing-point shall be left, the unopposed tooth will continue growing circularly until, curling round, its farther development is stopped by pressure of the animal's own skull. A preparation illustrative of this may be seen in the Museum of the Royal College of Surgeons.

Teeth, regarded as to material, are composed of a hard outer covering known as enamel, and an inner portion of soft bone furnished with nervous branches; as in toothache we discover. Chemically, tooth-enamel is remarkable in the circumstance of its holding a considerable portion of fluoride of calcium, the material of fluor, or Derbyshire spar, in point of fact. The full complement of human teeth is thirty-two, four of which, however, coming late, are called wisdom-teeth. Everybody who is of suitable age remembers that, when a child, his first teeth fell out, these having been the first set, or milk-teeth.

The coming of the milk-teeth belongs to those oblivious days of infancy and early childhood which, going, leave no memory behind. That order, however, was the following: the milk, or deciduous, teeth were twenty in number, and they made their appearance thus: first came the four central incisors, about the seventh month after birth, but occasionally earlier or later, those of the lower jaw appearing first; next in order came the lateral incisors, the lower jaw again having precedence. Those teeth usually appear between the seventh and tenth month. Then there was a short period of rest, after which the front molars came forth soon after the twelfth month; these were followed by the canines, which appeared between the fourteenth and twentieth months. The posterior molars were the last, and being the most uncertain as to time, one cannot specify when they came for any particular individual, say any time between the eighteenth and thirty-sixth months.

The second dentition consists in the replacement of the deciduous, or milk, teeth by the second or permanent set. It usually commences about the seventh or eighth year. The gums of the new teeth, however, are prepared; ready, and waiting, a long time before this. The middle incisors are first shed and renewed; then the lateral incisors. Next are shed the anterior or milk molars, to be replaced by the anterior bicuspid. About a year afterwards the posterior milk molars fall out, being replaced by other bicuspids. The canines are the last of the milk-teeth to be exchanged. Next year the second pair of true molars will appear; but the third pair, or *dentes sapientiæ*—otherwise wisdom-teeth—may come at any subsequent period.

It has been already stated that, in exceptional cases, a third set of teeth has been known to come. Looking over the records of extreme old age, it will be remarked that any considerable extension of life beyond ninety has often been accompanied by the growth of one or more of a third set of teeth. A remarkable instance of this I find narrated by Dr. Slare, in a book written by him in advocacy of a saccharine diet, and published in 1715. Most of us are aware that amongst certain people sugar has the evil repute of destroying the teeth of persons much addicted to its use, unjustly, I believe, and have already recorded. I am not aware that the imputation rests on any firmer basis than that of the economical spirit of thrifty housekeepers. In the early days of sugar the teeth-destroying prejudice against sugar was much stronger than now. As an aid towards confuting that prejudice, Dr. Slare—the great sugar-advocate of the last century—published the case of Mr. Malory, his grandfather by the mother's side. This very old gentleman led, testifies the doctor, an active, but sober and temperate life: loved hunting, a gun, and a hawk; was very regular in his eating and drinking; did make three meals a day, but did only eat flesh at dinner; drank every morning near a pint of good soft ale; then walked in his orchard as many turns as did make a mile; seldom drank wine, but when he did 'twas canary: did this in the even of his old age. His eyesight was so good that, when between eighty and ninety, he could take up a pin from the ground. His stomach never failed him to the last, and—what concerns us most—when this old gentleman was past eighty-one, his hair did change somewhat dark, and certain of his teeth coming out they were replaced by new ones, and so did they continue to come until he had a new set quite round. He delighted in all manner of sweetmeats; used in the morning to spread honey upon his bread; at other times to strew sugar over his bread-and-butter. He loved to have all his sauces very sweet, especially his mutton, hashed or boiled, or any other sort of meat that would bear sauces.

The utility of teeth needs no expatiation; yet they are not in most cases treated judiciously, nor with the respect the memory of 'gone once for ever gone' demands. Amongst the evil habits most to be reprobated is the use of hard toothbrushes. The opinion prevails in some circles of injudicious people that some latent virtue, some strengthening power, resides in the bristles of a hard toothbrush. A greater error than this it would be difficult to imagine. The teeth, though bony, are organised. They have to receive their due blood-supply from vessels of the gums. When, from any cause, the blood-supply is cut off, then do the teeth loosen in their sockets, decay, and ache. Far from hardness being a quality desirable, the bristles of a toothbrush cannot well be too soft. If hard, they infallibly denude the gums after a time. When this has come to pass, decay and pain are not far off. In respect to dentifrices, again, much error prevails. They are pretty often mechanical, often chemical. Some are compounded of hard, gritty materials, that wear away the enamel and mechanically abrade the gums; others hold chemical agents, that whiten the enamel-surface of the teeth indeed, but at the price of destruction. Long before any admonition conveyed by pain, caries will set in. The fact can only be determined by examination by some intelligent dentist. Now is the time for preservation by filling, and not when toothache has established itself. A dentist is not a mere cosmetic or beauty-artist, as he is too commonly regarded; he is a physician who works by giving effect to ordinary powers of digestion instead of physic. The importance of mastication as a preliminary to digestion can hardly be overstated; and, of course, the perfection of this mechanical act will be correlative with the perfection of teeth. The remark is common enough that dentists are not what they should be; not reliable as men of honour; chiefly more intent on running-up long bills. The opprobrium is far too sweeping; there are honourable and dishonourable dentists, as there are honourable and dishonourable doctors and lawyers. Wherever many opportunities for cheating exist, many provocatives to dishonour, there some men will be found to take advantage of them. As regards dentists, the proposition may in a general way be laid down, that the higher-priced men are in the end the cheapest. The work of such may ever be relied upon as the best; and to patients who may be unable to pay the full honorarium, such gentlemen are ever considerate.

One class of dentists are to be avoided—those who exhibit specimen-cases in druggists' shops, and put brass-plates on druggists' doors. These practitioners, vaunting themselves as being economical, are the very reverse; they are most expensive; and it could not well be otherwise, as they have to divide profits with the exhibiting druggists. In teeth-economy the principle should be established of keeping a tooth as long as it is useful, but no longer. When a tooth has ceased to be good for mastication or for ornament, the sooner it is removed the better. When removed, an artificial tooth should be established in its place. The time has gone by for natural-artificial teeth to have preference; and the consideration of this fact should do away with the hesitation that some people have for using false teeth. Sentiment is a very powerful influence in this world. Reason about it as we like, sentiment is a feeling that must and will be respected. But for sentiment, the utilitarianism of life might attain to a wider development. We might eat cat's-meat to make flesh and blood; we might convert our dead into smelling-salts, prussian-blue, lucifer-matches, skin door-mats, gloves, boots and shoes, and perhaps a hundred other useful products. Sentiment restrains us—even the most philosophical; and the sentiment against fixing the teeth of dead human beings in the mouths of living ones is undoubtedly potent. There is now no need for doing this, so many excellent materials of non-human origin standing in aid. Taken all in all, artificial teeth of hard enamel are chiefly to be recommended, and those of American manufacture are the very best known. The particular sort of teeth, however, will depend a good deal on the shape of the palate and the number to be set in a block. Excellent sets are made of hippopotamus ivory; that of the elephant is too soft, and stains too rapidly, to be of any great use to the dentist. As a matter of sentiment, the advantages of enamel or porcelain teeth, as we may call them, need no expatiation. Being wholly non-absorbent, they never stain or otherwise change colour. This leads up to an observation and a precept; one that wearers of this sort of artificial teeth should more frequently remember than they do. It is this—natural teeth are never white. Except sometimes in early childhood they have not the faintest claim to whiteness. A miniature-painter, or others having a discriminating eye for colour, would not fail to discover in by far the majority of natural teeth those mingled tints of green, blue, yellow, &c. that, taken together, go to make-up a general result of grayness of some preponderating shade. If this be so of natural teeth naturally, by how much more will the tint of teeth be varied from white by the thousand contingencies of coloured food and drink, of physic, and perhaps of smoking?

A common failing with middle-aged and elderly, nay too often young, people is, that they choose artificial teeth of the most brilliant whiteness they can find. Nothing can be more absurd. To commit this error is to reveal to any apprehension of ordinary acuteness the secret of false teeth. Another common error is that of having artificial teeth more regular and more block-like than is ever seen in nature. If the most regular set of naturally-grown teeth be examined as to absolute mechanical evenness, they will be found deficient in this quality, and still that very defect shall conduce to the general result of beauty. The fact is certain, though the foundation of it lies too deep for easy revelation—maybe for any—that some degree of irregularity of feature is needed to awaken in an appreciative mind the highest sentiment of beauty. Few of us but can remember to have seen faces so wholly regular, so feature by feature unexceptionable, that the result fell tame and unimpressive on the eye. As regards the teeth, it will generally be found that the most pleasing expression, male and female—nay, the highest types of male and female feature-beauty—is correlated with some sort of irregularity in the teeth. In one the precise irregularity is, perhaps, that a tooth slightly overlaps; in another the front teeth are slightly parted, it may be. Of whatever sort the natural peculiarity may have been, the dentist should be allowed to follow it in his copy. Here, too, in a general way, the remark may be made, that if by any chance a set of teeth gives admiration for its pure white tint and general evenness of run, when seen on a table or under a case, that set will not be satisfactory when placed to do duty, for beauty and utility, in the mouth.

Persons who select artificial teeth of greater whiteness than is ever seen in nature will perhaps be surprised to learn at what cost of trouble and ingenuity varying tints are imparted by the manufacturer of artificial teeth to naturally white materials. Yellow tints are given by titanium; blue by platinum; bright blue by cobalt; bluish yellow by titanium and platinum mingled. It would be altogether too technical to particularise here the exact composition of mineral teeth. The best general exposition will consist in the statement that they are made-up of a material holding felspar, borax, clay, occasionally flint-glass—though that is not advisable—and silica. They are moulded either in plaster-of-paris, porous stone, or metal; the last being preferable. They are next burned in a furnace like any ordinary porcelain. Sometimes whole blocks of this latter material are moulded, gums included; but whether blocks or single teeth, the process of enamelling is necessary. It closely resembles the enamelling or glazing of porcelain, especially real porcelain, of which New Sèvres is typical, and it is conducted in the same manner as the glazing of porcelain, but more delicately. If the very whitest natural tooth be carefully examined, three distinct shades of tint at least will be noticed upon it. First there is the tint belonging to the general body of the tooth; then that of the crown, or bearing-edge, or surface; lastly, of the part running into the gum. All these three tints must be imitated and indicated by the true dental artist. Occasionally entire blocks—several teeth, gums and all—are made in one piece of this porcelain or enamel material. In this case, besides the three tints appertaining to the teeth proper, the roseate aspect of the gum must be represented. To accomplish this the colouring-matter used is gold; to which also are due the lovely red tints we admire so much in certain pieces of Bohemian glass.

On the whole, block-teeth are not to be recommended, whatever the material of them may be. Far more efficient are teeth mounted on either metal or vulcanite. The metals used for this purpose are gold, palladium, and sometimes platinum—the only objection to which last is its extreme weight. Silver, considered as a metal for dentistry purposes, would be wholly objectionable, on account of the facility with which it blackens when brought into contact with sulphur, or things holding sulphur; an alloy of silver and palladium, however, is good. In saliva there is much of sulphur; no inconsiderable amount in many varieties of food. Among condiments, mustard teems with sulphur; and perhaps, with the single exception of salt, no article of either food or condiment is wholly devoid of sulphur. From all this it follows that pure silver would not serve the dentist's purpose at all. Occasionally teeth are filled with silver instead of gold-leaf; concerning which practice all the chemist can record is—pity dentists don't know better.

In respect to gold, whether employed in mounting dentistry, or for any other constructive purpose, the fact need hardly be explained that the noble metal is never used pure; absolutely pure gold is scarcely more rigid, hard, and mechanically enduring than absolutely pure lead. It needs alloy to give mechanical hardness and impart endurance. The gold coins of this realm are composed of twenty-two parts gold to two parts copper in twenty-four. Hence, in technical language they are said to be twenty-two carats fine. No gold for dentistry purposes should have a lower quality than twenty carats; in other words, should hold more than four parts of copper or other alloy in the twenty-four. Gold-foil for filling teeth should be made of absolutely pure gold; in technical language, gold of four-and-twenty carats fine.

Toothache one needs must touch on. Why the two fell tortures of gout and toothache are so commonly regarded as ailments absolved from pity, I know not of my own knowledge, and never found any one who did. Toothache has this advantage over gout, that it is always alleviable, and that in most instances without removing the tooth. Few, very few, aching teeth will resist the application of aconite judiciously used; and though aconite be a poison, and the treatment sounds poisonous, yet in any but the most careless hands it may be used to stop toothache with impunity. The best mode of application is this: having immersed some cotton-wool in tincture of aconite poured into a dish and set in a warm place, wait until the tincture has evaporated and left the cotton-wool impregnated with aconite paste. This paste-mixture of cotton and aconite is what the tooth is to be filled with. Pain usually departs in about ten minutes. It is not intended that the patient shall swallow any part of this aconite paste or its products; but even if deglutition do occur, no poisoning will ensue, the quantity of the active principle of aconite thus capable of finding its way to the stomach being insufficient to develop any bad consequences. There is an incorporation of arsenic and morphia slightly more efficacious than aconite for alleviating toothache; but it is altogether too dangerous for domestic or private use.

THE METAMORPHOSES OF MATTER.

So far as the discoveries of chemistry have hitherto gone, the elementary bodies of terrestrial creation, and probably of the entire universe, are no more than about 63.*

Considering the immense diversity of material things within our cognisance, the existence of a far greater number of material elements would have seemed probable; and feelings of surprise rise to their culminating point when individuals not versed in chemistry are informed that even of the 63 elementary bodies known, Nature—somewhat fantastically as it might seem—has decreed that nearly two-thirds of the materials of the earth's accessible crust should be made up of two elements alone, these being oxygen and silicon. Nor is the surprise thus begotten likely to be diminished by the assurance that chemical analysis of animal and vegetable beings demonstrates the fact, that the main elements—the bulk of their composition — are only four: viz. hydrogen, oxygen, nitrogen, and carbon. Belief in the immutability of chemical elements may be regarded as the axiomatic basis of modern chemistry, as distinguished from ancient and mediæval alchemy; nevertheless, within the last quarter of a century, some curious revelations have been made that seem almost at variance with the dogma. Of these a very cursory notice must on this occasion suffice; seeing that the scheme and tendencies of this paper lead us in another direction. Perhaps the best popular illustration of the mutation of aspect and qualities of which an element may be susceptible without combination, is that afforded by the element phosphorus.

* The number is not exactly determined.

In the year 1849, Professor Schrötter of Vienna astonished the chemical section of the British Association, holding its *séance* at Birmingham, by the substance he called 'amorphous' or 'allotropic' phosphorus: a substance that, though wholly different from common phosphorus in appearance and many qualities, may nevertheless be transformed into ordinary phosphorus by mere elevation of temperature; a substance which, torture it, analyse it as you will, reveals the presence of no second element. It is phosphorus under another form, but nevertheless phosphorus. To present some illustrations of the points of distinction between ordinary and allotropic phosphorus, consider well the following: Ordinary phosphorus is a body so highly inflammable that it must be stored away in water; allotropic phosphorus is so devoid of inflammability at the temperature of the human body, that the Viennese chemist produced a specimen of it out of his waistcoat-pocket. Ordinary phosphorus is light yellow in colour, and of the consistence of bees'-wax; allotropic phosphorus is puce-coloured, and, when not in powder, very hard. Ordinary phosphorus is readily soluble in bisulphide of carbon, when thus in solution constituting the liquid denominated by Captains Disney and Norton 'liquid fire;'* whereas allotropic phosphorus is not soluble in that liquid at all. Finally, whereas ordinary phosphorus is so dangerously poisonous, that even the fumes of it, as breathed in the operation of manufacturing lucifer-matches, prove rapidly fatal, allotropic phosphorus is wholly devoid of any poisonous quality.

Whether a material capable of assuming states so diverse is to be regarded as simple or compound, as constituted of one element or more than one, may indeed involve some nice points of metaphysical inquiry, may suggest to philosophers the propriety of looking narrowly at their definitions. For the chemist, it only remains to speak of things as he may find them according to his evidence; and in this case he is im-

* More lately Charleston and Fenian fire.

pelled to proclaim that ordinary and allotropic phosphorus, elementarily considered, are one and the same. He has devised the word 'allotropism' to designate the second aspect which phosphorus and certain other elements may assume, and having done this,—not much, indeed,—the man of real science, humble as every votary of real science needs must be, proclaims the rest a mystery.

This casual notice and illustration of the mystery of allotropism will suffice at the time being. The exemplifications of this property are rare, after all. Most of the myriad varieties of form and quality under which matter presents itself to our senses are clearly traceable to results of combination.

Matter is ever combining and recombining. Nothing certainly in this world, of the materials of which alone we have full chemical cognisance, perpetually rests. Rather let us say, nothing for an instant rests in all its parts. Even the rocks slowly disintegrate and decay. They yield up their elemental parts to other forms, assuming other states of combination. But it is when contemplating the living beings of the world, that the full grandeur of elemental combination becomes apparent. To die is the destiny of all that lives or shall live; but death and dying, how shorn of the terrible are the words when understood, as the philosopher alone can understand them—under the meaning of change of elemental parts: the upspringing of new developments!

Out of four elements alone, carbon, hydrogen, oxygen, and nitrogen, variously combined, the bulk of living beings, animal and vegetable, is made up; though, in small proportions, other elements are so widely diffused, and so invariable in their localities of diffusion, that to regard them as casualties would be highly unphilosophical. Thus iron is a constituent of all blood: so is manganese. Phosphorus, that highly combustible element and deadly poison, enters so largely into the composition of animals, that from bones and certain animal fluids it was, until recently, always extracted.* Sulphur, too, is so invariably present in the animal world, that chemical tests can reveal its presence in the merest bit of feather, or scrap of the oldest blanket. Eggs contain so large an amount of sulphur, that the presence of it is revealed by the silver egg-spoon, which turns black (a well-known chemical function of sulphur) under the natural operation for the performance of which egg-spoons are made and appointed. A gas, holding sulphur for one of its constituents (sulphuretted hydrogen), is continually evolved from the hair, and hence the philosophy of certain modern hair-dyes. Lead and lead compounds, bismuth and bismuth compounds, blacken, like silver and silver compounds, under the influence of sulphur; whence it follows that, if litharge (oxide of lead) be made into a paste, and the latter mingled with the hair, blackness follows. Silica, or the matter of flint, is another curious constituent of vegetables and animals. The shiny part of the stalk of grasses is nearly pure silica, and the teeth of animals hold it in considerable proportions. According to Decandolle, the violet and the vine always contain gold in minute proportions; and copper is said to be an invariable constituent of tobacco.

These examples will show how widely diffused, in small quantities, are certain elements in living organisms. The list might readily be extended; and perhaps in no case should be closed without taking some cognisance of the curious metallic elements potassium and sodium. Curiously enough, though the metal—now hardly a curiosity—aluminium is a constituent of clay, and perhaps of every variety of soil, no vegetable or animal has ever yet been known to reveal aluminium as one of the elements of its constituent organisation.

Passing away from these, and many more curious constituents of living beings, we find on near examination, as before announced, that carbon, oxygen, hydrogen, and nitrogen constitute the great material staple of all things that, endowed

* For the present source of phosphorus see ante, pp. 13–16.

with organisation, are raised to the dignity of life and its attendant death.

To trace the metamorphosis of these four elements, combining, separating, recombining, living, dying, then springing into life only to die and live again, is only possible to the chemist. Neither of these elements can exist alone in any living form. Oxygen and hydrogen always unite together when they can, the result of union being water. Retrospect and calculation alone can bring into evidence the enormous extent to which the fluid water enters into living beings, and is necessary to the condition of vitality. The loss of weight experienced by all animal and vegetable bodies under the process of desiccation is always considerable, in some cases enormous. Even the materials of an adult human body lose at least three-fifths when wholly deprived of their constituent water; and medusæ, or marine jelly-fish, when dried, shrivel almost into nothing; water constituting at least ninety-nine hundredths of their miscalled substance.

Of all the metamorphoses that the four chief elements of living things can undergo, those of carbon are the most remarkable. It is curious enough to know that charcoal and the diamond are one and the same element—another example of allotropism, by the way, or existence of one element under two forms. But the metamorphoses of carbon by combination are still more extraordinary when united with hydrogen; sometimes in varying quantities, at other times in identical percentage quantities; generating results, nevertheless, which are diverse amongst each other, owing to a sort of complex allotropism. Carbon is the very Proteus of creation. United with hydrogen in one proportion (or rather perhaps in one of several possible proportions), it becomes ordinary illuminative gas. Combination effected with hydrogen in other proportions, the result may be oil or fat: then consider the all but innumerable varieties of oily and fatty bodies! Carbon and hydrogen joined again in wedlock, we have the oils of turpentine and lemons; materials, strange to say, not only identical as to components, but also relative amounts of components. Then again all the so-called mineral oils, bodies now so extensively used for illuminative purposes (and of these there are myriads), are nothing else than compounds of carbon and hydrogen.

India-rubber and gutta-percha swell the list; the number of which would fill a large volume, were they all enumerated. United with oxygen, carbon yields carbonic acid and carbonic oxide, both gases as we ordinarily obtain them, but the first capable of being solidified without farther union; and in union with various materials, especially lime, giving rise to some of the most fixed and solid materials of our planet's crust. Add hydrogen, and another protean phase of strange metamorphosis comes before us. Sugar and starch are materials of this constitution, both harmless—in one sense nutritious; but crystallised oxalic acid has exactly the same elements, only in different proportions. Oxalic acid, again, is a deadly poison; but unite it with lime (another poison), a wholly innocuous compound results; one that occurs naturally in each member of the rhubarb tribe. To the triad of carbon, oxygen, and hydrogen, add—by combination—nitrogen, this in its simple state the most inert of all the elements, and other series come upon the scene: quinine and cinchonine so useful in medicine, prussic acid, strychnine, and a host of deadly poisons. Yes, it is a strange matter for contemplation, but not more strange than true, that an old boot, the lean of a mutton-chop or a beefsteak, contains all the elements necessary to form prussic acid, and out of which prussic acid may readily, by the chemist's skill, be eliminated.

The most familiar aspect under which carbon meets our view is pit-coal. Pit-coal—let us contemplate it. Seen day by day, this very wonderful material is completely vulgarised; but reflected upon, is soon found replete with poetry, marvel, and mystery. It is suggestive of awe-inspiring thoughts, this pit-coal. In the first place, except Nature goes to work differently now to what she was wont to do in times of yore, every atom of carbon in pit-coal came originally from the air. Yes; the metamorphosis of carbon is one of the most curious matters of philosophic contemplation presented by the world's economy. The air, the earth, and living things upon the earth, all hold this protean element in one form or another. Start from what point we will, this curious element attends our exploratory steps, and springs up in evidence before us. Picture now an ideal scene. By some vast cataclysm all animated nature is swept from the earth: the air is voiceless, for its birds are dead, and creatures of the water are destroyed. The world is tenantless, for the last man has gone to his narrow home. The globe is void of animated life down to the veriest atomy. The material elements of once living forms have yielded themselves up, the trammels of life cast aside. New vital forces have marshalled, or are marshalling, them into other forms: onward, thronging still to other destinies. What has become of these once elements of animated nature? what *is* to become of them? Chiefly before all, what would be the destinies of carbon under the conditions of that life-extinction which we have assumed? At the lowest estimation, carbon makes up seven-tenths of dry animal materials. The number of human beings existing is considered to amount to about 1200 millions. The average weight of an adult human being may be considered as about 154 pounds, of which, as already remarked, about 90 pounds is water. In the remnant, that is to say the dry portion, we have to seek for carbon; and now our calculation, hitherto vague, begins to assume an aspect of almost complete certainty.

Nearly 45 (say 45) parts by weight of the dry portions of an average adult human body are carbon; in other words, 45 pounds for an average adult. But inasmuch as humanity is not made up of adults, inasmuch as we must take the large and the small together, establishing an average, we may be perhaps warranted in arriving at the conclusion that a medium weight of $22\frac{1}{2}$ pounds is a fair carbon-estimate for every human individual. Upon this assumption, the total weight of carbon present in the bodies of living humanity amounts to the astounding figure of 12,051,212 TONS!

So much, then, for the carbon of humanity. I am not aware that any estimate has been made of the aggregate weight of animated creation as contradistinguished from mere humanity. Until a census be taken of fowls of the air and fishes of the sea, animals of all sizes and degrees, from whales and elephants to microscopic animalcules, one cannot even approach the absolute in a speculation like this. But considering the teeming ocean with its giant cetacea, its fish, its molluscs large and small, and all and every sprawling thing which naturalists' drag-nets bring from the deep upwards; considering that the upper world has double vantage over mere humanity, inasmuch as neither men, nor women, nor children of either gender fly; considering the beasts of the field, wild and tame; pondering on the animated masses, non-human, of living flesh,—shall I be deemed to have strained a point in arriving at the conclusion, that the aggregate weight of vitalised non-human carbon is double that already eliminated as being the carbon-equivalent of living humanity? More than 24,100,000 tons. Let us adopt that estimate, and adopted, it will be seen to bear out the conclusion, that the world's full complement of animated carbon, suddenly dead and abandoned to dissolution, hither and thither dissipated over the face of the globe, all that once solid mass of once vitalised carbon will have to be sought for in other forms of combination. You and I will have to die some day. You and I will have to yield our carbon, no less than other elements, back to the commonwealth of nature. Ashes to ashes, dust to dust: thus is it written, and thus shall it be. Yes, proud emperor, or you, fair lady, even unto you, and this in despite of cere-cloths and lead coffins.

Lady, a word with you. You are as great as great can be, and I, what am I? Nobody. Nobody! I smile; the Scytheman smiles. Nobody! Yes, I am a body, or I have a body, put the case as you will. Calmly let us see what will become of your body, and what will become of my body.

When you die, some fashionable undertaker will solder your 150 pounds of bone and blood and flesh into a leaden coffin, and pack the leaden coffin away into another coffin, decking the second out with velvet and gewgaws as befits your superior station. Then to the vault you shall be borne; earth must not hold you. The cloistered charnel is your resting-place; there to defy all elemental change; braving dissolution.

Alas, my lady, if you could but see, as I by the light of chemistry can see, that festering wreck of poisonous corruption seething within that leaden box of yours in twelve short months or less! Your flesh, instead of dissolving harmlessly into thin air, or crumbling little by little to mother earth, thence passing into trees and flowers, a part of their very being,—the elements of your body will have fretted into poisonous compounds, the veriest breath of which bursting free, as some day it must, will speed about pestilence-breeding. There's no avoiding the common lot, my lady—none. Ashes to ashes, dust to dust: thus it is written, and thus shall it be. Material elements know their destiny, and knowing must obey. To move on, combining and recombining, idle never, that is their destiny: and—typical enough of what we see in life—if their energies be restrained, if honest fields of energy be barred, they take to mischief.

Your 150 pounds (more or less) of bodily material are only lent, my lady; held on the frailest of tenures. They are not freehold, nor even leasehold. The holding is not yearly, monthly, weekly—not even daily. Asleep or awake, Dame Nature puts her physical forces in possession, and takes your very substance in kind every moment of your existence;

and, when the God of nature dispatches Death to garner in the fruits of dissolution, think you to escape the common lot? O, no, my lady. Ashes to ashes, dust to dust: thus is it written, and thus must it be.

Fair one, this much of you; and now of me. When I die, a plain elm coffin awaits me, and that for decency's sake. Nobody will deem it worth the while to solder me up in lead or pewter. Living humanity will have had enough of me; my elements will be free to pass on. And the spirit—if spirit it be that thinks within me now—would never trouble any one who helped the dissolution; liberating the elements by some process more rapid than decay. It matters not, save for the sentiment of it,—but sentiment may be the spirit-life within, for aught we know,—it matters not, but I fancy mine would be an unhappy ghost, could it but look down—or up, as the case might be—and contemplate the noxious forms that matter can assume whilst striving to be useful according to its destiny. This even when no repressive agency is at work; the grave willing, ay ready, to resign its burden; Nature caressingly luring the pure elements struggling from corruption to join in her life-long revelry of change and travel, dance and rout,—a life-long masquerade. The nitrogen of my substance,—Nature wants it; she will make ammonia of it, and, as smelling salts, would not a ghost, looking on, be gratified to see the pungent salt, in crystal bottled, nestled in the soft recess of a lady's bosom, or warming her delicate nose? Ay, and think of my carbon too: what destinies await it! Diffusing sweet odours, perhaps from the petals of a rose. Tended gently by fair hands; helping to make up a floral love-token: why not? In some form of life and action my carbon must be passing on. Many years must roll by, and many an accident of flood and field must happen, ere that element would be likely to find a resting-place awhile in pit-coal, limestone, marble, charcoal, or the diamond: as one who, tired with dancing or the chase, has gone to sleep awhile, waiting for the dawn. And yet perchance it might happen sooner than assumed. The charcoal-burner might lop off some wooden stem in which the carbon of my dissolution was busy at life work.

Charcoal, next to its fair allotropic sister the diamond, is perhaps the most indestructible thing in creation—Nature's slow agencies alone regarded. Century after century water can flow over it without effecting one touch of dissolution. Whether free in the air or buried in the earth, charcoal never decays. Touched by fire, charcoal wakes out of its resting sleep, indeed; assumes an invisible form, and fleets about ready for other duties. More lasting is the diamond, though far from meriting the designation ἀδάμας, which formerly it won. Heat them enough, and diamonds burn, vanishing into thin air. Can my disembodied spirit ever hope to see the carbon-elements of that bodily frame which yielded her up in death, glittering consolidated, transformed into the most beautiful of all gems? Given time enough—a long time indeed—that event might come to pass. It must indeed be a long time, except some ingenious chemist should take my carbon-elements in hand and bend them to his purposes. I am not sure that diamonds have not been artificially made: nay, I am not quite sure they cannot be made by more than one process. Many appearances go to beget the supposition that diamonds have crystallised out of some fluid menstruum. Occasionally little globules of fluid are to be seen within a diamond, and occasionally, when an incautious observer has exposed to heat a diamond of this sort, it has exploded with a loud noise; the liquid wholly disappearing. Taking cognisance of this fact, taking cognisance, moreover, of the extreme refrangibility of this imprisoned fluid, a modern chemist has stated it as his belief, that it is nothing else than liquid carbonic acid; a fluid that, if the presumption of analogy do not lead the mind astray, should be capable of dissolving carbon, and furnishing conditions favourable to crystallisation.

Beyond the mere watery moisture of animal bodies, there is yet some oxygen and hydrogen to be disposed of. Circumstances will determine the manner in which these elements shall escape, and how, amongst themselves, or with other elements, they shall afterwards recombine. Wedding itself to phosphorus, hydrogen may generate a spontaneously inflammable gas, to dance and glimmer fairy-like about, a rollicking Will-o'-the-wisp. Wedding with sulphur, some may expand into that noxious and evil-smelling gas, hydro-sulphuric acid, reeking pestilent; a gas so laden with the germs of death, that all who breathe an atmosphere holding no more than twelve parts of it in a hundred fall down dead, as though they had been touched by the wand of Azrael: a gas that can even kill by skin-contact;* and which, present under a still more diluted form, as on the swampy coast of Western Africa, breeds the desolating fever of that fatal region. But the pestiferous gas has only a short time in which to wreak its vengeance. Oxygen lies in wait for it, unites with it by a kind of slow combustion, and forms two other compounds—water, harmless water, the one; sulphurous acid (gas of burning brimstone) the other. And to the latter is accorded a short term of existence. By union with more oxygen, oil of vitriol is next formed. Oil of vitriol must needs wed, and its spouses are many. It combines with ammonia; it combines with lime; with magnesia too:—are not the marriage credentials of this acid graven on the walls of the New Palace at Westminster? And now, my body, my flesh, my bones, but little remain of ye! Some phosphorus has fleeted away, but some, united with lime, still clings to the tomb in the form of phosphate of lime, the chief material of bones. This material in process of time is decomposed by natural agencies; or greedy chemists, exercising their mystic art, may grub-up my bones and extract my

* Some years ago the experiment was tried in France of enveloping a horse, all but the head, in a bag of sulphuretted hydrogen gas. The animal was killed.

phosphorus bodily. My observant ghost, looking calmly on, may see an element of its once-cherished body blazing at the end of a wooden match, doing duty in one of Sir William Armstrong's shell-fusees, or made up into phosphor-paste, luring rats to destruction.

Decay and dissolution are never pleasant to think about. They are passing changes that hardly bear unveiling, save under the irradiation of the lamp of chemical knowledge; which teaches that decay—dissolution—is not destruction. No, decay is not pleasant to contemplate. It opens to new regions of life and beauty, but the opening process is rough. And even the very throes and travail and progeny of dissolution, so to say,—sights which chill with horror, and odours which, floating heavily on the breeze, seem like Pandora's pestilent death-scattering maladies,—even all this is beautiful to reflect upon, as spirits may from other worlds looking down, or philosophers in this. No, corruption is not nice:—bury it, then; burn it, then. That is what Nature prompts us to do, and that is why she made it so offensive. An organism burnt, its elements are liberated at once; and well-pleased Nature absolves the living from the pest-laden odours of the dead. Buried, corruption goes on indeed, but gently, gradually; and, if mother Earth be not overworked, for the most part harmlessly. Not merely has earth—the soil—the power of absorbing emanations and yielding them up gradually, but has the farther power of working chemical changes upon them, so that they may be transmuted into other forms.

The most deadly poisons known to chemists are products of animal and vegetable bodies. Some of these are secreted during life, others the products of chemical union. It is a remarkable fact that all this class of poisons, without one exception, are unstable, fleeting, and evanescent. Their composition is unstable; their elements continually tending to fly apart. The chemist cannot in many cases lay hold of them; they defy all his analysis. Nature seems to intimate, by the frail tenure and instability of these, that the elements performing for a time such deadly duty shall soon be more genially employed. Pure prussic acid is so very deadly, that one breath of it into the nostrils extinguishes life in an instant; and one drop of it poured into the eye of a strong dog kills the animal not less suddenly than if his heart had been torn out by a cannon-ball. Now contemplate this:—if nitrogen, hydrogen, and carbon had been destined to combine naturally, forming prussic acid to any considerable extent, the existence of animated life would not have been possible. If the decomposition of animal bodies be allowed to go on gradually without impediment, as when buried under earth, carbon, hydrogen, and nitrogen do not unite to generate prussic acid; but, let decomposition proceed under the modified circumstance of restraint, as in a lead coffin, then is that deadly compound prussic acid generated, amongst others; a sort of indication that Nature rebels against the monopoly of her elements which human pomp would enjoin.

A while ago we seemed to have made out that if all the carbon present in all the bodies of animated things now living on the earth could be collected and weighed, it would be seen to amount to the enormous quantity of 24,102,424 tons; presently we will compare it with the bulk of carbon already exhausted from the earth in the form of pit-coal; but prior to this it may not be amiss to contemplate the vast amount of carbon evolved from the lungs of humanity day by day. In the breath that we expire charcoal exists. Though under ordinary circumstances invisible (and well too, or how sooty we should be!) the chemist can make it visible—can collect it, weigh it. This done, every adult human being is found on the average to evolve no less than thirteen and a half ounces of charcoal during the twenty-four hours, which for 1200 millions of adults would be about 23,000 tons, and which if halved, in consideration of youths, old age, and babies, would still be enormous.

We will not pause to calculate the figure to which this carbon-evolution is raised by the breathing of animals; the reader curious in such matters may think out the case for himself.

From breathing and decay, and other sources, the air is ever supplied with carbonic acid, and as continually yields the carbon of it up to plants, wherein it becomes fixed. So far as present operations and analogy can lead us to perceive, all the carbon present in organic life must have come originally from the atmosphere, and, by a parity of reasoning, all the carbon ever excavated in the form of pit-coal, or remaining to be excavated. This seems astounding; but accepting Liebig's estimate, that the atmosphere holds no less than 1,332,142,857 tons of carbon dissolved under an invisible form,—present as carbonic acid gas,—much of the astonishment vanishes.

In regard to the amount of pit-coal already excavated, consumed, resolved into the atmosphere, a Prussian engineer, M. de Carrnal, has made some curious calculations. The quantity of coal actually dug up to the end of 1857 amounted, according to him, to 125 millions of tons, a quantity represented by a compact cubical mass of ten miles across on every face. Nineteen-twentieths of this at least are carbon; being equal to about one-eleventh the carbon-complement of the whole world's atmosphere; and nearly five times greater than the carbon-estimate of the amount of animated creation existing at the present time. Farther, if the world's 1200 millions of human inhabitants could live, breathing as they do now, until their breath-carbon had yielded an amount equal to the amount of coal already dug up and consumed, they would have to live and breathe away for about 5432 days and a half.

PREADAMITE MAN.

THERE is hardly a topic of speculation and debate in respect of which an under-current of belief does not exist in advance of printed documents. By more in advance is not meant more truthful of necessity,—that would be altogether begging the question—but more outspoken, more free, and, if not necessarily more true, more like what the speaker himself believes to be true. It would be perhaps impossible to indicate a topic to which the remark just enunciated more forcibly applies than that of the dawn of man upon the earth. If any time during the last half-century a geological naturalist or a physiologist had been asked by an intimate friend, in whose presence reserve was habitually thrown aside,—if he had been asked whether he believed or disbelieved in the Mosaic account of the creation of man, the chances are much in favour of the reply point-blank, 'I do *not* believe.' That is one phase, the private phase, of a man's bearing in respect to the matter in debate. Had the same man—the geological naturalist or physiologist—to write a book involving in any way a reference to the same topic, he would most probably have treated it in a different way. Without absolutely changing his former '*non credo*' into '*credo*,' he would have probably weighed and measured out his words in such wise that his opinions on the topic might seem either acquiescent, indeterminate, or if determinate and resolved out, so very abstruse as to frighten ordinary readers from even trying to understand. If it be inquired whether the dealing by a subject thus be truthful, the answer is plain. It is *not* truthful; the word 'duplicity' exactly represents it. Thousands of topics exist, nevertheless, in respect of which an equal amount of duplicity is shown. I am not concerned here to show the reason.

Of late various causes have conspired to bring phases of private thought more into the foreground of public opinion than heretofore. Amongst these may be mentioned the free outspokenness of the Bishop of Natal, and the license of non-natural interpretations claimed and taken by certain theologians. With these examples before them, lay philosophers might well take heart of grace; saying each to himself, 'What need of this reticence for peace and quietness' sake, lest dogmatic theology should be disturbed, seeing that it already *is* disturbed? The acquiescence of theologians was only a pretence, after all—a lie, to be plain. At least, then, will not I be in complicity.'

Relative to the question to be discussed—whether the Mosaic account of the creation of man be or be not literally true—we have first to give attention to the element of time. If true as to time, then up to the present year 1870 (inasmuch as the creation is fixed at 4004 years before Christ), man will have been a denizen of this planet for just 5874 years. To simplify the case, we will, for the present, consider the element of time exclusively; asking ourselves, in how far does the assumption of less than six thousand years accord with the teaching of evidence? In treating of this, it will be well to begin at a point at which theologians and naturalists, with some rare exceptions, coincide. The point to which I would refer is that marking the concurrence of men of science and theologians in the belief that the Mosaic account of creation can only be held to signify rearrangement; and that, granting, for the sake of argument, the creation of man to have happened at the time evolved from the Mosaic account, still the fossil remains of bone, turning up, demonstrate the existence of animals upon our planet before the conceded advent of man. I would not be understood to assert that concurrence at the point indicated is universal, but *nearly* universal. People of exceptional minds there are, to whom the bodily presence of a mastodon or other extinct animal in any geological formation would signify no more than that the Enemy of man had deposited the semblance of bones there as a snare and a delusion to lead men astray. Such minds are exceptional; upon the possessors of them argument is thrown away. There exist very few such; the point of concurrence being pretty much as indicated.

Assuming it then for granted that the materials of our planet existed in a consolidated form long before the stated Mosaic date of creation, and that in those antecedent periods animal beings had been created, as proved by their osteological remains, the first question that suggests itself is: If human beings lived in those antediluvian periods, ought not their remains to be found also? Certainly they *ought* to be found, and the purport of what is to follow is intended to prove they *are* found; but the contrary belief long prevailed amongst geologists. The fact is, that in science there can be no such thing as any immutable article of faith—of belief. As evidence turns up, so faith, belief, may have to alter. The matter in hand furnishes examples of some remarkable changes of belief: examples that the dogmatist, in whatever department, might study with gain to his charity. The first example is furnished by Dr. Buckland, who no longer opposes the belief in the existence of prehistoric man, although a contrary belief had been set forth in his work the *Reliquiæ Diluvianæ*, published in 1823.

It treats of the organic remains contained in caves, fissures, and 'diluvial gravel' in England; and in it the writer declared that none of the human bones or stone implements met with by him in any of the caverns could be considered to have the same antiquity as the bones of the mammoth and other extinct quadrupeds. With this profession of faith English opinion was made to harmonise, notwithstanding that testimony derived from the Torquay caves themselves was not wanting to cast doubt upon it. For example, the Rev. Mr. M'Enery, a Roman-Catholic priest residing near Torquay, had found in a cave one mile east of that town, and called Kent's Hole, not only bones of the mammoth and the three-horned rhinoceros, the cave-boar, and other mammalia, but several flint tools. There were also the remains of man in the same cave, but these were considered to be of later date. A farther exploration of Kent's Hole ten years later, *i.e.* in 1842, by Mr. Godwin Austin, furnished new evidence. The explorer testified that he had found works of man from undisturbed loam or clay, and mingled with the remains of extinct animals. He maintained that the hypothesis of sepulture was not valid, seeing that not only human bones were found, but flint implements, the work of man also, and distributed extensively throughout the loam underneath the stalagmite. Three or four miles west of Torquay, at Brixham, a new and undisturbed bone-cave was discovered in 1850, and systematically examined, the Royal Society having made two grants towards defraying the expenses. The result was very interesting. Bones were found of the reindeer, the mammoth, the three-horned rhinoceros, of the cave-lion, cave-bear, and cave-hyena species, all extinct. No human bones were discovered, but an abundance of flint implements, that could only have been made by human hands; and these implements were found in a geological formation underneath, and therefore older than the one on which rested the quadrupedal bones. Hence the evidence went to prove that the quadrupeds must have come to die above the instruments made by human hands, not that the instruments got mingled with some then ancient bones.

Whilst these discoveries made at Brixham had tended to shake the belief expressed by Professor Sedgwick, evidence even stronger had been accumulating on the Continent. For many years previous to 1833, the late Dr. Schmerling, of Liége, an ardent palæontologist, caused himself to be let down, day after day, by a rope into certain subterranean caves, resembling in their general character those already alluded to at Torquay and Brixham. He collected a large quantity of osseous remains, mostly quadrupedal, but some human; and what is even more expressive, he found mingled with those remains some well-fashioned flint implements, one of them a hatchet. The animal bones comprised not only those of the mammoth, the cave-bear, rhinoceros, and hyena—species all prehistorical—but of the red-deer, roe, wild-cat, wild-boar, wolf, weasel, fox, beaver, hare, rabbit, hedgehog, mole, dormouse, field-mouse, water-rat, shrew, and other species now extant. 'When,' writes Sir Charles Lyell, 'in the year 1833, I passed through Liége on my way to the Rhine, and conversed with Dr. Schmerling, who showed me his splendid collection, and when I expressed some incredulity respecting the alleged antiquity of the fossil human bones, he pointedly remarked, that if I doubted their having been contemporaneous with the bear or rhinoceros, on the ground of man being a species of more modern date, I ought equally to doubt the co-existence of all the other living species, such as the red-deer, roe, wild-cat, boar, wolf, fox, weasel, beaver, hare, rabbit, hedgehog, mole, dormouse, field-mouse, water-rat, shrew, and others, the bones of which he had discovered scattered everywhere indiscriminately.' The argument was irresistible, and the veteran geologist Sir Charles Lyell testifies to the effect of it upon him. He cited Schmerling's opinions, he writes, without pretending to call in question their trustworthiness, but, at the same time, without giving them the weight which he now considers they were entitled to. 'Schmerling,' now testifies Sir Charles, 'had accumulated ample evidence to prove that man had been introduced into the earth at an earlier period than geologists were then willing to believe.'

The first great emancipation of thought relative to man's prehistorical antiquity was accomplished thirteen years after the publication of Schmerling's researches, by M. Boucher de la Perthes, who discovered some flint implements at Abbeville, in Picardy, so geologically associated as to leave no doubt in his mind relative to their prehistorical antiquity. M. Boucher de la Perthes was an antiquarian as well as a palæontologist. He discovered a difference of character between those flint instruments and others of the same material, but of a later period, and called celts. He began to collect these implements in 1841, subsequently to which time they have been frequently dug out. It was with the French as with the Belgian palæontologist: the scientific world had no faith in his deductions; they mostly would not believe that works of art, however rude, had been met with in undisturbed beds of such antiquity. Various theories were propounded to explain away the deduction founded on the instruments of wrought flint. Might some of them not have owed their peculiar forms to accidental fracture? Might not the workmen have committed frauds? The gravel might have been disturbed, the wrought flints of a later period might have got mingled with the bones of an earlier period. It was even suggested that gun-flints might have been manufactured on the spot, and that the reputed antediluvian hatchets, knives, and arrow-heads might be only the refuse chippings.

Foremost amongst the sceptics as to the deductions of M. Boucher de la Perthes was the late Dr. Rigollot of Amiens. He had written in the year 1819 a memoir on the fossil mammalia of the valley of the Somme, not heeding the flint implements, which rose to so much importance under M. Boucher de la Perthes. He would not believe in the recorded proofs of man's antiquity; so the change wrought on his thoughts, after having visited the scene of M. Boucher de la Perthes' labours and investigated for himself, must be accepted as wholly devoid of previous bias. He went to Abbeville; he inspected the collection of M. Boucher de la Perthes; he then returned home to look himself for flint tools in the Amiens gravel-pits. There, about forty miles from Abbeville, he found abundance, exactly as M. Boucher de la Perthes had recorded. Dr. Rigollot communicated the results of his discovery to the scientific world in an able memoir. He distinctly pointed out that it was not in the vegetable soil, nor in the brick-earth with land and freshwater shells next below, but in the underlying beds of flint-gravel—twelve, twenty, even twenty-five feet below the surface—that the flint tools were discovered. To his mind the inevitable deduction was, that the flint tools (and of course the makers of them) were contemporaneous with the mammoth, the three-horned rhinoceros, the cave-bear, hyena, and other extinct species, of which the bones were found in company with them. This brings us up in point of time to the cave-exploration at Brixham, near Torquay, which took place four years after the publication of Dr. Rigollot's monograph.

Although, then, the public expression of belief in the prehistorical existence of man is an event of only a few years, a private under-current of contrary belief has existed during the last half-century; the occurrence from time to time of human bones, and the evidences of human handiwork, having caused the opinion to prevail that man's advent upon earth must be referred to some earlier date than had been imagined. These evidences had been found in the superficial deposits termed drift or diluvium, and also in caves. They had been often found in association with remains of extinct species, such as of the hyena tribe, the bear, elephant, and rhinoceros. The opinion grew slowly, and for a reason almost too obvious to need mention. If it be accepted, then the Mosaic account of creation in respect of time at least must be repudiated. Under the pressure of this conviction, naturalists manifested a reserve in speaking and writing of this matter that their private opinions belied; nor was it until every plausible hypothesis had been exhausted that the real views of geologists relative to man's antiquity were made public. In this way it was assumed that caves had been inhabited by a succession of tenants; that man had not only dwelt in them, but been buried in them; that streams had flowed through those recording caves or along those bone-revealing drifts, mingling together the remnants of different species at different times. The simple truth is, that English social feeling, until within the last few years, imposed the alternative either of silence on the expression of the belief in man's geological antiquity, or excommunication. The period of outspokenness on the matter may be said to have dated from 1858, when the systematic investigation took place of the Brixham cave, near Torquay, already referred to.

The first point that would perhaps strike an investigator of the evidence just set forth is the paucity of actual human remains in comparison with the frequency of articles of presumed human handiwork. Bony remnants are confessedly few; and only one example of a perfect human skeleton has been found under circumstances that point to prehistoric existence—that skeleton discovered in a cave at Neanderthal, near Dusseldorf, in 1857.* The more this topic is reasoned upon, however, the more consistent is it found to be with what, according to theory, should have been. The arrowheads, knives, hatchets, and other results of human handiwork prepared by any individual man at the time when every one may be assumed to have made his own, must have amounted in the course of an entire life to a bulk altogether disproportionate to the bulk of the bones of a human skeleton. Then, inasmuch as the tools and other proofs of handiwork were made of flint or jade—both stones on which time has no effect, whereas bones easily crumble to earth when not buried under special circumstances—in this again we perceive a reason ex-

* The skeleton is supposed to have been complete before some parts were accidentally destroyed in the process of excavation.

planatory of the result as actually found. Those persons who rely much on the negative testimony of the paucity of human bones, compared with the abundant presence of instruments the assumed product of human handicraft, may ponder on the fact presently to be stated with advantage.

The great Haarlem Lake, drained within the last few years and reclaimed to dry land, did not reveal one trace of human bones, though sea-fights had taken place upon its waters during the contests between the Dutch and the Spanish; and moreover, in times before the Zuyder Zee broke over it and it became a lake, its bed comprehended the site of at least two burying-fields. It may readily be assumed that mankind in all ages, under all states of society and grades of civilisation, would have mostly disposed of the remains of the dead with some reference to sepulture, involving conditions of early decay; to which, amongst other reasons, the paucity of human remains may be attributable. Again, it seems reasonable to assume that, granting the existence of man in prehistoric times, the number of mankind would be still small in comparison with the animals associated. Be this as it may, no amount of hypothetical assumption can be held sufficient to controvert one positive fact. If the point be granted that remains of man or of man's handiwork have been found in geological formations referable to prehistoric times, then all hypothetical objections, showing why such evidences should *not* be found, sink into unimportance.

The term 'prehistoric,' which is here frequently employed, is designedly loose and elastic. Any term anterior to the first accepted records of history, whether by hundreds or thousands, tens of thousands, or, in short, any possible number of years, may be called prehistorical. The human records already adverted to—remnants from the Brixham caves, the Liége caverns, and the valley of the Somme—give the impression of having belonged to a period of time not only prehistorical, but that by some indefinitely long period—a time whilst other animals than those now known were denizens of the earth. If this point be conceded, then the natural question arises, whether in periods nearer our own, but still before the records of history, some traces of the existence of man might not have been reasonably expected. Assuredly; and they have been found, notably in the peat-lands of Denmark and the submerged dwellings of certain Swiss and other lakes.

In the peat-formation of Denmark a quantity of human implements has been found, indicative of a chronological succession of periods, which have been called by Danish naturalists the ages of stone, of bronze, and of iron, according to the materials of which the implements are made. In reference to this division, it must be stated that the vegetation of Denmark has undergone three marked phases of mutation. There was a time, as made evident by remains, when the Scotch fir (*pinus sylvestris*) was indigenous to that country. None have grown naturally in Denmark within historical periods, and when planted there do not thrive. After the Scotch fir died out, a sort of scrub-oak prevailed, which in its turn has almost disappeared; and the common beech is now the prevailing tree-growth of Denmark. The Danish age of stone coincided with the prevalence of Scotch fir, and to some extent with the second or oaken period. A considerable portion, however, of the oak period corresponded with the age of bronze, as proved by the discovery of swords and shields of bronze in oak-peats. The age of iron almost exactly corresponds with the prevalence of the beech-tree, and belongs mostly to historical times. The use of bronze implements implies enormous advance in the arts. Not only is bronze a compound metal, but tin, one element of the compound, never occurs native, and is wholly absent both from Switzerland and Scandinavia. If, as some have imagined, an age of copper must have followed that of stone and preceded that of bronze, the duration of it in Europe must have been very short. Copper hatchets have indeed been found in certain of the Danish peats; but the opinion is that the people of the stone age were conquered by a race coming from the East, and to whom the use of bronze tools was familiar. Over various parts of this peat-formation heaps of refuse, comparable to dust-heaps, have accumulated; and in these frequent evidences of human handiwork are disclosed, though none comparable for workmanship and finish to what have been recovered from the lacustrine villages presently to be noticed.

During the dry winter of 1853-4 the lakes and rivers of Switzerland had sunk lower than ever had been known. So low had the water of the Lake of Zurich fallen, that the inhabitants resolved to embank and turn to account a portion of the shore. They sought to accomplish this by dredging the shallow water, and banking up the mud on the already denuded land. In the course of this operation they made a strange discovery. A number of wooden piles were found driven into the bed of the lake, and amongst them a great many tools, such as axes, celts (*i.e.* flint cutting-instruments), hammers, &c. All these, with two exceptions, belonged to the stone period; the exceptions were an armlet of thin brass wire and a small bronze hatchet. Fragments of pottery too were abundant; also charred wood, the latter in such profusion as to warrant the belief that the lacustrine village had been destroyed by fire.

In many Swiss lakes wooden piles are seen projecting from the bottom, and occasionally the remains of ancient cottages have been found upon these piles. Evidently they once supported villages mostly of unknown date, though the most ancient of them corresponded with a period when man in those parts had not learned the use of metals for the construction of edge-tools. This is proved by the existence of cutting-instruments of flint, like those already alluded to as mingled with human bones at Liége and in the valley of the Somme —only perhaps a little more elaborately formed. They are exactly like the flint-tools found in Danish shell-mounds and peat-mosses. The most recent of lacustrine dwellings, though very ancient, are not prehistorical. Thus Herodotus adverts to a Thracian tribe who, in the year 520 B.C., dwelt in Prasias, a small mountain lake of Pæonia, now part of modern Roumelia. He describes the lacustrine dwellings as having been built on platforms above the lake, resting upon piles. Between them and the shore communication was established by a narrow bridge similarly formed. According to Herodotus, the Pæonians lived on these pile constructions, together with their families and horses; hence they must have been of considerable extent. The Pæonians are stated to have lived upon fish, with which the lake abundantly supplied them.

Still following the testimony of Herodotus, the Pæonians maintained their independence during the Persian invasion, bidding defiance to Xerxes by the position of their dwellings. 'But,' remarks Mr. Wylie, in a valuable paper on lacustrine dwellings, 'their safety was probably owing to their living in the middle of the lake, ἐν μέσῃ τῇ λίμνῃ; whereas the ancient Swiss settlers were compelled by the rapidly-increasing depth of the water near the margins of their lakes to construct their habitations at a short distance from the shore, within easy bow-shot of the land, and therefore not out of reach of fiery projectiles, against which thatched roofs and wooden walls could present but a poor defence.' To these circumstances, Sir C. Lyell surmises, we are indebted for the frequent preservation of the most precious tools and works of art, such as would never have been thrown into the Danish shell-mounds, which have been aptly compared to a modern dust-hole.

Lacustrine dwellings, similar as to position at least with those discovered in Switzerland, are found in New Guinea; and a sketch of them has been published by M. Dumont d'Urville. Availing himself of this groundwork, Dr. Ferdinand Keller of Zurich has drawn up a series of illustrated memoirs of the relics in stone, bone, and bronze which the dredgings of the Lake of Zurich have revealed. He has thus ideally reproduced an ancient Swiss village, as the New-Guinea representative seems to warrant him in imagining it must have been.

M. Lohle, who has also written on these lacustrine dwellings, believes that as many as 300 wooden huts were some times aggregated in one settlement, and that they may have held 1000 inhabitants. M. Troyon, in his work on Swiss lake-habitations, specifies the different places of their occurrence. He enumerates the Lakes of Constance, Zurich, Geneva, and Neufchatel, and most of the smaller ones. Some belong exclusively to the stone age; others are of the bronze period. More than twenty of these last have been referred to the Lake of Geneva alone, twelve on the Lake of Neufchatel, and ten on the small Lake of Bienne.

The small Lake Mooseedorf, near Berne, was the one first studied. The dwellings here belonged exclusively to the stone period; implements of stone, horn, and bone, but none of metal, having been discovered. The neighbourhood is not one that yields flints naturally, yet flint fragments are scattered about in profusion; the material must have been imported, probably from the south of France. Hatchets and wedges of jade have also been found; the jade said by mineralogists to be of a sort not found naturally in Switzerland or any adjoining part of Europe. Amber also was found; brought, most probably, from the shores of the Baltic.

At Wangen, near Stein, the relics discovered were still more curious. Here hatchets of serpentine and greenstone were found, and arrow-heads of quartz; specimens of cloth too, not woven but plaited, the material seemingly flax. Professor Heer has discovered masses of half-burnt wheat—the wheat of two varieties; barley also; round flat cakes of bread; carbonised apples, pears; stones of the wild plum; seeds of the raspberry and blackberry, beech-nuts and hazel-nuts, the latter in profusion. The discovery of these lake-dwellings, then, has proved the existence of man in times belonging to the present geological period: that is to say, since our planet has assumed its present consolidation and outline; yet, so far as relates to the Danish peat records, and the Swiss lake villages, at times before the earliest historical notice. The discovery has proved, moreover, that human beings living at periods which, though historically remote, are geologically recent, died and decomposed, leaving no personal remnants: which demonstrated, a cause is shown for not expecting to discover human personal remnants in geological formations of date immeasurably earlier.

The new phase of thought which has dawned in respect to the antiquity of man upon the earth—a phase dating from the last half-century, and especially since the exploration of the Torquay caves—naturally associates itself with another topic of speculation, that, though not now, has been of late much discussed—namely, the theory of development in regard to animal species. It starts naturally from the question—whether animal species are fixed and immutable, or whether subject to change? The first impression likely to be conveyed would be in favour of the fixity of species. Thus, appealing each to his own individual experience, we find that horses beget horses, dogs beget dogs, and so on for other animals; but slight consideration suffices to suggest the doubt that the experience acquired in the space of any one human life may not be conclusive. The question is not, what happens during the short period of sixty, seventy, or eighty years; not what *has* happened during the whole span of history; but what *may have* happened during the countless ages of geological mutation. The theory of development does not assume that in the almost infinitesimally small space of time of which history is made up, far less that in the life of any one human being, any complete mutation of species shall have been observed. It will be enough to give countenance to the hypothesis if any tendency to such metamorphosis shall have been observed; and in respect to this, naturalists, who best should know, and whose judgment should be entitled to respect in the highest degree, following Mr. Darwin, mostly uphold the hypothesis. Imprinted on the pages of the stone-book of geology are found remnants of creatures innumerable, which, so far as the evidence of bones and footprints can go—nay of flesh in some rare instances—prove that the earth was inhabited in times of unknown date by creatures of which the oldest historical narrative takes no cognisance.

To persons holding the extreme opinions that the forms in question are mere delusions of the Enemy of man, made to turn up from time to time for no other purpose than to shake our faith and make us doubt, or rather cast aside, the literal authority of holy writ—to such as those, of course, the naturalist does not address himself. To the majority, who see an existing skeleton, perfect bone by bone, the question will inevitably arise, whether these creatures changed into others as countless ages rolled on, or whether they were extinguished one by one, and new species created. The theory of development necessarily assumes the former; and of this theory there have been several modifications. Amongst the naturalists who believed in the faculty of development under one or another of its phases, Maillot and Buffon must be enumerated; but more especially Jean Baptiste Lamarck, whose views were extreme.

He assumed that all organised beings, no matter how high or how low the form, were progressively developed from particles of similar form and nature. He believed in the existence of a formative substance, that had only to change its form in order to be converted into a new being. Lamarck also believed in spontaneous generation; a theory that has been newly debated during the last few years. According to him, any soft formless gelatinous mass of organic matter had only to be fermented by surrounding fluids in order to generate a permanent living growth. What the new organs might be, use and circumstances, he held, would determine. He divides the animal kingdom into three classes—the 'apathiques,' the 'sensibles,' and the 'intelligents;' intelligence being merely, according to him, an expression of the will of the Divine Being.

The theory of development which of late years has come most into vogue is that of 'natural election,' as upheld and expounded by Mr. Darwin. By natural election is meant the faculty wherby organised forms, having become adapted to flourish under given conditions, pair with others that have undergone a similar adaptation; and thus in course of time and by descent, though it may be countless ages, acquire such an exaggeration of the characteristics which led to election as to constitute in the end new species. We have already explained under what disadvantage the naturalist labours when engaged on this field, seeing that he has to speculate on the possible influences brought to bear accumulatively through countless ages by the intelligence which is limited within the space of one; nevertheless Mr. Darwin feels assured that he has acquired a sufficiency of positive testimony to uphold his theory of development by natural election from his experience in the breeding of pigeons. Considering it most advantageous to study special groups, Mr. Darwin addicted himself to the pigeon. He has kept every breed which he could purchase or otherwise obtain, and has moreover procured skins from various parts of the world; he has consulted old books on pigeon-fancying; the result of all this attention being to awaken his surprise at the astounding diversity of breeds; all of which, however, seem to have descended from one common stock. When the English carrier is compared with the foreign shortfaced tumbler, a wonderful difference will be found in their beaks, entailing corresponding differences in the skull. The carrier, especially the male bird, is also remarkable for the strange development of carunculated skin about the head, accompanied by greatly elongated eyelids, large external orifice to the nostrils, and wide gape of mouth. The outline of the shortfaced tumbler's beak is almost like that of a finch; and the common tumbler has acquired by inheritance the strange habit of flying to a great height, then tumbling down head-over-heels. The runt is a very large breed of pigeon, having long massive beak and large feet. Some runts have very long necks, others very long wings and tails, others very short tails. The barb has a short and broad beak. The pouter has an elongated body, wings, and legs; moreover, an enormously-developed crop, which it is continually inflating, giving rise to an appearance whence the name of pouter has been acquired. The neck-feathers of the jacobin are all reversed, giving the bird the appearance of a hood; its wings, moreover, are very elongated, so are its tail-feathers. The voice of the trumpeter and laugher are different from those of other pigeons. The tail-feathers of the fantail amount to thirty or even forty, instead of twelve or fourteen, the ordinary number in most of the pigeon family.

What the anatomist will most be struck with is the skeleton peculiarity in different breeds of pigeons. In several, the development of the facial bones differs enormously in curvature; moreover, not only the length and breadth, but the shape of the ramus of the lower jaw varies remarkably. More extraordinary, the number of vertebræ is subject to variation, entailing a corresponding variation in the number of the ribs. 'Altogether,' concludes Mr. Darwin, 'at least a score of pigeons might be chosen, which if shown to an ornithologist, and he were told that they were wild birds, would certainly, I think, be ranked by him as well-defined species. Moreover, I do not believe any ornithologist would place the English carrier, the shortfaced tumbler, the runt, the barb, pouter, and fantail in the same genus; more especially as in each of these breeds several truly inherited sub-breeds or species, as he might have called them, could be shown him.' Nevertheless the author is convinced that the common opinion of naturalists, according to which all the breeds of pigeons are descended from the rock-pigeon (*columba livia*) is correct—including under this term many geographical races or sub-species. If not varieties; if tame pigeons be *not* descended as assumed, then they must have come from seven or eight aboriginal stocks at least. Such aboriginal stocks must have all been rock-pigeons, adverse to perching upon trees; yet, besides the *columba livia*, including its geographical sub-species, only two or three other specimens of rock-pigeons are known; and these do not resemble any breed of domestic birds. Proceeding on this hypothesis, the aboriginal stocks must still either exist in the countries in which they were originally domesticated, and yet be unknown to ornithologists—a most improbable conjecture—or in the wild state they must have become extinct, for which there is no warranty.

In all its smaller aspects, the mutation of race-characteristics is an accepted fact. Nobody doubts the ability of a cattle-breeder to modify the form and outline of horned-cattle and sheep, or the rabbit-fancier to perpetuate the varieties originally developed through selection. It is only when the theory is pressed to its extreme limits that the mind finds any difficulty in its reception. So long as we speculate on the changes effected on the feathers, the crops, or even the skull-bones of a pigeon, or the face and limbs of an ox or a sheep, the mind is acquiescent; but when it comes to the issue of assuming man to have arrived at what he is through the intermediate state of some lower animal, the proposition is startling, to say the least.

There can be no room for doubt as to the general effect of election or selection on species, however uncertain the limits may be up to which the effect is shown. Not only do the operations of the cattle-breeder and pigeon-fancier prove this, but it is a conclusion that follows an *à priori* consideration of the case. Thus, for the sake of illustration, if the hypothesis of Lamarck be assumed in its entirety, whereby a multitude of organised forms will have sprung up, their character mostly determined by external conditions, then it is reasonable to assume the permanence, in the highest degree, of those forms which are most adapted to the conditions. Some would have a greater degree of viability, or power of living, than the others; and thus, time being given, the forms vitable in the lowest degree would die out. Amongst the external conditions upon which the permanence of a species may depend, the presence of other species and the correlation between them must not be left out of account. Probably, Mr. Darwin remarks, there does not exist any one organised species, whether animal or vegetable, that is not in some measure correlated with all other species, though the links of correlation are not often manifest. In the course of many ages the vegetable characteristics of several regions adequately studied are known to have undergone a radical change, of which an example has been already furnished when treating of the Danish bog-formations. If a naturalist were now asked to explain the nature of the conditions through the operation of which the growth of Scotch firs declined in Denmark, then wholly ceased, forests of scrub-oak taking their place; why, at some subsequent epoch, the latter gave place to beech forests —the naturalist questioned on this matter would be unable to explain. He would nevertheless be able to illustrate by way of parallelism. Correlative dependencies still operating are ready to proclaim the general truth to all who seek it.

Thus the flourishing of the Scotch fir in Scotland is seen to be determined to so great an extent by the presence of cattle as to warrant the naturalist in assuming that if Scotch cattle were exterminated, the natural growth of Scotch fir, by which is meant growth without man's intervention, would cease. The explanation is consistent enough. When the firs grow, heather grows too, and so thickly that, if not browsed down, the heather suffocates the young fir-trees. Here the explanation is obvious and the correlation is immediate. Less obvious, because more extended through a mediate correlation, is the dependence of clover and heartsease upon cats. As to heartsease, it should have seemed that cats would tend to the destruction of the species, judging from what we see of feline operations in a garden. To discover the conservative influence of toms and tabbies, one must consult the pages of Mr. Darwin's book. It comes in this wise: neither clover nor heartsease can be impregnated—fertilised—as it seems, except through the intervention of some agency external to themselves; the shape and disposition of the pistils and stamens precludes this; wherefore the device of fertilisation through the trailing of pollen by insect feet has been adopted by Nature. But insects cannot be assumed to have the fertilisation of a flower present to their imagination—if imagination they possess; they are purely mercenary in their doings—labouring for reward. They alight on flowers in quest of honey; and now mark the correlation. The humble bee, it seems, is the only insect whose proboscis is long enough to get at the deep-seated honey of clover and heartsease flowers; wherefore the more numerous humble bees, the more fertile heartsease and clover. In what manner cats are involved in the correlation does not yet appear, though it presently will, when the fact is stated that amongst the greatest enemies of humble bees are mice. In this way it is easy to trace the correlation between cats and clover. Q.E.D.

EXTINCT SPECIES.

THE study of geology teaches us that our planet has undergone many successive physical revolutions; the crust of it being made up of layer upon layer, after the manner of the successive peels of an onion. Each of these successive depositions constitutes the tomb of animal forms, that have lived and passed away.

Now it is a fresh-water or a marine shell that the exploratory geologist discloses; *now* the skeleton, or parts of a skeleton—bones, from the evidence of which a comparative anatomist can reproduce, by model or picture, the exact original forms. Occasionally Science has to build up her presentment of animals that were from the scanty evidence of their mere footfalls. As the poacher is guided to the timid hare, crouching in her seat, by the vestiges of footprints on the snow, so the geologist can, in many cases, arrive at tolerably certain conclusions relative to the size and aspect of an extinct animal by the evidence of footsteps on now solid rock. If it be demanded how it happens that now solid rocks can bear the traces of such soft impressions, the reply is simple. There evidently *was* a time when these rocks, now so hard and solid, were mere agglomerations of plastic matter—comparable for consistence to ordinary clay. It needs not even the weight of a footfall to impress material of temper so soft as this. The plashes of rain are distinctly visible upon many rocks now hard, and which have only acquired their consistence with the lapse of countless ages.

The geologist's notion of the word 'recent' comprehends a span of time, of beginning so remote that the oldest records of human history fade to insignificance by comparison. Since this world of ours acquired its final surface settlement, so to speak, numerous species have become extinct. The process of exhaustion has gone steadily on. It has been determined by various causes—some readily explicable, others involved in doubt. The fact is well established, for example, that all Northern Asia was at one time, not geologically remote, overrun by herds of mammoth creatures, which, as to size, dwarf the largest elephants now existing; and which, among other points distinguishing them from modern elephants, the mammoths were covered by a crop of long hair. Very much of the ivory manufactured in Russia consists of the tusks of these now extinct mammoths, untombed from time to time.

Tilesius declares his belief that mammoth skeletons still left in Northern Russia exceed in number all the elephants now existing upon the globe. Doubtless the process of mammoth extinction was very gradual, and extended over an enormous space of time. This circumstance is indicated by the varying condition in which the tusks and teeth are found. Whereas the gelatine, or soft animal matter, of many specimens remains—imparting one of the characteristics necessary to the being of ivory—other specimens have lost this material, and mineral substances, infiltrating, have taken its place. The gem turquoise is pretty generally conceded to be nothing else than the fossilised tooth of some extinct animal—probably the mammoth.

Curiosity of speculation prompts the mind to imagine to itself the time when the last of these gigantic animals succumbed to influences that were finally destined to sweep them all from earth. Had men come upon the scene when they roamed their native wilds? Were those wilds the same as now, as to climate and vegetable growths? Testimony is mute. Time silently unveils the sepulchred remains, leaving Fancy to expatiate, as she will, on a topic so wholly beyond the scope of mortal intelligence.

Inasmuch as bones and tusks of the mammoth are dug up in enormous quantities, over tracts now almost bare of trees, and scanty as to other vegetation, certain naturalists have assumed that, in times coeval with mammoth or mastodonic life, the vegetation of these regions must have been richer than now; otherwise how could such troops of enormous beasts have gained their sustenance?

On this point Sir Charles Lyell bids us not be too affirmatively confident. He remarks that luxuriance of vegetable growth is not seen, at the time being, to correspond with the prevalence of the associated fauna. The northern island of the New Zealand group, at the period when Europeans first set foot there, was mostly covered by a luxuriant growth of forest-trees, of shrubs, and grasses. Admirably adapted to the being of herbivorous animals, the land was wholly devoid of the same. Brazilian forests offer another case in illustration; a stronger case than the wilds of New Zealand, inasmuch as the climate may be assumed as more congenial to the development of animal life. Nowhere on earth does Nature teem with an equal amount of vegetable luxuriance; yet Brazilian forests are remarkable for the almost total absence of large animals. Perhaps no present tract is so densely endowed with animal life as that of South Africa. There sterility is the prevailing characteristic. There forest-trees are rare, and other vegetation scant. There water, too, is infrequent.

Present examples, such as these, should make a naturalist hesitate before coming to the conclusion that Siberian wilds, even as now, were wholly incompatible with the existence and support of troops of mammoths or mastodons. Speculating as to the latest time of the existence of mastodons in Siberia, a circumstance has to be noted that would seem to countenance the belief in their existence up to a not very remote period of historic times. In the year 1843, the season being warmer than usual, a mass of Siberian ice thawed, and, in thawing, untombed one of these animals, perfect in all respects, even to the skin and hair. The flesh of this creature furnished repast to wolves and bears, so little alteration had it undergone. Another mastodon was disentombed on the Tas, between the Obi and Yẹnesei, near the Arctic circle, about lat. 66° 30′ N., with some parts of its flesh in so perfect a state, that the bulb of the eye now exists preserved in the Moscow museum. Another adult carcass, accompanied by an individual of the same species, was found in 1843, in lat. 75° 15′ N., near the river Taimyr, the flesh being decayed. Associated with it, Middendorf observed the trunk of a larch tree (*pinus larix*), the same wood that now grows in the same neighbourhood abundantly.

It is no part of my intention to discuss the causes of mammoth extinction. This result has assuredly not been caused by any onslaught of the destroyer man. The Siberian wilds are scantily populated now, and it has never been suggested that at any anterior period their human denizens were more plentiful. Nature often establishes the balance of her organic life through a series of agencies so abstrusely refined, and acting, besides, over so long a period, that they altogether escape man's cognisance.

The believer in the God of nature's adaptation of means to ends will see no reason to make an exception in animal species to what is demonstrated by examples in so many other cases to be a general law. The dogma, that no general law is without exceptions—though one to which implicit credence has been given—may nevertheless be devoid of the universality commonly imputed. On the contrary, the application of this dogma may extend over a very narrow field; may be only referable to the codifications, artificial and wholly conventional, which mankind for their convenience establish, and under a false impression elevate to the position of laws.

If logical proof in syllogistic form be demanded as to the proposition that laws established by Nature have no exceptions, the fulfilment of demand would not be possible, inasmuch as human reason is too impotent for grasping, and too restricted in its energies for investigating, the multifarious issues which the discussion of such a thesis would involve. As coming events, however, are said by the poet to cast their shadows before, so, as heralds and harbingers of truths beyond logical proof, come beliefs, faiths, even moral convictions. Of this sort is the assurance of the balance established by Nature at each passing epoch of existence in the world.

The naturalist is impressed with the firm belief that the number of animal species existing on the earth, and the number of individuals in each species, are balanced and apportioned in some way and by some mysterious co-relation to the needs of the universe.

Some presumptive testimony in favour of this belief is afforded by the discussion, barely yet concluded, relative to the effect of small-bird destruction. Without any more elaborate reasoning on this topic than follows necessarily as the result of newspaper reading, the general concession will be made by any one of unbiassed mind, that if small-bird destruction could be enacted to its exhaustive finality—if every small bird could be destroyed—the aggregate of life thus disposed of would be balanced through the increase of other organisms. Insect life would teem and multiply to an extent proportionate with the removal of an anterior restraining cause.

The nature of the topic on which we are engaged does not force upon us the question, whether such proportionate increase of insect life be advantageous or disadvantageous. What we are alone concerned to place in evidence is, the balance kept up between vital organisms of different species by Nature. Nor is the balance of vitality established between different animal species. It also may be traced, and even more distinctly, between the vegetable and animal kingdoms, each regarded in its entirety. Vegetables can only grow by the assimilation of an element (carbon) which animals evolve by respiration, as being a poison. Consideration of this fact well-nigh forces the conclusion upon the mind—if, indeed, the conclusion be not inevitable—that if through any vast cataclysm animated life were to become suddenly extinct throughout the world, vegetable life would languish until the last traces of atmospheric carbon had become exhausted, and then perish.

In maintenance of her vital balance, through the operation of some occult law, it often happens that animals that have ceased to be 'obviously useful,' as taking part in a general economy around them, are seen to die out. Whilst wolves and elks roamed over Ireland, the magnificent Irish wolf-dog was common. With the disappearance of wolves the breed of wolf-dogs languished, and has ultimately become extinct. As a matter of zoological curiosity, many an Irish gentleman would have desired to perpetuate this gigantic and interesting race of dogs; but the operation—the tendency to vital equilibrium—has been over-strong to be contravened: the race of Irish wolf-dogs has fleeted away. Speaking now of the huge Siberian mammoths, from which we diverged, faith in Nature's balanced adaptation assures us that they died out so soon as they ceased to be necessary as a compensation to some unknown force in the vital economy.

Spans and periods of time such as these, when compared by the human mind with the normal period of individual human existence, dwindle to nothingness, if we attempt to make them the units of measurement in calculations involving the duration of species. Perhaps the data are not available for enabling the most careful investigator to come to an approximate conclusion as to the number of years that must elapse before the race of existing elephants, African and Indian, will become extinct; departing from the earth as mammoths have departed. The time, however, must inevitably arrive for that consummation, under the rule of the present course of things.

Without forests for shade and sustenance, the race of wild elephants cannot exist; and, inasmuch as elephants never breed in captivity, each tame elephant having been once reclaimed from the forests, it follows, from the consideration of inevitable results, that sooner or later (but some day, nevertheless), one of two possible issues must be consummated,—either that man shall cease to go on subduing the earth, cutting down forests and bringing the land into cultivation; or else elephants must become extinct. Who can entertain a doubt as to the alternative? Man has gone on conquering and to conquer from the time he came upon the scene. Animals, save those he can domesticate, have gone on fleeting and fleeting away. It is most probable, nevertheless, that one proportionate aggregate of vitality has at every period been maintained.

The most marked examples of the passing away of animal species within periods of time in some cases not very remote, pronounced of even in an historical sense—is seen in the record of certain gigantic birds. The largest individuals of the feathered tribes now extant are ostriches; but the time was when these plumed denizens of the Sahara were small indeed by comparison with existing species. Some idea of the bulk of the epiornis—an extinct species—may be gathered from a comparison of the bulk of one of its eggs with that of other birds. According to M. Isidore Geoffroy—who some time since presented one of these eggs to the French Academy of Sciences—the capacity of it was no less than eight litres and three-fourths. This would prove it to be about six times the size of the ostrich's egg, 148 times that of an ordinary fowl, and no less than 50,000 times the size of the egg of the humming-bird. The egg exhibited was one of very few that have been discovered; hence nothing tends to the belief that it was one of the largest. The first knowledge of the existence of this gigantic bird was acquired in 1851. The sole remains of the species hitherto found are some egg-shells and a few bones. These suffice, however, for an ideal reproduction of the creature under the synthetical treatment of comparative anatomy. The epiornis inhabited Madagascar. The creature's height could not have been less than from nine to twelve feet; and the preservation of its remains are such as to warrant the belief in its comparatively recent existence.

Of a structure as large as the epiornis—probably larger, though differing from the latter in certain anatomical particulars, according to the belief of Professor Owen—is a certain New-Zealand giant bird, called by him the *dinornis*. As in the case of the Madagascar bird, the evidence relating to this is very recent. Some few years ago an English gentleman received from a relative settled in New Zealand some fragments of large bones that had belonged to some creature of species undetermined. He sent them to Professor Owen for examination, and was not a little surprised at the assurance that the bones in question, though seemingly having belonged to an animal as large as an ox, were actually those of a bird. The comparative anatomist was guided in coming to this conclusion by a certain cancellated structure possessed by the bony fragments—a characteristic of the bones of birds. For a time Professor Owen's dictum was received with hesitation, not to say disbelief. The subsequent finding of more remains—eggs as well as bones—soon justified the naturalist's verdict. Not the slightest doubt remains now upon the mind of any zoologist relative to the past existence of the dinornis; nay, the impression prevails that this feathered monster may be living in some of the more inaccessible parts of the southern island of New Zealand at the present time. Be that as it may, the dinornis can only have become extinct recently, even using this word in an historical sense; as the following testimony will make manifest:

A sort of mummification process was customary amongst the Maories, until Christianity had gained ground amongst them. The process was not exactly similar to that by which Egyptian mummies were formed; but resembled it in the particular of desiccation. Smoking was the exact process followed; and smoked Maori heads are common enough in naturalists' museums. In a general way, Maori heads alone were smoked; certain principles of food-economy prompting a more utilitarian treatment of entire bodies. Nevertheless —as a mark of particular respect to some important chief now and then—affectionate survivors exempted his corpse from the oven; and, smoking it entire, set it up amongst Maori lares and penates, as an ornament. This explanation is not altogether *par parenthèse*, for it leads up to evidence favourable to the opinion that the dinornis cannot have been extinct in New Zealand even at a recent historical period.

Not long ago, the body of a Maori was found in a certain remote crypt; and, resting on one hand, was an egg of this bird-giant. Contemplate now the bearings of the testimony. The Maori race is not indigenous to New Zealand, but arrived there by migration from Hawai. Not alone do the records of the two groups of Pacific islands in question advert to such migration, but certain radical coincidences of language lend confirmation. It is, farther, a matter of tradition that the migration took place about three hundred years ago. Now, even if the recently discovered specimen of Maori mummy art had been executed on the very first advent of the race, the period elapsed would be—historically speaking—recent. The laws of chance, however, are adverse to any such assumption; and, moreover, the degree of civilisation—if the expression may be used—implied by the dedication of an entire human body to an æsthetic purpose, instead of devoting it to one of common utility, could only have been achieved after a certain lapse of time.

According to Professor Owen, there must have been many species of dinornis. The largest individuals of one species, according to him, could not have been less than four yards high. According to the same naturalist, moreover, these birds were not remarkable by their size alone; they had, he avers, certain peculiarities of form, establishing a link between them and the cassowary and apteryx: the latter a curious bird still found in New Zealand, but very rare.

Of colossal dimensions as were the dinornis and epiornis, the size of both sinks into insignificance by comparison with another giant bird, traces of which, and only traces, are discoverable in North America, at the epoch when the deposit of the conchylian stage of Massachusetts was yet soft enough to yield under the feet of creatures stepping upon its surface. Footsteps, indeed, are the only traces left of these giant birds, and they are found side by side with the imprints of drops of rain which fell on the yielding surface in those early times. Mostly the footmarks only correspond with three toes, but occasionally there are traces of a fourth—a toe comparable to a thumb, only directed forwards, not backwards. Marks of claws are occasionally found. Every trace and lineament of the Mississippian bird is marvellously exceptional. The feet must have been no less than fifteen inches long, without reckoning the hinder claw; the length of which alone is two inches. The width must have been ten inches. The intervals between these footmarks correspond evidently with the stride of the monster, which got over the ground by covering successive stages of from four to five feet! When we consider that the stride of an ostrich is no more than from ten to twelve inches, the application of this record will be obvious. Here closes the testimony already revealed in respect of this bird, except we also refer to it—which is apocryphal—certain coproliths, or excrementitious matters, found in the same formation.

For the preceding facts naturalists are indebted to the investigations of Mr. Hitchcock. The evidence adduced leaves no place for doubt as to the previous existence of a giant bird, to which the traces are referable. Naturalists were slow to come to this conclusion, so extraordinary did it seem for a bird to have lived at a period so remote as that when these geological formations were deposited. To gain some idea of the antiquity of that formation, one has only to remember that the conchylian stage is only the fifth in the order of time of the twenty-eight stages of which, according to Alcide d'Orbigny, the crust of the earth is made up, from the period of primitive rocks to the present date. However, many recent facts have tended to prove that several animals —mammalians and saurians amongst others—are far more ancient than had been imagined; under the light of which evidence these giant-bird footprints have lost much of the improbability that once seemed to attach to them.

Pass we on now to the traces of another very curious bird, the existence of which has been demonstrated by Professor Owen, according to whom the creature must have lived at the epoch of the schists of Sobenhofen. The name given by Professor Owen to this curious extinct bird is *Archeopterix*. Its peculiarities are so numerous that for some time naturalists doubted whether it should be considered a reptile or a bird; between which two there exist numerous points of similarity. And now, whilst dealing with bird-giants, it would be wrong not to make some reference to a discovery made in 1855, at Bas Meudon, of certain osseous remains, referable to a bird that must have attained the dimensions of a horse; a bird that floated on water like a swan, and poised itself at roost upon one leg. Monsieur Constant Prevost, the naturalist who has most studied this bird, gave to it the name of *Gastornis Parisiensis*. The bony remains of this creature were found in the tertiary formation in a conglomerate associated with chalk; circumstances which refer the gastornis to a date more remote than any yet accorded to any other bird.

From a bare record of facts contemplate we now our planet as it must have been, when inhabited by the monstrous birds and reptiles and quadrupeds which preceded the advent of man. Those were times when animated forms attained dimensions which are now wholly exceptional. That may be described as the age when physical and physiological forces were dominant, as the force of moral agency dominates over the present, and is destined, as appearances tend to prove, to dominate more fully hereafter. Might it not seem that in nature an economy is recognisable similar to the economy of human existence? Can we not recognise an antagonism between the development of brute force and of the quality of mind? Would it not even seem that nature could not at one and the same time develop mental and corporeal giants? The physiological reign has only declined to prepare the advent of moral ascendancy. Giant bodies seem departing from the earth, and giant spirits commencing to rule. Humanity is progressive: is not this progression made manifest by zoological revelations? The first bone-traces of human beings range back to an epoch posterior to the monstrous quadrupeds entombed in the diluvium. Hereafter giants, probably, will only be seen in the moral world, grosser corporeal giant forms having become extinct. The physical gigantesque is not yet indeed banished from the earth, but the period of its banishment would seem to be at hand.

Probably all the great birds to which reference has been made were, like the ostrich, incapable of flight. This defect, when contemplated from the point of view suggested by modern classifications, seems one of the most remarkable aberrations of nature of which we have cognisance. For a bird to be deprived of what seems the most essential characteristic of bird-life—to be banished from the region that we have come to regard as the special domain of bird-life—bound to the earth, forced to mingle with quadrupeds—seems to the mind the completest of all possible departures from established type.

Thoughts such as these result from our artificial systems and classifications. Apart from these, the condition of giant walking-birds that *were*, and to a limited extent still *are*, will be found to harmonise well with surrounding conditions. Suppose we take the case of the ostrich for example, this bird being the chief living representative of giant bird-life remaining to us from the past. In the ostrich, then, do we view a creature so perfectly adapted to conditions which surround it, that no need falls short and no quality is in excess. A complete bird in most anatomical characteristics, it borrows others from another type. The sum of the vital elements which normally, had the ostrich been like flying birds, should have gone to endow the wings, has been directed towards the legs and feet, and thereupon concentrated. Bird qualities and beast qualities have mingled, and, as we now perceive, have harmonised. If to the ostrich flying is denied—if it can only travel on foot, yet is it an excellent pedestrian. A quality of which it has been deprived we now find to have been transmuted into another quality—*the ostrich has found its equivalent.*

Reflecting thus, we cease to pity the ostrich. We begin to see that Nature has been supremely wise, our classifications only having led us into error. A new thought dawns upon our apprehension: instead of longer regarding the ostrich as furnishing an example of nature's bird-creative power gone astray, we come to look upon this creature as designed upon the type of ordinary walking animals, and having some bird characteristics added. Assuredly this point of view is better than the other; for whereas the first reveals nature to us through the distorting medium of an abstraction, the other shows us nature herself. It is not a matter of complete certainty that the bird-type as naturalists explain and define it in their systems exists; but there can be no doubt as to the existence of the ostrich. In this mode of expression there is nothing paradoxical; and doubtless, when we come to reflect upon it, the case will not fail to seem a little strange, that we are so commonly in the habit of testing the inequalities of beings by reference to systems, instead of following the opposite course, viz. that of testing the value and completeness of systems by reference to the qualities of individuals they embrace. Naturalists invent a system and make it their touchstone of truth; whereas the real touchstone would be the creature systematised. The ostrich simply goes to prove that the zoological types imagined by naturalists are endowed with less of the absolute than philosophers in their pride of science had imagined. Animal types are *not* the strangers to each other that artificial classifications would make them appear.

Neither is flexibility of bird-type alone manifested by the examples wherein a bird acquires characteristics of quadrupeds and other walking animals. Wings may even become metamorphosed into a sort of fins, thus establishing a connection between bird-life and fish-life. This occurs in the manchot, a bird not less aquatic in its habits than the seal—of flying and walking almost equally incapable—a bird the natural locomotive condition of which is to be plunged in water up to the neck. Assuredly nothing can be more absurd than the attempt to recognise, in these ambiguous organisations, so many attempts of nature to pass from one type to another.

No matter what religious system one may have adopted, or what philosophical code: the interpretation of Nature according to which she is represented as making essays, trying experiments, is alike inadmissible. Neither God omniscient, nor nature infallible, can be assumed by the philosopher as trying experiments. There are, indeed, *no* essays, *no experiments* in nature; but degrees—transitions. Wherefore these transitions? is a question that brings Philosophy to bay, and demonstrates her weakness. It is a question that cannot be pondered too deeply. Therein lies the germ of some great mystery.

Reverting to bird-giants, past and present, it is assuredly incorrect to assume—as certain naturalists have assumed—that flying would have been incompatible with their bulk. There exist birds of prey, of whose bodies the specific gravity does not differ much from that of the ostrich, and are powerful in flight nevertheless.

Another class of facts rises up in opposition to the hypothesis, that mere grandeur of dimensions is the limit to winged flying. The apterix and the manchot do not fly any more than the ostrich. Neither of these is a *large* bird, nor, relatively to size, a *heavy* bird. As regards the epiornis, the fact is not universally accepted by naturalists that the creature was—like the ostrich, the apterix, and cassowary—a mere walking bird. An Italian naturalist, Signor Bianconi, has noted a certain peculiarity in the metatarsal bones of the creature, which induces him to refer it to the category of winged birds of prey. If this hypothesis be tenable, then a sort of giant vulture the epiornis would have been—one in whose imposing presence the condor of the Andes would have dwindled to the dimensions of a buzzard. Further, if Signor Bianconi's assumption hold good, then may we not have done amiss in banishing the 'roc' to the realms of fiction? Old Marco Polo, writing in the thirteenth century, described the roc circumstantially; and his account has been long considered as either a fiction or a mistake. Signor Bianconi, coming to the rescue of his fellow-countryman, thinks that the Italian traveller may have actually described a giant bird of prey extant at the time when he wrote, but which has now become extinct.

A notice of extinct birds would be incomplete without reference to the dodo, the very existence of which had been lately questioned; so completely has it fleeted away from the earth. Messrs. Broderip, Strickland, and Melville, however, have amply vindicated the dodo's claim to be regarded a former denizen of the world we live in.

The dodo was first seen by the Dutch when they landed on the Isle of France, at that time uninhabited, immediately subsequent to the doubling of Cape Horn by the Portuguese. These birds were described as having no wings, but in the place of them three or four black feathers. Where the tail should be, there grew instead four or five curling plumes of a grayish colour. In its stomach each dodo was said to have commonly a stone as big as a fist, and hard as the gray Bentemer stone. The boat's crew of the Jacob van Neck called dodos *Walgh-vogels* (surfeit-birds), because they could not cook them or make them tender; or because they were able to get so many turtle-doves, birds which had a much more pleasant flavour, so that they took a disgust to dodos. Likewise, it is said that three or four of these birds were enough to afford a whole ship's company one full meal. Indeed, the sailors salted down some of them, and carried them on the voyage.

Many descriptions of the dodo were given by naturalists after the commencement of the seventeenth century; and the British Museum contains a painting said to have been copied from a living individual. Underneath the painting is a leg still finely preserved; and in respect of this leg, naturalists are agreed that it cannot belong to any existing species. The dodo must have been a curious bird, if Mr. Strickland's notion of him be correct; and Professor Reinhardt, of Copenhagen, holds a similar opinion. The dodo, these naturalists affirm, was a vulture-like dove—a sort of ugly giant pigeon—but with beak and claws like a vulture. He had companions, or neighbours at least, not dissimilar in nature. Thus, a bird called the *solitaire* inhabited the small island of Roderigues, three hundred miles east of the Mauritius. Man has exterminated the solitaire, as well as other birds nearly allied, formerly denizens of the Isle of Bourbon.

The dodo will be seen no more; the race has fleeted away. Among birds, the emeu, the cassowary, and the apterix are species rapidly vanishing: amongst quadrupeds, the kangaroo, the platypus: others slowly, but not less surely. After a while they will be gone from the earth wholly, as bears, wolves, mammoths, and hyenas have gone from our own islands. The *Bos primigenus*, or great wild bull, was common in Germany when Julius Cæsar flourished. The race has become wholly extinct, if, indeed, not incorporated with the breed of large tame oxen of Northern Europe. The *urus* would have become extinct but for the care taken by Russian emperors to preserve a remnant in Lithuanian forests. The beaver built his mud huts along the Saone and Rhone up to the last few generations of man; and when Hannibal passed through Gaul on his way to Italy, beavers in Gaul were common. Thus have animals migrated or died out; passed away, the balance of life remaining.

Man has gone on conquering; now exterminating, *now* subjecting. Save the fishes of the sea and the birds of the air, the time will perhaps come when creatures will have to choose between subjection or death. Ostriches would seem to be reserved for the first alternative, seeing that in South Africa, in Southern France, and Italy, these birds have lately been bred—domiciled into tame fowls—in behalf of their feathers. Very profitable would ostrich-farming seem to be. These giant birds want no food but grass, and the yearly feather-yield of each adult ostrich realises about twenty-five pounds sterling.

THE MAROONS.

'In the name of God, amen! Whereas Captain Cudjoe, Captain Acompong, Captain Johnny, Captain Cuffee, Captain Quaco, and several other negroes, their dependents and adherents, have been in a state of war and hostility for several years past against our sovereign lord the king; and whereas peace and friendship among mankind, and the preventing the effusion of human blood, is agreeable to God, consonant to reason, and desired by every good man,'—and whereas and *whereas*, through many specifications, we come to the conclusion that, 'first, all hostilities shall cease on both sides for ever; secondly, that the said Captain Cudjoe, the rest of his captains, adherents, and men, shall be for ever after in a perfect state of freedom and liberty; excepting those who have been taken by them, or fled to them within two years last past.'

Such is the literal beginning of articles of pacification with the Maroons of Trelawney Town, and concluded March 1st, 1738, by John Guthrie and Francis Sadler, Esquires, on behalf of his late most gracious Majesty King George the Second. From the tenor of this document it seems, then, that the Maroons were a people of some importance; as, indeed, the result of many a sanguinary mountain fight in Jamaica proved them to be. That the Maroons were still in force at the time of the late Jamaica outbreak, the fact of their coöperation proved. They still hold their own, may even, indeed, be said to flourish, in the mountain region of

Jamaica. Who, then, are the Maroons? Negroes, certainly; the multiplicity of captains specified in the treaty, as well as the grotesque names borne by those captains, prove that much. Very strange the circumstances must have been to have permitted a band of negroes in the highlands of Jamaica to have settled themselves down in the heydey of slavery, to have bid defiance to soldiers and bloodhounds, to have worsted the king's troops again and again, finally to have brought about terms of compromise, and the signature of a treaty of friendship couched in such language as we have just transcribed.

The origin of the Maroons was in this wise: Jamaica was conquered from the Spaniards during the protectorate of Cromwell, in the year 1655, by an armament under the command of Admiral Penn and General Venables. Before the attack the Spaniards are said to have possessed about 1,500 enslaved negroes, most of whom, on the surrender of their masters, retreated to the mountains, whence they made frequent excursions to harass the English. 'Those blacks will prove a thorn in the sides of the English,' wrote Major-general Sedgewick, one of the British officers, to Secretary Thurloe in 1650. 'They give no quarter to my men,' he further wrote, 'destroying them remorselessly.' Well might the major-general have thus testified. Hardly a week passed without the murder of one or more of his soldiers. 'They have no moral sense,' wrote he, 'and not understanding what the laws and customs of civil nations mean, we know not how to capitulate or treat with any of them. But be assured they must either be destroyed or brought in upon some terms or other.' He wrote the truth; what he predicted soon came to pass.

Towards the latter end of the same year the British army gained some trifling advantages over the Maroons, who soon proved, by retaliation, the snake was scotched, not killed. Forty soldiers having wandered from head-quarters were captured and killed. The English were furious. A Maroon hunt was got up, but not with much effect. Seven or eight dead negroes are said to have been all that the British had to show for it, whilst the main body of Maroons, escaping under the direction of a leader of some talent, and named Juan de Bolas, maintained their ground so well that, when it came to negotiation, they obtained pardon and freedom. A large party, however, would not condescend to treat with the British government at all. Retiring to the mountains, they held their ground; and to this party was first applied the special designation of Maroons—why, nobody seems to have been able satisfactorily to explain.

According to Mr. Long, the word signifies among Spanish Americans hog-hunters; and as the woods of Jamaica abound with wild pigs—a favourite food with runaway negroes—herein may be found the explanation. The French encyclopædists, however, under the word *marron*, gave another etymology. Marron, the writer there explains, is the name given in the Mauritius to runaway negroes, being derived from the Spanish word *simaran*, which signifies an ape. As the runaway slaves retired to the wild woods, the abode of monkeys, so the encyclopædist writer explains that the Spaniards classed them with the monkeyish race.

The Maroons must have well maintained their independence for the next seven years, when we find that, in 1663, the Lieutenant-governor of Jamaica, Sir Charles Lyttelton, and his council issued a proclamation, offering a full pardon, twenty acres of land each, and freedom from all manner of slavery, to such of them as should surrender. Tempting proposals, certainly, for such as liked them; but the Maroons liked them not. They held their own hunting-grounds—the woods—and were content. Far from settlements, they took care that none should come near, by killing every pioneer of advance who was rash enough to make that experiment. Meantime the governor having made friends with Juan de

Bolas—a name not unknown to us—having placed him as colonel at the head of a black regiment, and sent the black regiment against the Maroons proper—those who affected the independent form of life—great hopes of success were nurtured. All in vain. The black Don with his regiment fell into ambush, and was cut to pieces. Thence, for forty years, the Maroons had it all their own way with the English. Not the slightest impression was made upon them; and, when opportunity happened, they murdered every white that came in their way—man, woman, or child.

In forty years, forty-four Acts of Assembly were passed, and two hundred and forty thousand pounds spent for suppressing the Maroons, yet were they not suppressed. On the contrary, in 1730 they were grown so formidable, under an able general named Cudjoe, that the colony had to be strengthened against them by the addition of two regiments of regular troops. Regular soldiers never seemed to be of much avail in Maroon warfare. The mountain negroes, though they generally managed to get the better of troops sent against them, were not and are not a race of preëminent fire-eaters. They did not like, and do not like, fighting for fighting's sake. Their favourite practice was to disperse in small parties, penetrate to the settlements of the whites, burn, massacre, and otherwise destroy; and so did they continue to gain strength and consequence, until, by 1733, their depredations had become intolerable. Then, as a memorial from the legislature of Jamaica set forth, the Maroons had, within a few years, greatly increased, notwithstanding all the measures that had been concerted and made use of for their suppression; that they were the great terror of his Majesty's subjects in those parts, who had severely suffered by the frequent robberies, murders, and depredations committed by them; that they plundered all around them, causing several plantations to be thrown up and abandoned; and in the same strain the memorial went on. Government responded, and in a manner that, however bad the Maroons might have been, shocks every sentiment of humanity. It makes an Englishman feel ashamed to learn that, not much more than a hundred years ago, bloodhounds were brought from Cuba to Jamaica for the express purpose of hunting the Maroons to their strongholds. Small blockhouse garrisons were established, at frequent intervals, on the margin of the Maroon retreats. Thence, skirmishing expeditions were dispatched under guidance of European officers. The actual combatants were bloodhounds, as already stated, and also certain warrior Indians specially imported from Central America.

Reprehensible though the system of warfare was, it nevertheless had the effect of giving such a blow to the Maroon community, that they sued for peace. They were far from being utterly broken, nevertheless; in testimony of which, the convention entered into between them and the British government, the opening clauses of which were given at the beginning of this sketch, stands in proof. As regards the mutual amity promised, the friendship that, between English and Maroon, was to last *for ever*, if such particular vow of eternal friendship has not been rigorously kept, why even then the Maroons cannot be upbraided with greater violation of a treaty-pledge than the government of many a European nation that, for the sake of politeness, one had better not name, though it would not be so very hard. Upon the whole, the Maroons have got on very well with their colonial neighbours since the latter end of the last century, when there occurred a rather serious passage at arms. They have become somewhat civilised now, though still not much to boast of. How terribly savage they were about a hundred years ago, let the following anecdote, resting on good authority, make known.

Soon after the execution of the treaty noticed in the beginning of this sketch, an important Jamaica colonialist desired to test the amount of confidence that might be reposed in the new allies. By one clause of the convention, it was stipulated that the Maroons should hunt, and capture if they could, at so much per head, such stray negro slaves as they might have been set upon the trail of. An opportunity of seeing how the Maroons would behave on any such emergency soon occurred. Three negro slaves having run to the woods, our gentle Maroon friends and allies, between whom and the British perpetual peace and good fellowship were vowed, were armed and set upon the trail. Did they give satisfaction? To affirm they did would be rather too much. Our new allies failed in just that particular, *too much zeal*, which the wily Talleyrand deprecated so sternly. They responded promptly to call; came up with the runaways; caught them and killed them; and, horrible to announce, *devoured them*—at least, in part.

On another occasion they outwitted their employers in a fashion one cannot regret, seeing that by virtue of the trick the lives of men who had done no worse than run from slavery were saved. Certain slaves had run to the woods. Inveterate law-breakers were the aforesaid slaves. They had run and been caught, and brought back again and again. They were deemed incorrigible offenders. They were known to be brave men too; men who would sell their lives dearly if brought to bay. To catch them alive was deemed hopeless; so to the Maroons the request went forth that the runaways should be dealt with summarily. They were to be killed, in point of fact, and some personal attestation of the killing was to be produced at head-quarters to justify payment of the reward. No long time passed before some Captain Quasho, or Johnny, or Tommy—name not recorded, but surely some captain at least; maybe some Colonel or even General Tommy or Johnny—presented himself at head-quarters, the bearer of a little bag. Opening that little bag, he produces certain dusky-looking leathery things that, when speered at, are seen to be negroes' ears. Behold the proof—the personal attestations! These were the ears of said runaway slaves—thus testified deponents. It seemed all square; so ears were counted, and blood-money paid. But after a certain time, the Honourable Custos Rotulorum, of so-and-so, found he had been done. His honour, if that be the proper title—his clemency, his serenity, or whatever other peg more properly belongs to such a functionary to hang his many honours upon—acquired the knowledge one day that negroes' ears upon the whole were pretty much alike; so it just came within the bounds of possibility that the flagrant criminals, the felonious runaways, men who, so to speak, had stolen themselves, might be alive and kicking to that day, the bag of ears notwithstanding. Alive to that day they were, as farther events soon proved. They came one night from their hiding-places, and added to their crime by setting fire to some outhouses of their once masters. But how about the ears? for veritable ears they were. They, too, were accounted for all in good season. No need to shudder; nothing cruel this time, only a trifle disgusting. Some old general of a Maroon had obtained those trophies, those sure attestations, from a churchyard that lay convenient. *Voilà tout!*

With the beginning of this century a better feeling began to subsist between the Maroons and the British. Upon the whole, they have stood very well upon the stipulations of treaties made. Whilst slavery lasted they lent efficient aid towards the capture of runaway negroes, for whose restoration they were paid a fixed sum per head; and they now seem to have forgotten all the wrongs that, with more or less injustice, they attributed to us for our strenuous opposition to their independence. They take it as a great honour to be visited by the white man; and so often as this happens, there is much rough hospitality and a wild saturnalia. They are said to be good Christians now; but upon this point, as several others, much turns on a definition. Their belief in Obeah men is unbounded; and for reputed witches and wizards, Maroonland may vie with England, Scotland, or even New England itself, in times gone by. They are a remarkably fine set of people, in physical stature and mental capabilities far above the other Jamaica blacks. It has been assumed indeed, but on what seems no good authority, that old Carib, or aboriginal, blood mingles with that of the negro in the Maroon population. The opinion is improbable. The Spaniards are described as having made a total clearance of the entire native race. Whilst the Maroons gave us trouble, much was alleged against the impolicy of the ordinances which restricted them within certain limits. It was argued that if they had been allowed to mingle freely with the rest of the negro community, time might have wrought an amalgamation of the two. Against the validity of that opinion much might be adduced; at any rate this much is certain, viz. that since the abolition of slavery, the Maroons have shown no disposition to merge into the general negro population of Jamaica. They still prefer their mountain life, their hunter's habits; and while wild pigs are to be had in plenty, these people will hardly settle down into the condition of any sober agricultural occupation.

PEACE ESTABLISHMENTS AND WAR SALARIES.

It is hardly worth while to claim acquiescence in the proposition, that knowledge of the principles and practice of an art of mechanical handicraft, implying the capability of practising it with effect, demands previous study and attention.

If the axiom be undoubted, that *poeta nascitur, non fit*, the same does not admit with any degree of justice of being said in respect of a carpenter, a tailor, a blacksmith, or—for the sake of literally applying the motto, *ne sutor ultra crepidam*—of a shoemaker.

I choose to view the case in its broadest aspect, by citing the mechanical arts; but in truth a much wider scope might have been claimed and accepted, without prejudice to the general deduction. The profession of a soldier might have been cited, for example; wherefore I now accordingly *do* cite it, as having close and immediate reference to the subject that has presently to receive attention.

The military calling, even in its lowest or nonscientific branches, involves the need of long training. A soldier—albeit a common soldier, a private—cannot be made by the ceremonial of placing a red coat upon his back, and an Enfield musket in his hand. As in every other case requiring dexterity of motion and apprehension of technical details, he must serve an apprenticeship, call it by whatever name we may, before he becomes an effective able workman. Ascending higher in the gradation of military rank—coming at length to the officers—it could easily be proved that a trained soldier is misused when thrust into civilian employ. In the highest degree, however, is the argument with its consequent objection applicable in the case when scientific branches of the military service—the artillery and engineering branches, that is to say—come under notice.

According to parliamentary estimates not long ago, the cost of the British army was between fourteen and fifteen millions. The sum-total is enormous in proportion to the numerical strength of the army supported. Whether the cost be or be not disproportionately great, is beyond the scope of present argument, the purport of which is to show that—owing to the employment of engineer lieutenant-colonels in government manufacturing establishments, and as paid members of committees—either the scientific branch of the military service is over-supplied with officers, or that the military service of the country is prejudiced; its efficiency being affected by the withdrawing of a portion of its scientific officers from their purely military avocations, and their employment in civilian capacities, mostly needing a special training for effective discharge. Whichever of these alternatives be adopted, the financial loss to the country follows as the corollary.

The expression 'government *manufacturing establishment*' is one that may perhaps need explanation. The government is, and perhaps necessarily must be, manufacturer in certain technical branches appertaining to national defence. The government of this country is less exclusively manufacturing than perhaps any other. The tendency of circumstances and times in which we live, is to abolish, more and more, the manufacturing function of the British government, and to commit the war-resources of the country to the charge of private competition.

Thus, taking ordnance and their projectiles, the manufacture is partly accomplished by government, and partly delegated to private firms. British small-arms, again, are not exclusively turned out at Enfield, but are manufactured by contract at Birmingham, and in times of pressure elsewhere; for example, at Liége. Then in respect to war-ships, and more especially iron war-ships, the government dockyards are hardly yet competent to enter into rivalry on equal terms with private firms. Gunpowder, a state monopoly in most countries, is an absolutely open manufacture in this. Competition, ever so theoretically beneficial, does not fail to develop and make known its benefits through the evidence of the private British gunpowder manufacture. The result is held to be equal at least in every respect to that produced at the government mills; wherefore in times of war, and occasionally in times of peace, the naval and military services of this country are supplied with the gunpowder of private mills.

Through such examples do we see that the supply of the munitions of war does not need a previous military or naval education on the part of those who minister to the supply. The mere circumstance that a man, after a considerable expenditure of time and training, had made himself a thoroughly efficient engineer or artillery officer, would imply the existence of no special quality favouring the hypothesis that he would be a successful manufacturer of gunpowder. A man might be a most accomplished artillerist, with all the formulæ of times of flight and resistances, that had ever been committed to paper from the time of Galileo and Tartalea, at his fingers' ends; he might be deep in all the utilities of time, and percussion and concussion fuses, and still a mere ignoramus in all that concerns the efficient manufacture of these things. Practically the military and naval authorities of this country fully admit the competence of private manufacturers of war-material and appliances to stand on even ground with manufacturers of the same conducting their operations under special government auspices.

On this admission certain economists have founded an incrimination against the government factories *in toto*, the argument being, that, inasmuch as the competence of private individuals and firms is demonstrated, therefore special government factories are proved to be useless at the very least, a surplusage.

I am very far from acceding to this proposition; and although the very essence and tenor of these remarks goes to inculpate the practice of applying military faculties, the result of military education, to the management of civil technical organisations, yet I can by no means follow certain members of the quasi-purist school of reformers in that train of argument whereby the germs of honour and the springs of principle are affected to be sought in the commercial grades of civil life alone. I by no means think that the naval and military careers are, from their very nature, calculated to foster principles of dishonour; nay rather believe that these special avocations comprehend within themselves leavening elements of truth and honour not usually found in commerce, and ought not to be expected.

This very complete, and as to some it may seem extreme, confession made, it can be taken in no very bad part by the naval and military service when a critic says, that gentlemen so environed with the pomp and glamour of this wicked world as they are, naturally tend, through the very gravitation of circumstances, to assume a position of dogmatism begotten by habits of command; a position not well calculated to subserve the interests of a technical operation founded upon the results of experience.

On the other side is a list of the government manufacturing establishments presided over by lieutenant-colonels of the Engineers and Artillery together, with a statement of salaries respectively. Let the fact be borne in mind, that the military pay goes on simultaneously with the pay for civilian supervision. Every colonel, then, placed at the head of a government manufacturing establishment is paid double: first, in his military capacity; second, in consideration of his efficiency in the civilian department at the head of which he is placed. Unquestionably the system is not economical; it is, on the contrary, expensive. The question then arises, whether any result, in the shape of a *quid pro quo*, can be traced to its exercise and operation? One may be no disciple of the political school of cheese-parers; one may advocate liberal payment in all relations of life, in all avocations involving talent, experience, or responsibility; but in consideration of the liberal payment, one may reasonably assume it is the duty of every employer, public or private, to assume a corresponding amount of efficiency. The chief argument of such a liberal critic is

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Government Manufacturing Establishments.	Regimental pay.	Allowance for office they hold.	Total.
Royal Carriage Department:	£	£	£
Superintendent	327	500	827
Assistant ditto	301	200	501
Captain Instructor	221	200	421
Royal Gun-factory:			
Superintendent	327	518	845
Assistant ditto	Civilian	1200	1200
Captain Instructor	201	250	451
Royal Laboratory:			
Superintendent	306	518	824
Assistant ditto	221	218	439
Captain Instructor	201	218	419
Temporary ditto	201	150	351
Small-Arms Factory:			
Superintendent	327	818	1145
Assistant ditto	237	268	505
Chief Inspector	Civilian	535	535
Pimlico Small-Arms Factory:			
Assistant Superintendent	221	495	716
Birmingham Small-Arms Factory:			
Assistant Superintendent	221	418	639
Second ditto	301	268	569
Gunpowder Factory, Waltham:			
Superintendent	475	518	993
Assistant ditto	301	200	501
Ordnance Select Committee:			
President	326	830	1156
Vice-President	456	500	956
Four Members	1266	1200	2466
Two Secretaries	422	750	1172

N.B. Be it remembered that for every officer so employed, an officer of equal rank has to be retained on the muster-roll, thus involving double expense.

the very basis of incrimination: that the tendency of the existing system, of using military men in technical civilian capacities, is to foster inefficiency, to promote incompetence. Without in the slightest degree wishing to hurt the feelings of any military gentleman now occupying himself in a civilian capacity, as appointed by superior powers, it may be at least assumed, without offence, that military gentlemen, no more than other persons, have the faculty of acquiring technical knowledge in the natural way, like the measles. They must learn it as other people have to learn it, and one may fairly assume that they must devote an equal time to the learning. Of all the aberrations of human intellect, none are more offensive, few more dangerous, than the aberration which prompts an individual to believe that he possesses an inborn genius for any given avocation—*an inspiration*, so to speak, beyond the range to be acquired, through education, by any ordinary capacity. When a military man is appointed to a civil chieftainship, the natural tendency of circumstances will be to impress him with this idea. As a man of sense and a man of education—a gentleman withal—he will, of course, endeavour to master and bring into subjection this tendency. Let it be assumed that he succeeds in wholly conquering the dominance of this tendency; what follows? It follows that the newly-appointed military man must devote, as a newly-appointed civilian would have had to devote, a portion of time, more or less considerable according to capacity and according to circumstances, to the mastery of principles foreign to what the tenor of his previous education had made him familiar with. It results as a consequence, that for a period immediately subsequent on each new appointment, either the department made subject to military technical supervision must be inadequately controlled and regulated, or that the control and regulation must be vicariously effected through the military chief, under the actual control of nominal civilian inferiors.

Believing that military men occupying the positions referred to endeavour to master their subject and do *their* duty, as every right-minded man—another definition for gentleman—will endeavour to master the principles of an occupation imposed upon him and do *his* duty, one next comes to inquire what duration of time is presumptively necessary to acquire a sufficient mastery of technical principles. Probably they who are most conversant with the difficulties which persons in quest of technical knowledge have to encounter, will not consider ten years of apprenticeship to be an over-liberal allocation of time to this end. It follows then that—according to the existing system of appointing soldiers to the control of technical operations of grave importance—the latter may be considered as made to devolve, at uncertain and irregularly-recurring periods, upon the supervision of apprentices.

Referring to the detailed list already given of the government manufactories presided over by military men, it would not be easy for the warmest advocate of the system reprobated to place his finger on one instance, and from conscience say that reasons could be urged favourable to the pretensions of military men. In contemplating some departments now subject to military chiefdom, the incongruity between a soldier's education and the civil function he is called on to assume rises to the ridiculous: for example, to the chiefdom of the clothing department. When it becomes a case of the chiefdom of an establishment for the manufacture of arms or ammunition, then the war-association of these things does away with the first suggestion of ridicule, but in the end is found to lend no sufficient countenance to the appointment. Lest here the circumstance may be thought inconsequential, approving of the existence of government factories, not trusting to public tender and competition altogether for acquiring the material and appliances of war, an explanation shall follow.

Government technical establishments—on however small a scale—are perhaps necessary, for the purpose of affording a check to the possible extortion that might arise, were the manufacture of government war-material wholly thrown open to competition. On the first establishment of the Enfield factory for small-arms, a great outcry arose from Birmingham; the complaint being, that the government prejudiced private small-arms manufacturers by entering upon the field of competition, under chosen and favoured circumstances; such, for example, as being in a manner independent of the vicissitudes of the money-market; as being absolved from the pressure of taxation, of rent, &c. A certain section of British political economists took up the cry, and made the most of it; but with only the result of justifying the establishment of the Enfield factory, and the permanent maintenance of it.

This testimony of opinion fails to imply belief that a military chief should be expected to display more technical efficiency than a civilian accustomed to the manufacture of small-arms from his earliest days. Confessedly all the technical supervision and control exercised by the military chief of department at Enfield is vicariously exercised through his subordinates; and not this alone—but what is more abnormal and prejudicial—the military chief uses his technical subordinate in the double capacity of receiving technical instruction *from* him and conveying technical orders *through* him.

The objections advanced in respect of the two government manufacturing departments already brought under consideration, will be found to apply to all the rest, though not perhaps with equal force. The radical and unmitigated badness of the system does not rest on the presumptive evidence of tendencies alone. It is demonstrated, and is made to appear self-condemned, by actual experience. If the system possess elements of good, they should be recognisable through the light and testimony of experience. To challenge acquiescence in the existing arrangement, through scrutiny of the muster-roll of names of military technical chiefs who have made themselves distinguished, would be only to court and bring about discomfiture. It would puzzle the most strenuous defender of the *status quo* to point to more than one name of a military man thus employed that has risen, during the past fifty years, even so high as the grade of mediocrity; and certainly no one single name could be adduced to range *above* the line of mediocrity. The excepted name will be no mystery to persons who have given attention to the matter. Here no mention of it shall be made—so that any number of military civilians, each rating himself at his own value, may assume the compliment as personal.

Reflecting upon the duties of a chief of the laboratory department, and bringing them successively under consideration, it would be difficult for the most strenuous advocate of things as they are to adduce a rational argument in defence of the practice of devolving them on a military man, receiving military as well as civilian pay; though wholly prevented, owing to the very tenure of his civilian office, from performing military duties. Placed in a situation involving the need of pronouncing authoritatively on propositions of chemistry, of mechanism, and—what is of no small moment in a manufacturing establishment—on the *cost* of operations, the chief of the laboratory department should, were he to discharge the functions allotted to him with self-intelligence, *not* reflected learning, possess a store of deep and varied knowledge not fairly to be expected of any one man. The fact is, that what is called the *laboratory department*, involving details of chemistry, mechanism, pyrotechnic art, and material economy, must necessarily depend upon the thoughts of many individual heads and the labours of many individual hands. The responsibility of action, of doing, must necessarily rest with specialty men; chemists for the chemistry, mechanicians for the mechanism, and so on for the rest. As for the chief of the department—for such a chief there of course must be—his functions should be limited to the condition of seeing done the thing ordered to be done. To this end what need of a military man, receiving double pay, deriving his intelligence from subordinates, whom he is almost necessarily driven to ignore as to the part they play in advancing his own technical education? It is a remark commonly enough made, that to put a man in position to exercise authority, without the possession of abilities needful to the rational exercise of the same, is to solicit a meddlesome interference, more prejudicial than complete inaction.

It is not pleasant for any right-minded man to be under the imputation, self-conveyed, that he is a mere sinecurist, eating idle salt; accordingly the danger is ever imminent that one so circumstanced will exercise the power belonging to him, to the prejudice of others on whom many responsibilities should legitimately fall. One has seen illustrations of this evil tendency; the following is an example: At the beginning of the Russian war, it was resolved to give a trial to Hale's rotatory war-rockets, which differ from the ordinary Congreves in the particular of requiring no sticks. Mr. Hale was engaged to proceed to Woolwich and superintend the manufacture of these his own projectiles. Prior to the time of Mr. Hale's visit to Woolwich, it had been the habit followed in the rocket department to charge the iron rocket-cases with composition by monkey-ramming; but Mr. Hale had learned, through experience, that for his projectiles at least the quiet force of hydrostatic pressure supplied a more eligible method of impaction. Now the operation of monkey-ramming, involving a succession of sharp blows, could not have been prosecuted with the necessary safety had the rammers been made of steel. Gun-metal was the material of these monkey-rammers, and necessarily. It sufficed to withstand without bending the utmost percussive efforts of the monkey-ramming machine. To have expected, however, that gun-metal should have withstood hydrostatic force without bending and warping, would have been to display unacquaintance with the altered conditions introduced, as well as ignorance to how great an extent the conditions of danger were abrogated through the substitution of a quiet continuous for a percussive jerking force. Nevertheless, happening to call at shed No. 50, where Mr. Hale was at work charging his rockets, a certain inquisitive outsider saw gun-metal rammers bent and warped lying about: the result of unavailing efforts to make them withstand the application of a force to which the cohesion between their particles was altogether inefficient. Here was a case in which the mischievous tendency to do something countervailed what should have been the sole responsibility of the inventor; who should have been admitted to know more about the conditions relative to the manufacture of his own rockets than anybody else.

It may have been thought desirable, at a certain epoch of British military-store manufacture, to beget and foster the impression that the preparation of war-appliances was a secret held exclusively by the government. This may be thought desirable even now; but, be this as it may, to give effect to the desire is impossible. Notwithstanding all the special education which military and naval men receive, it is on record, beyond the chance or power of contradiction, that since the time of Shrapnell, no war-invention of much purport or consequence is traceable to an individual of either naval or military service. One may be reminded, perhaps, of the Moorson concussion spherical shell, a projectile not to be forgotten. Its sphere of efficiency, subsequent to the introduction of rifled heavy ordnance, has been much restricted; and, measured as to relative importance with the molten iron-charged shell of Mr. Martin, a civilian, it ranks low indeed as a triumph of inventive skill. As to ordnance and small-arms, in their respective mutations during the past twenty years, that individual must have followed contemporary records bearing upon these matters to their issues with small effect indeed, if he still need to be informed that nearly all improvements in this career, if not absolutely all, are referable to civilian labours.

Objections to the system of employing military men in civilian technical capacities would miss a strong collateral illustration, were omission made of the circumstance much commented upon, and now pretty generally admitted, that the late Bengal army was demoralised, and that the Indian mutiny was precipitated, through the withdrawal of military officers to perform surveying, administrative, and other civilian duties. In India, under circumstances as they existed, the result of this misappropriation of military talent was demoralisation of the army, referable in part to paucity of officers. There need be no apprehension that the scientific military branches will suffer demoralisation through the operation of any similar cause; for the reason that, whilst there is redundancy of competition, the performance of military duties can always be secured by the expedient of paying double; but this necessity of paying double is, as will be remembered, one of the objections alleged against the system to which reference is made.

Passing now to the second part of the subject, namely, the installation of military men upon technical committees, it will be found that the practice is chargeable with abuses, at least equal to, if not greater than, such as those already alleged against the practice of constituting military men the chiefs of manufacturing establishments. First in order, no less than in importance, in the list of technical committees bearing upon matters of naval and military import, was the late Ordnance Select Committee. The Ordnance Select Committee was one, the origin of which extends a long way back, though, as will presently appear, the organisation of it underwent a profound alteration a few years ago, contemporaneously with the passing of Sir William Armstrong's breech-loading ordnance into the British service. It may be as well, indeed, to state what that modification consisted in, and why it came about, now as later.

Every member of the Ordnance Select Committee in its latest development was a paid member, though before the period of General Cator's committee, only the president was paid, every other member being called upon to give his services gratuitously. During General Cator's presidency it was that the proposition of adopting the Armstrong breech-loading ordnance into the British service came, as a matter of business, before the Ordnance Select Committee. The latter (all save the president unpaid) declined to recommend the Armstrong breech-loader; whereupon the committee was dissolved, and the War-office, with a liberality the motives of which have never been explained, appointed another Ordnance Select Committee, of which every member was paid. That committee it was that passed the Armstrong gun; and the passing of the Armstrong gun has cost the country upwards of three millions sterling! This much, *obiter dictum*, about the origin of the Ordnance Select Committee.

Seeing that one function—perhaps the chief function—of the Ordnance Select Committee was that of scrutinising propositions relative to appliances of war, involving a knowledge of chemistry and of mechanism, it would seem only rational that a mechanical and a chemical element should be recognised in its aggregate. Nothing of the sort, until just before the Ordnance Select Committee was abolished. For your constitution of that body was military wholly, with the exception of the vice-president, who was always a naval officer. Sure an outsider civilian may be that, when protesting against the undue preponderance of the military over the naval element, he will find himself backed by the naval service. Englishmen are accustomed to regard their navy as foremost in rank, comparing it with the army; and—questions of mere heraldic precedence apart—there are specialities in naval armaments which naval men should best sit in judgment upon, save and except it admits of proof that the naval service, man for man, is inferior to the sister service in talent and intelligence. If the latter, then the preponderance of military over naval men in the Ordnance Select Committee is justifiable and intelligible; if otherwise, that preponderance is an absurdity, and something worse. No apportionment of constituents, however, as between the naval, the military, and the civilian ranks, could make the Ordnance Select Committee efficient, until the power should have been conferred upon it of making its deliberate and recorded judgments respected. The principle of paying members of the Select Committee at all, seems objectionable, as tending to make the Ordnance Select Committee mere tools in the hands of the war-minister; but, paid or unpaid, the Ordnance Select Committee should have been no sham. It should have been respectable, respected, and efficient. It was neither the one nor the other. It could not be, so long as its matured decrees were subject to be contravened by the dictum of a secret committee.

On a certain occasion attention was called to the remarkable statement made by Lord Hartington, that the War-office did not consider itself bound to adopt the recommendation of their own committee—that is to say, the Ordnance Select Committee. A very strange statement, this, to come from a British war-minister, and to be addressed to a British House of Commons. Writing on this matter, somebody propounded the question: If the War-office do not feel itself bound to adopt the recommendations of the Ordnance Select Committee relative to propositions submitted to the investigation of the same, and by the same adjudicated upon, then upon whose recommendation did and *does* the War-office consider itself bound to act?

In course of time the answer came. The War-office recognised a secret committee; professed to act upon the recommendation of a secret committee. Wherefore it stood demonstrated, that the Ordnance Select Committee was a mere noxious plaything; a mere device for amusing the public, tormenting inventors, and awarding to certain favoured gentlemen of the service a no contemptible *douceur* in addition to their professional pay. In these days, since the fashion has come into vogue of accepting words in non-natural senses—since the difference between truth and falsehood has come to be regarded as a matter of less marked import than it would have been some few years ago,—it may be necessary to state that one need not use the words *secret committee* in any ideal, oblique, reserved, or non-natural sense. An outside critic desires the reader to understand that he has seen, touched, perused, handled, stared, and wondered—as stare and wonder well he might—at a certain printed War-office document, in which it is stated,—*literæ non rident,* Horace testifies, or assuredly the letters of the print of the testimony would blush,—wherein it is stated that such and such an invention, deliberated upon by the Ordnance Select Committee, and recommended for adoption, has not been adopted, for the reason that the secret committee condemned it!

The *secret committee!* Are we Englishmen, or Venetians, or Japanese, or what? Who *are*, or were, the members of this secret committee? What is it or was it? Where does it or did it sit? What are or were its functions and organisation? Not at all surprising will it be to discover that English people, reading these plain English words, pause at the confidence with which this thing is asserted. No wonder; but of this one thing be assured, if what any outside critic should assert to be true, should happen not to be true, there will be somebody in authority coming forward to impeach his testimony.

Fortunately, in regard to the outside critic himself,—though unfortunately in regard to all such as might desire to impeach his record,—he has the incriminatory document at this moment before him, and is willing to show it, if called on, to any member of the legislature who may see fit to demand information of the minister of war in relation to the existence and organisation of this controlling secret committee.

Until the mystery of this secret committee is wholly revealed; until the organisation of it is wholly abolished, and pledges taken for the non-establishment of it, the Ordnance Select Committee, or any substitute for it, is only a deception and a snare. Until such time, it would be an act of folly to set about the remodelling of that committee or its equivalent; seeing that, even granting its establishment on the most perfect organisation conceivable, its decrees would be equally futile.

The Ordnance Select Committee was typical of many others which do not, like it, sit permanently, but are instituted from time to time to deal with some specific topic or proposition. The Small-arms Committee, which abrogated its functions in 1859 or '60, was one of these. Relative to those temporary and minor committees, it is unnecessary to state more than that they are open to the same general animadversions as the Ordnance Select Committee itself, with the addition of another, specially dependent on the circumstance of their temporary nature and organisation.

The pay of members of these temporary committees is considerable—enough to make the reception of it by comparatively speaking poor men a matter of consequence. The tendency of circumstances is, to prolong deliberations beyond the time needful for the eliciting of truth and arriving at some conclusion. The thought may have often occurred, that if some independent member of Parliament, strong in the economics of finance and expenditure, would deign to scrutinise narrowly the manner in which the army and navy estimates are expended, instead of inveighing (as too ordinarily the practice) against war-appliances in the aggregate; if, instead of launching incriminations against war-establishments and the morality of warfare, such independent member, contenting himself to accept the *status quo* as regards the practice of warfare, would do his country the service of seeing that the war-funds were well expended, the public would owe deep recognition. As matters stand, it so happens that leading men amongst the class of politicians referred to, ignore the department of war so completely, because of its unholiness, its unjustifiableness, in their estimation, that successive war-ministers acquire the power of distributing the war-funds nearly as they please.

It is not a little strange that practical business-people, as we English profess to be—and in all civil relations of life undoubtedly are—should have so long allowed the war-organisation of the country to rest on such an insecure basis of oppugnant elements and interests as it does. Ostensibly the war-administration is tripartite, there being the war-minister, the commander-in-chief, and the Admiralty. As between the two first, it would not be easy to indicate the precise line at which the functions of the one begin, and those of the other end; nor, indeed, are the responsibilities of the Admiralty nearly so well defined as consideration of naval needs and specialities would seem to suggest. Thus, for example, it might have reasonably been imagined, that the Admiralty would have been allowed to choose the armament deemed most suitable by naval men to naval exigencies. Nothing so reasonable has been conceded. Again and again one may have noted a most unseemly contest between the Admiralty and the Ordnance Select Committee—or rather perhaps say the War-office secret committee, that dominated over the Ordnance Select Committee—relative to the sort of ordnance best adapted for naval use. A sort of battledoor-and-shuttlecock game has been played, to the disparagement of the naval armament and the stultification of the Admiralty. The practical result is, that owing to the influence of the War-office Select Committee, the war-minister has pretty much his own way in the ruling of questions bearing upon the national armament. Is a Briton over-sanguine in expressing the belief that the secrecy of the dominating committee will not be ever impenetrable; and that when penetrated, the result may be to demonstrate that the tremendous responsibility now devolved upon it may have been misplaced?

THE FIRE-DAMP'S FAMILY CIRCLE.

Perhaps the supernatural world of ghosts and hobgoblins never suffered a discomfiture so great as when old Van Helmont began shrewdly to suspect, in the beginning of the seventeenth century, the existence of more kinds of air than one; and thus threw open the new course of investigation which ended in Priestley's showing us how to catch gases and bottle them up; manipulating them as certainly as if they were so many solids or liquids, and displaying the characteristics of each.

Thenceforth the nature and powers of thousands of invisible things became manifest. Chemistry began to assign reasons for many phenomena which had heretofore been complacently handed over to the disposition of ghosts. It is a fact, though one does not often reflect on the etymology of the thing, that the words 'geist' and 'gas' come from the same Teutonic stock;—and this gives us some clue to the notion which Van Helmont entertained of the nature of the elastic and for the most part invisible bodies, to which the word *gas* is, in our modern vocabulary, applied.

Unfortunately there happen every year, and many times too often in the course of the year, illustrations of the power of one tribe of combustible gases.

The records of all mining communities demonstrate the fact that miners are an imaginative—or, at all events, a superstitious—race. No wonder. If people who tread the upper world have been deceived by what seemed to them supernatural appearances, how much more likely is it that fancy should exercise a greater sway over the imaginations of men employed in the depths of a mine?

There, fathoms deep below the surface, with sooty black coal or glittering minerals around them, on which the taper sheds a glimmering light,—what marvel that the highly-wrought imaginations of men should have conjured up the lineaments of those gnomes and erdgeister, which have formed such copious stock-in-trade for Volksmärchen and Nursery Tales? What a field for the begetting of phantoms and chimeras! Nor was the superstitious element likely to suffer abatement by the real terrors to which miners have been subject at all times. A miner struck down dead by some invisible foe, now known to be carbonic acid gas, or blown to pieces by the inflammable fire-damp, would supply, by these very facts, the elements for perpetuating the belief in subterraneous ghosts and hobgoblins, of which the early literature of Germany and all mining countries is so rife.

Between the period when all this class of accidents was complacently referred to the agency of supernatural causes, to ghosts and spirits, and those later times when the phenomena attendant upon them were traced to the agency of gas, there occurred a middle period, in which miners, abandoning the language of mysticism, had not yet adopted the nomenclature of chemistry.

This middle period corresponds with the adoption of the word *damp* or *dampf;* a term which has taken firm root in the popular vocabulary, and is not likely to be soon displaced. Now *dampf* is the German word for vapour; and inasmuch as the distinction between gases and vapours is known to be altogether arbitrary and conventional, it is even more correct than chemical purists of some thirty years ago might have supposed.

As may readily be imagined, the subject of mine-damps puzzled men not a little, before the means of catching and investigating the properties of gases was devised. The early numbers of the *Philosophical Transactions* (a series commenced, as is well known, in the year 1663) contain frequent disquisitions upon it.

The first precise account of damps in mineral veins I have met with, is contained in a letter by Dr. Edward Brown, published in the Philosophical Transactions for 1669. It is concerning damps in the mines of Hungary, and their effects.

Damps, the doctor was informed, occur in most of those mines that are deep; they happen not only in cuniculi or direct passages, but also in putei or perpendicular cuts or descents. They are met with, he was informed, in ground both soft and hard. A notable example of the latter occurred in a copper-mine at Herngroundt (*sic*), where the ground was so hard that cutting tools would not touch it, and which had consequently to be blasted with gunpowder.

Some damps, he tells us, suffocate; others only cause faintness. The doctor then proceeds to inform the reader, that the German miners cure a damp by blowing it with a pair of bellows, or by the insertion of a tube down upon it, and communicating with the air at the other extremity: methods effectual enough, there can be little doubt, where the mining excavations are inconsiderable. 'At Windschach,' says he, 'they showed me a place where five miners and a gentleman of quality were lost; for which reason they have now placed a tube there.' At Chremnitz they told the doctor that twenty-eight men had been killed at one time in four cuniculi; seven in each. Evidently the description given by the Hungarian miners to Dr. Brown refers to choke-damp, or an accumulation of some kind of gas uncongenial to respiration, most probably carbonic acid. As regards fire-damp, it was of course out of the questian in the Hungarian mines adverted to, as they were not coal-mines.

At this time, when the theory and practice of ventilation are so well understood, one seldom hears of damps except in coal-mines, and of the choke-damp only as a consequence of the destruction of ventilative works, determined by the previonsly occurring ravages of fire-damp. Anciently, however, the choke-damp often proved fatal in our coal-mines quite independently of the fire-damp. A circumstantial account of an accident from this cause may be seen in a letter transmitted by Sir R. Moray to the publishers of the Philosophical Transactions, and printed in the first volume of that series. The accident occurred in a coal-mine belonging to Lord Sinclair, in Scotland.

Sir R. Moray, 'that eminent virtnoso,' as the publisher called him (there were no editors in those days), after describing how the fall of a roof interfered with the working of the mine, and led to its temporary abandonment, goes on to say that, 'next day, seven or eight of them (miners) came no sooner so far down the stairs that led them to the place where they had been the day before, as they intended, but upon their stepping into the place where the air was infected, they fell down dead as if they had been shot; and there being amongst them one whose wife was informed he was stifled in that place, she went down so far without inconvenience, that, seeing her husband near her, ventured to go to him; but being choked by the damp as soon as she came near him, she fell down dead by him.'

One of the most industrious contributors to the early numbers of the Philosophical Transactions was Mr. Lister. He dealt with a variety of snbjects. From disquisitions on the colour of negro blood—which he assures us, after having seen it drawn many times *both in health* (*!*) and disease, was blacker than the blood of other people, and whence he argued a negro must be indeed black in grain—to the vomiting of hexapodes and the generation of fairy circles, there seemed to be no subject in the whole field of nature too recondite for the penetration of his genius. Mr. Lister, amongst other things, publishes certain particulars about mine-damps in the Yorkshire coal district. His communication was made in the year 1665. It is a transcript of a letter received by him from a Mr. Jessup; and as it gives the particulars of all he had been able to ascertain in relation to coal-mine damps, I shall quote from it pretty largely.

He divides coal-mine damps into four kinds: two of which are readily distinguishable as the choke-damp (carbonic acid and nitrogen) and fire-damp (carburetted hydrogen, &c.) respectively; but the other two are more puzzling. Let Mr. Lister, however, or rather Mr. Jessup, explain his own views. 'There is, first,' he states, 'the ordinary sort, of which I need not say much, being known everywhere.' He mentions, as indicative of its presence, a peculiar orbicular combustion of a candle-flame; also shortness of breath and swooning. 'Those,' he proceeds to remark, 'that swoon away and escape absolute suffocation are, at their first recovery, tormented with violent convulsions, the pain whereof, when they begin to recover their senses, causeth them to roar exceedingly.'

This description, it is evident, refers to the choke-damp. Not so well commended to one's understanding is the medical treatment recommended by our authority. 'The ordinary remedy,' states Mr. Jessup, 'is to dig a hole in the earth, and lay them on their bellies, with their mouths in it; if that fail, they tun them full of good ale; but if *that* fail, they conclude them desperate.' (I should think so too, Mr. Jessup.)

Hanging a drowned man up by the heels, in order that the water supposed to have been swallowed might leak out of the mouth (a treatment repudiated by modern practitioners), is reasonable practice in comparison with the ale-tunning therapeutics of Mr. Jessup.

Come we now to the second sort of damp indicated by our authority. 'They call it pease-bloom damp,' remarks Mr. Jessup, 'because, as they say [mark the narrator's caution], it smells like pease-bloom. They tell me it always comes on in the summer time, and those groves [parts of the mine] are not free from it which are never troubled with any other sort of damps. I never heard that it was mortal; but by reason of it many good groves lie idle at the best and most profitable part of the year, when the subterraneous waters are at the lowest.'

The next damp mentioned by our authority is a veritable curiosity in its way: 'It is the strangest and most pestilential of any, if all be true which is said concerning it. Those who pretend to have seen it (for it is visible) describe it thus. In the highest parts of those passages which branch out from the main grove, they often see a round thing hanging about the bigness of a football, covered with a skin of the thickness of a cobweb. This, they say, if by any accident, as the splinter of a stone or the like, it be broken, immediately disperseth itself and suffocates all the company. Therefore, to prevent casualties, as soon as they have espied it (they say), they have a way, by the help of a stick and a long rope, of breaking it at a distance; which done, they purify the place well by fire before they dare enter it again.'

One must needs demur to the channel through which evidence in this case was obtained. It reminds one of the first circumstantial accounts of the aspect of the upas tree, published by the Dutch surgeon Foersch, though that same veritable historian had previously informed his readers how no living thing could approach the fearful tree nearer than twelve miles, and still live. I strongly suspect the cobweb-covered thing '*about the bigness of a football*' to have been a veritable *nidus equæ*, and that the whole tale was a canard. The narrator seems himself to have had some faint notion of the kind, for he tells us: 'I dare not avouch the truth of this story in all its circumstances, because the proof of it seems impossible, since they say it kills all that are likely to bear witness to all the particulars. Neither dare I deny but such a thing *may* have been seen hanging on the roof, since I have heard many affirm it. Perhaps the general tradition they have amongst them hath made them ascribe all strange and surprising effects to this cause. They are not without a reason for it, which is not altogether irrational (if the matter of fact be true); for they say that the steam which ariseth from their bodies and their candles ascends into the highest parts of the vault, and there condenseth; and in time a kind of film grows round about it, which at length corrupting, becomes pestilential. Thus I have heard many of our underground philosophers discourse.'

We are next introduced to the fire-damp: 'The fourth, which they also call a damp, although how properly I will not now argue, is that vapour which being touched by their candle presently takes fire, and giving a crack like a gun produceth the like effects, or rather those of lightning. A fellow they called Dobby Leech is at this day a sad example of the force of one of those blasts in Hasleberg Hills, having his arms and legs broken, and his body strangely distorted.'

Accidents arising from the ignition of fire-damp were very common in the latter part of the seventeenth century, though, as may be *à priori* inferred from considering the smallness of coal-mine workings in those times, the results were far less serious than such as have characterised our own epoch. The method commonly adopted for purifying a mine affected by fire-damp would provoke smiles of incredulity amongst the mining population of the present day. It was one which belongs to the same class of preventive measures as artificial inoculation for small-pox; safety being sought in the choice of time for attacking an enemy, instead of permitting him to attack his victim unawares.

The miners of the latter part of the seventeenth century actually endeavoured to moderate the ravages of the enemy by firing it; sometimes by lowering a lighted candle attached to the end of a rope; and on other occasions, when that treatment would not suffice, they adopted the bolder expedient of sending a man of mark on all fours through the galleries, bearing in his hand a lighted candle attached to the end of a pole; which candle he would thrust into all the nooks and corners where the fire-damp might be reasonably supposed to exist, and in this manner exploding it by instalments. The records of a case of this sort are now before me, and are so curious that they must not be passed over without notice.

It appears that, about the year 1640, excavations were begun for coal at Mostyn in Flintshire, and that the mines continued to be worked without much inconvenience from fire-damp for about twenty years. As the pit deepened lower, the miners' troubles began. In 1667, whilst they were engaged in driving an adit to carry off water, they met with the fire-damp, 'which did by little and little begin to breed, and to appear in crevices and slits of the coal, with a small bluish flame working and moving continually. The workmen made sport of it at first, and so neglected it, until it had gotten some strength; and then upon a morning, the first collier that went down going forwards into the witchet (adit) with candle in hand, the damp presently darted out violently at his candle, struck the man clean down, singed all his hair and clothes, and disabled him from working a while after. Some other warnings it gave them, inasmuch as they resolved to employ a man of purpose that was more resolute than the rest, to go down awhile every morning to chase it from place to place, and so to weaken it. His usual manner was to dress himself in the worst rags he had, and to wet them well in water; and as soon as he came within danger of it, then he fell grovelling down on his belly, and went so forward, holding in one hand a long wand or pole, at the end whereof he tied candles burning, and reached them by diving towards it; then the damp would fly at them, and if it missed of putting them out, it would quench itself with a blast, and leave an ill-scented smoke behind it.'

This was indeed bearding the enemy in his own dominions. The temerity of the practice needs no comment. It appears, however, to have been for a time effectual. Under the cover of its protection, the coal was worked down to the bottom of the original seam, the fire-damp not being again met with until the latter end of the year 1675, when it reappeared under a more redoubtable aspect.

Observations having demonstrated the existence of an outcrop of coal belonging to a seam underlying the last, the original workings of the mine were deepened, when there were many appearances of the fire-damp flashing and dashing from side to side of the pit. The enemy appeared to have established himself in strong force; but so little does the presence of fire-damp seem to have been dreaded in those early days of coal-mining—so little were the full powers it was capable of bringing into operation known—that my chronicle states, 'the miners frequently lighted their candles at its flame, when from any cause they would become extinguished; and so in this pit it did no farther harm.'

Nevertheless, as the works advanced, the fire-damp grew in energy; until a cessation from labour of some days allowed it to accumulate in proportions more dangerous than hitherto.

'In the interim the damp gained great strength; so by the time the workmen went down they would see it flashing and shooting from side to side like sword-blades cross one another, and none durst adventure to go down into the pit. Upon this they took a pole, and bound candles several times to the end of it, which they no sooner set over the eye of the pit, but the damp would fly up with a long sharp flame and put out the candles, leaving a foul smoke each time behind it. Finding that these things would not allay it, they adventured to bind some candles at a hook hanging at the rope's end that was used up and down in the pit; when they had lowered down these a little way into the shaft of the pit, up comes the damp in a full body, blows out the candles, disperseth itself about the eye of the pit, and burneth a great part of the men's hair, beards, and clothes, and strikes down one of them, in the mean time making a noise like the lowing or roaring of a bull, but louder; and, in the end, leaving a smoke and a smell behind it worse than that of a carrion.'

We of the nineteenth century, more alive to the real powers of the fire-damp, must needs admit that, considering the provocations given by the Mostyn miners, the enemy behaved with moderation. When, anticipating a little the course of events, it is affirmed that the colliers were so emboldened by long impunity, that they resolutely turned a deaf ear and a blind eye to all admonitory hints, neglected the friendly admonitions of bellowings, flashings, hair- and beard-burnings; in a word, continued to do as they had done, the sequel must be obvious.

One fine morning the Mostyn pit blew up in earnest, and the blow-up occurred after this fashion. I must premise that the fire-damp having accumulated in great quantities, the mine was abandoned for one day. Next morning the overseer, accompanied by two chosen men, descended the pit for the purpose of learning by actual inspection what means of safety were available, having previously requested the other men to remain behind. The latter, however, disdaining to be absent from the post of danger, hurried after them.

'One of them (the miners), more indiscreet than the rest, went headlong with his candle over the eye of the damp pit, at which the damp immediately catched, and flew to and fro over all the hollows of the work with a great wind and a continued fire, and, as it went, keeping up a mighty great roaring noise on all sides. The men at first appearance of it had most of them fallen down on their faces, and hid themselves as well as they could, yet nevertheless the damp returning out of hollows and drawing towards the eye of the pit, it came up with incredible force. The wind and the fire tore most of their clothes off their backs and singed what was left, burning their hair, faces, and hands, the blast falling so sharp on their skin as if they had been whipt with rods: some that had least shelter were carried fifteen or sixteen yards from the first station, and beaten against the roof of the coal and sides of the posts, and lay afterwards a good while senseless. As it drew up the day-pit, it caught one of the men along with it that was next the eye, and up it comes with such a terrible crack, not unlike but more shrill than a canon, that it was heard fifteen miles off along with the wind, and such a pillar of smoke as darkened all the sky overhead for a good while. The brow of the hill above the pit was eighteen yards high, and on it grew trees fourteen or fifteen yards long; yet the man's body and other things from the pit were seen above the highest trees at least a hundred yards.'

Though the fire-damp proved mischievous almost from the first period when coal-mines were worked in Great Britain, yet not until the middle of the eighteenth century did it begin to commit ravages on a large scale. As coal-workings up to that time were small, accumulations of gas could not so readily take place. It was natural that miners, so continually exposed as they were to the attacks of invisible enemies, should try to discover their qualities, their composition and analogies. I pass over, as altogether unworthy of serious notice, the vague speculations on this matter during the seventeenth century: for though Van Helmont in the beginning of that epoch suspected the existence of other gaseous fluids than air—though he applied to them the designation *gas*, and at a still later period individualised, under the name of *gas sylvestre*, our present carbonic acid gas; though, more, in his treatise *De Flatibus* he mentioned that the gas produced from animal digestion, and liberated by proper contrivances into the flame of a candle, would take fire and burn; yet a systematic examination of gaseous bodies was altogether beyond the means of philosophers: indeed, Van Helmont seemed half inclined to consider gases as a sort of quasi spirits—partly spiritual, partly immaterial, having the qualities of both.

Towards the middle of the eighteenth century, and considerably before the epoch when it is usually understood that the discovery of the individual existence of separate gases was made by Cavendish, Priestley, and Lavoisier, the student of fire-damp will find scattered about some curious information on this subject. Amongst other things of this kind, it will be easy to prove by satisfactory evidence that the discovery of hydrogen gas ought no longer to be attributed exclusively to Cavendish, but partly to Mr. John Maud, in the year 1733. The circumstances of the discovery were as follow:

The colliers of Sir James Louther, in sinking a pit near Whitehaven, came upon a blower of fire-damp, which, after giving some annoyance, was finally disposed of by conveying it to the surface through a pipe, and there allowing it to escape. An undiminished jet of gas continued to be liberated from this pipe for several years, and was made subservient to some investigations on the nature of fire-damp before the Royal Society.

The experiments were conducted by means of gas which had been collected in a bladder, and they have the collateral interest of drawing attention to what was long supposed to be a fact—namely, that the sparks of flint and steel would not ignite mixtures of coal-mine inflammable gas and atmospheric air (fire-damp); 'for which reason,' states the narrative, 'it is frequent to use flint and steel in places affected with this sort of damp, which will give a glimmering light that is a great help to the workmen in difficult cases.'

Here we have then the origin of the *steel-mill*, the sparks of which were considered to be totally incapable of igniting fire-damp until the year 1783, when the fallacy of the opinion was demonstrated by an explosion at the Wallsend colliery. The experiments performed at the Royal Society on actual fire-damp gas were followed by others still more interesting; involving, as we shall presently see, the discovery of hydrogen.

Mr. John Maud, having been led by theoretical considerations to assume that fire-damp was of a sulphureous nature, and believing that the gases evolved during some operations of metallic solution were also sulphureous, he arrived at the conclusion that hydrogen (of course, unknown to him as such) was similar to fire-damp, if not identical with it. Alluding to the sulphureous fumes which he assumed to be evolved by metals under particular circumstances, he goes on to say that of these fumes 'iron emits a great quantity whilst dissolving in oil of vitriol, which are very inflammable and not easily condensed.

'These fumes I collected into a bladder with the desired success; and having produced before the society two bladders of this fictitious air, at the same time that Sir James Louther was pleased to make a trial of his, they both exhibited the same phenomena.'

From this account it will be seen that Mr. Maud unquestionably generated hydrogen, collected it, and operated upon it. He imagined, however, that it came from the iron employed in the experiment, or the sulphur united with the iron, and believed it to possess a sulphureous nature. Indeed, the notion that the fire-damp was either a kind of sulphur or in some way allied to sulphur, continued to be a tenet held by philosophers of the last century not less firmly than it is held by working coal-miners of the present day.

As the elements of the ancients were four—fire, air, earth, and water—so the elements of the alchemists were three—salt, sulphur, and mercury. Of these, sulphur was the one assumed to be concerned in all that related to combustion or combustibility. Thus it is easy to perceive whence the notion of fire-damp being sulphureous originated, and wherefore the term 'sulphur' is conventionally applied in miners' language to fire-damp at the present time.

Two years later than the experiment just described, and which proved the similarity between fire-damp and hydrogen gas, a very demonstrative course of four experiments—for the time, very remarkable ones—was performed by Dr. Desaguliers. His record of these experiments, published in the Philosophical Transactions, is entitled 'An experiment to show that some damps in mines may be occasioned only by the burning of candles under ground, without the addition of any noxious vapour, even when the bottom of the pit has a communication with the outward air, unless the outward air be forcibly driven in at the said communication or pipe.'

As will be seen from a perusal of the title, the experiments of Desaguliers inculcate the laws of ventilation as now well understood; though at the time when Desaguliers performed his experiments, the word 'ventilation' does not seem to have taken its place in our vocabulary. The record of the doctor's experiments is given in so few words, the experiments are moreover so neat and demonstrative, that we will transcribe the account of them as originally given.

Exp. 1.—In a cylindric glass receiver open at both ends, whose lower end is plunged in water, and upper end covered with a plate with a hole of near an inch bore, a candle of six in the pound will not burn quite the time of one minute before it goes out.

Exp. 2.—A candle will burn almost as long when the receiver is quite covered.

Exp. 3.—The receiver, having the hole of the plate open, and a pipe at bottom communicating with the external air, will burn but a little longer than in the first experiments, and if you blow in at the pipe with your mouth, it will go out rather sooner.

Exp. 4.—Blow in at the pipe with bellows, and the candle will burn as long as you please.

The vast development which the industrial arts of the country underwent during the latter half of the last century led to a proportionate increase of coal-mine working. The steam-engine being now applied to pumping, coal-miners were no longer limited in their descent by the presence of subterraneous waters, and coal-mines assumed dimensions in comparison with which those of the preceding century were mere wells.

Along with increase of size, the ravages of fire-damp became more terrible and more frequent. The times had gone by when miners dared to chase it from place to place by lighted candles tied to poles; and the demand for coal was so great, that an infested mine could no longer be abandoned with the same indifference as in the earlier days of coal extraction.

At whatever cost and risk, the danger must needs be encountered; experiments therefore began to be made with the object of discovering, if possible, a means of producing light adequate to the miners' exigencies, but unaccompanied with fire, or at least the sort of fire which would ignite the explosive gas.

Amongst those illuminative expedients the only one which ever rose into general importance was the steel-mill—a cylinder of steel made to revolve against a piece of flint or pyrites. Various other means, however — some of them not a little curious—were adopted on extraordinary occasions; amongst which are noticeable the use of pyrophori or luminous chemical bodies, luminous decaying wood, and decomposing fish: so dire were the straits of coal-miners in their pursuit of coal under difficulties. These expedients, however, constitute a proper introduction to a notice of safety-lamps.

SAFETY-LAMPS.

When, in the beginning of the present century, a vast development of machinery and an increased demand for coal necessitated, to a proportionate extent, a deepening and extension of coal-mines, the ravages of fire-damp increased; and this class of accidents, from being a matter of interest to the colliery districts alone, assumed a national importance. At length, in 1812, a dreadful explosion occurred in the Felling pit. The desolation was greater than the records of any previous case could match, though exceeded by the fire-damp annals of late years. Coal owners stood aghast; and miners, though proverbially reckless, were prevailed upon with difficulty to expose themselves to dangers unparalleled by any civil occupation, and scarcely matched by the contingencies of war. A local society was formed under the auspices of Sir Ralph Milbanke, having for its object an investigation of the conditions under which the fire-damp originates, and a provision of means for controlling it.

Up to the period in question, the only *general* means adopted for obtaining light in passages charged with fire-damp was the steel-mill. Its character of being an instrument universally safe was destroyed, as will be presently made apparent, so early as 1783; nevertheless the amount of protection afforded by the steel-mill in dangerous workings was so considerable, that not until the year 1825 was it finally abandoned.

The Wallsend collieries had been wrought without the occurrence of any fatal accident from fire-damp, until 1783. In that year the shafts of two original pits having become embarrassed with rubbish, they had to be cleared out. Fire-damp, like other evil things, lurks in dilapidated places. Healthful ventilation of a coal-mine, in order and active, is uncongenial to the fire-damp's nature. It lingers in abandoned cavities, in goafs and *culs-de-sac*, into which the ventilative current is unable to penetrate. The Wallsend shafts and their offset branches became so infested, that no light, other than steel-mill glimmering, was thought desirable to be employed. To the safe keeping of the steel-mill, however, did the miners commit themselves, without fear or hesitation. Clearing operations were begun. Explosion followed explosion; and many lives were lost. Miners would not believe at first that the steel-mill had been treacherous. It was detected at last in the very act of committing destruction. A shower of sparks was seen to ignite the explosive gas; and—what is rare in the history of coal-mine explosions—those who saw it lived to tell the tale. The good repute of steel-mills was lost for ever.

True, science has made known the conditions under which alone the steel-mill is dangerous. It must be working in good order, as can only happen when surrounded by pure, and therefore non-explosive, air. The sparks of a steel-mill can only ignite fire-damp when darted from a pure atmosphere into a locality where fire-damp has accumulated. This is an exceptional case, but exceptions of the sort are not rare; so it was absolutely necessary to find a substitute for the steel-mill.

Before reverting to the labours of the Milbanke commission, and to the consequences of it in relation to safety-lamps, it may be worth while to say that the Wallsend explosion in 1783 not only demonstrated the treachery of steel-mills, but that an accident flowing out of it suggested the principle of illuminating mines by reflection; a principle, by the way, which Mr. Goldsworthy Gurney, about half-a-century later, suggested, under the impression that it was absolutely new.

The chapter of accidental suggestions, turned to practical account, discloses many a case of romantic interest. The stern historian of philosophy may be, perhaps, allowed to express a regret that the interest which attaches to accidental suggestions is so considerable. Truth-germs get so incrusted with mythologic concrete—poetic fiction gets so mixed up with philosophic fact, that the reasoner is often brought sharply up by the prompting fear, lest such and such an explanation be too pretty to be true. It is a pretty notion, doubtless, that Apollo got the idea of his lyre from a tortoise-shell with shrivelled tendons stretching from side to side. A pretty notion, that a little dog belonging to the Tyrian Hercules coming back one day with a purple mouth, the cause of the tint was traced to the little dog's having caught, and bruised between his teeth, a certain shell-fish—when lo, the Tyrian dye! A pretty notion, that the great Sir Isaac should have been led to speculate concerning gravitation by the fall of an apple. We begin by admiring the prettiness of a suggested discovery, and end by disbelieving it; nay, we often err by running to the opposite extreme; saying '*credat Judæus*' to the tale of many accidental suggestions, for no better reason than because the tale is pretty in its way.

Assuredly one of the most uncongenial domains in the world for harbouring poetic conceits is a parliamentary blue-book. Now a blue-book is my authority for a description of the accident which first suggested the illumination of coal-mines by reflected light.

After the danger of steel-mills was so lamentably demonstrated in the Wallsend pit, the miners were driven to great straits for want of light. Most of us have seen the pale phosphorescent shining of decomposed fish. The mere ghost of a light it is; scarcely brilliant enough to make darkness visible, far less to work by. Nevertheless, the Wallsend mechanics were glad of it, and were repairing an engine at the bottom of the shaft by means of it, when a friend came to the rescue in the following manner.

It happened, as a carpenter was mending the 'shear-legs' (a portion of machinery outside the pit, and immediately over the mouth of the shaft), that, turning a bright new hand-saw, which he was using, in the proper angular direction, a ray of sunlight was darted down the shaft.

The friendly ray alarmed not a little those who were working at the bottom of the shaft. Sudden flashes of light were not uncommon in that mine; but they were the indicators, if not the heralds, of death. The workmen thought another explosion must have happened. Trembling, they awaited the thunder of the death-blast, which in a few seconds might blow them up the shaft as from the mouth of a cannon. The death-blast did not come.

Other flashing lights, quickly succeeding the first, removed their apprehensions and roused their curiosity. They soon discovered whence the light came, and at once turned the suggested learning to account. A bright saw, though not a bad reflector, was inferior in this respect to a mirror. A mirror, therefore, being procured, a man was placed at the mouth of the shaft to hold it, and reflect sunbeams straight down the shaft, as the carpenter had done before.

The device succeeded well; sufficient light was furnished in this way to admit of repairs being effected at the bottom of the shaft. The expedient having been thus far successful, those in charge of the mine tried whether, by other reflectors placed within the mine, the sunbeam might not be bent right and left through the horizontal galleries. One angular reflection could be managed sufficiently well to throw a pencil of light upon a nail-head, or any small object; but the light was wanting in diffusiveness, and beyond one angular bend the sunbeam could not be made to turn, without incurring such loss of brilliancy that it was no longer of any use.

Thus not only was the idea of mine-illumination by reflected light suggested, but turned to useful account. Mr. Goldsworthy Gurney proposed the illumination of whole mines by reflected light—not sun-light, for that is both uncertain and difficult to focus. He suggested the employment either of lime for oxy-hydrogen light, or, when a fainter degree of illumination might be sufficient, the Bude-light. This gentleman believed it possible to illuminate an entire coal-mine without taking a flame down into it. Artificial light may be produced so intense, that, when placed in the focus of a parabolic reflector, it will throw a shadow eleven miles. He would have the source of light at the mouth of the shaft, and consequently in the open air. A parabolic reflector would be necessary for giving the light its first bend, but afterwards common reflectors would suffice. Of course, whether one source of light should be used, or more than one, must depend on the dimensions of the mine. For small mines Mr. Gurney believed that one light would suffice; but he was confident that if seven lights of the first order were placed in the focus of seven true twelve-inch parabolas, and arranged within a circle of three feet diameter, one of the largest mines might be effectually lighted in every gallery.

Many of the difficulties (theoretical ones at least) which oppose themselves to the adoption of Mr. Gurney's system are obvious. Supposing it conceded, to set out with, that artificial light *can* be procured of sufficient power to bear the numerous angular deflections which would be necessary in practice, a clear way is obviously necessary to give it transmission. It cannot, however brilliant, travel from one end to the other of a gallery, if the gallery be obstructed with opaque matters, whether stationary or in motion.

The galleries of a coal-mine are its high roads, its *traffic ways*, for man and beast. Every here and there across the road there is a doorway provided with an accurately shutting door, opened to let the traffic pass by, and then carefully shut again. The safety of every breathing thing within the mine depends on these doors. They are the very doors and doorways of life and death, inasmuch as they are subservient to and regulate ventilation.

Now light, even of the first order, and darted from a parabolic reflector, cannot get through a wooden door. 'Put glass panes in the door,' argued Mr. Gurney. Let us conceive it done. Again, it happens that the hands and the eyes of a human individual are situated in the same bodily aspect. A miner *faces* his work; Mr. Gurney's light would strike *à posteriori*, and treat the miner to a magnificent shadow. Again, mine-inspectors ask how the horses employed below would like to come unawares upon one of Mr. Gurney's artificial sunbeams darting into their eyes?

These objections are not mine. They have been urged before parliamentary committees, and are to be found in the pages of blue-books. They are sufficient at least to demonstrate that whenever the scheme of illuminating coal-mines by reflected light has been efficiently applied, no inconsiderable number of difficulties will have been overcome.

The explosion of the Felling colliery in 1812, and the local commission to which it gave rise, must be regarded as having inaugurated the era of safety-lamps. Not that the idea of a safety-lamp was quite new; so far from that, Humboldt in 1796 devised a lamp on the principle of surrounding an ignited wick with a limited quantity of air, and cutting off all connection between it and the external explosive atmosphere. Necessarily such a lamp would be safe; but for many and obvious reasons its employment would be impracticable.

Dr. Clanny too, before 1812, had devised a safety-lamp, the protective agency of which, like that of Humboldt's, consisted in cutting off connection between the external and the internal air. It had the advantage over the lamp of Humboldt, however, in this: means were contrived for establishing a continuous supply of air blown through water by a pair of bellows. It is easy to see that such a lamp must be safe; but the complexity of it, the great weight and size of it, would necessarily destroy the best quality next to safety which a miner's lamp can have—*portability.* That lamp never came into use; but Dr. Clanny, living in a mining district, placed in the very focus of fire-damp accidents, and cognisant of the miner's wants, once having set himself to the problem of making a safety-lamp, never abandoned that problem. Lamp after lamp came out, having Dr. Clanny for its inventor, so rapidly, that to speak of Clanny's safety-lamp without specifying the construction would lead to great mistakes.

This is a point which must by no means be lost sight of. There are those who more than inferentially accuse Davy of borrowing the idea of his own safety-lamp from that of

Dr. Clanny—of behaving dishonourably to Dr. Clanny, in point of fact. This is a grave accusation; and as a superficial view of the circumstances involved would tend in some measure to support it, I shall do my best to place the evidence in the right point of view.

A person going into the safety-lamp market, and asking for a 'Clanny,' at this time, would have an instrument given to him so nearly resembling the lamp of Davy, that, coupling the fact with the knowledge previously acquired, that Dr. Clanny had constructed a safety-lamp anterior to the year 1812, he would glean some *à priori* evidence in support of the charge of plagiarism. When informed, however, that the Clanny lamp of 1812 was a very different sort of thing from the Clanny lamp of 1857, the *à priori* evidence vanishes.

I am no blind partisan of Davy, as will be seen by and by; but I feel he has been very unjustly dealt with in the matter of the safety-lamp.

Some years ago there was an exhibition at the Society of Arts' rooms of all existing safety-lamps. Each was designated by the name of some inventor, and each (which is not unusual) was set forth to be greatly superior to every other. Now I believe I shall not err in asserting that one and all of these several lamps relied for their safety principle wholly or partially on wire gauze.

Good or bad, whatever the influence of wire gauze, or other form of short tubular system for cooling may be, the discovery of that system, the application of it, belongs to Davy. No matter whether the lamp be *with* glass or *without* glass, whether it feeds itself with air above or below, if it have one scrap of wire gauze in its construction, I call it a Davy. Nay more, if it substitute for wire gauze perforated plates or short tubes, applied with the specific end in view of cooling inflammable matter below the point of incandescence, I still call it a Davy.

The Felling explosion of 1812 gave publicity to the safety-lamps of Clanny and Stephenson; Davy's celebrated lamp was produced in 1815. Let us now consider to what extent it was possible for Davy to have plagiarised the discoveries of either. Humboldt's lamp was impracticable, because the volume of air employed to support combustion was limited. Dr. Clanny's was too complicated and cumbrous. A specimen of Stephenson's lamp has never happened to fall in my way, but I believe it correctly represented as depending for safety by the adoption, as closely as was practicable, of the exclusion system of Humboldt. The latter isolated his burning wick from the external air completely, whence the combustion only continued for a limited period. Stephenson, in providing fresh supplies of air, admitted it through one system of concentric rings, and gave exit to the air which had served the purposes of combustion by another system.

If Davy plagiarised from any one, it was from Stephenson; and sure I am that no person who looks at the case fairly will aver even that much. Stephenson, finding that air must be admitted by some channel or other, and again permitted to escape, limited the admission and the escape within the narrowest bounds. In Davy's lamp there is *no* air-limitation. The burning wick and the external air are free to commune as they please. Davy's aim was *not* to limit air, but to limit flame. And here I must pause to say a word in explanation of the principle on which Davy's lamp is constructed.

I suppose an inquirer to be seated in front of a burning wick: it will be a small wick, because that will best illustrate my position. A small wax-taper wick it shall be. The flame is bright and smokeless, because the combustion is perfect; but if now the experimenter plunges a cooling body—say a metallic wire—into the flame, it burns dull, emits smoke; in short, its combustive force is diminished.

If the experimenter bends the extremity of another cool wire into the form of a small ring, he can arrive at a stronger demonstration. Holding that ring within the flame, and gradually lowering it down upon the wick, the taper may absolutely be extinguished. Why is this? Because flame is gaseous matter heated to incandescence, and the wire ring cools it below the point at which incandescence is possible. On the application of this principle does the safety-lamp depend. It merely consists of a lamp-wick surrounded by a layer of wire gauze, the meshes of which, through giving free ingress and egress to the air, are supposed to cool flame below the degree of temperature at which flame is possible; so that, however much the fire-damp may ignite and rage within the wire-sheathing, its flame is unable to communicate with the great reservoir of fire-damp without.

Is theory borne out? is Davy's lamp absolutely, *functionally* safe? are the questions to be considered. To deal fairly with the memory of Davy, it is necessary to make a distinction between accidents originating with functional derangement of his lamp, and accidents caused by the latter in its most perfect condition. No one doubts that if the wire gauze of a Davy be broken or punctured, it is no longer safe; and however prone to such accidents the instrument may be, they must not be imputed to inefficiency of the lamp itself. To accidental derangements must be added what may be termed *criminal abuses;* such as removing the safety-sheath for the purpose of getting more light, of sucking the flame through the wire gauze by a tobacco-pipe, of thrusting a pointed wire through the gauze, there to become red hot, and withdrawing it to fire a charge of gunpowder. From each and all these causes accidents have arisen, and they in no way deserve to be laid to the charge of the lamp itself.

Functionally, I believe the lamp to be absolutely safe, except under one of two sets of conditions: what the first set of conditions are, will be most conveniently illustrated by the testimony of Mr. Buddle before the House of Commons Commission of 1835.

In answer to the question whether he had ever performed any experiments on the Davy lamp with a view of ascertaining what force is necessary to compel the passage of flame through the gauze, Mr. Buddle replied by giving a condensed history of Davy's lamp, of the first trials made with it, and of the part taken by Davy in pointing out the conditions of danger.

'I have not performed the experiments by myself,' said he, 'but in company with Sir Humphrey Davy, and I am very happy to have this opportunity of doing justice to the memory of my lamented friend on this particular point. The lamentable accidents which, prior to the year 1815, had occurred in our neighbourhood naturally directed the attention of all humane persons to the subject. Sir Humphrey Davy was introduced to me by the late Bishop of Bristol, and he called upon me at the Wallsend colliery one day to inquire into the nature and cause of this lamentable catastrophe. I explained to him, as well as I was able, the nature of our fiery mines, and that the great desideratum was a light that could be safely used in an explosive mixture. I had not the slightest idea of ever seeing the thing accomplished.

'After a great deal of conversation with Sir Humphrey Davy, and his making himself perfectly acquainted with the nature of our mines and what we wanted, just as we were parting he looked at me, and said, "I think I can do something for you." Thinking it was too much ever to be achieved, I gave him a look of incredulity; at the moment it was beyond my comprehension. However, smiling, he said, "Do not despair; I think I can do something for you in a very short time."

'I should think, to the best of my recollection, within fourteen days he wrote to me to say that he flattered himself he had done the thing; that he had made a discovery which would answer my object—namely, the procuring a safe light in an explosive mixture. In a few days he sent me down two of the Davy lamps as nearly as possible like that before the committee; but I have one of our working lamps with me. He told me that it would burn safely in an explosive mixture. I first tried it in an explosive mixture on the surface, and then took it into a mine; and to my astonishment and delight—it is impossible for me to express my feelings at the time when I first suspended the lamp in the mine and saw it red-hot. If it had been a monster destroyed, I could not have felt more exultation than I did. I said to those around me, "We have at last subdued this monster."'

Mr. Buddle then relates how, subsequently, Sir H. Davy went down the G pit of the Wallsend colliery, where he was shown all the gradations of explosive mixture; from a slightly contaminated atmosphere, just enough to produce an elongation of candle-flame, to where pillar working was going on, and large amounts of gas were accumulated as in a reservoir. 'Here,' said Mr. Buddle, 'we took the lamp, and suspended it for a length of time, till it was red-hot, during which we also exposed it to the ordinary impulse of currents of air, and in different parts we tried the lamp in a red-hot state for a considerable period of time. He then explained to us the danger of exposing the lamp to a strong current of gas, or even to a strong current of explosive mixture, as it would risk the passing of flame through the gauze, but he pointed out a remedy at the same time—namely, a tin screen.'

From this statement it is evident that Davy was aware of the conditions under which the gauze covering was not a protection; a fact which, according to Mr. Buddle, he strongly insisted upon at a previous time—namely, when Mr. Buddle accompanied him to one of the Earl of Durham's collieries, where a large 'blower,' or natural issue of inflammable gas, presented facilities for testing the permeability of the safety gauze. Having directed the gas jet against the safety sheath, and caused flame to pass, Davy is said to have commented on the fact in the following words: 'Now, gentlemen, you see the nature of the danger to which you are exposed in using the lamp; and I caution you to guard against it in the manner I have shown you. This is the only case in which the lamp will explode; and I caution and warn you not to use it in any such case.'

These admonitions are strong enough. Had they been as pointedly conveyed by Davy to the public, as they were to Mr. Buddle and his miners, Davy would have protected his memory from some injurious aspersions. On the whole, it will be difficult, even for Davy's best advocates, to acquit him of some *trimming* in respect of the weak point of his lamp — its capability of passing flame through the wire gauze under the influence of currents of air. In his book on flame he just adverts to the fact enough to save the mark; whereas, knowing the important issue at stake, it was incumbent on him to have been no less emphatic in his book than in his verbal communications to Mr. Buddle.

It is a lamentable peculiarity of fire-damp explosions, that in proportion as they are grave, so do they destroy cautionary evidence for the future. We need not marvel, therefore, that the difference of opinion, as to the practical amount of safety capable of being afforded by the safety-lamp, is still so considerable. Evidence enough is, I regret to say, forthcoming to show that there are conditions of air-currents totally beyond the ability of a miner, however careful, to foresee; which cannot be guarded against by shade or screen; and which may determine, as they have before, an explosion. Take the following as an example: Greenock pit, after remaining unworked for some time, filled with explosive gas. An agent and two men descended with a safety; but ventilation being imperfect, the agent returned to the surface, and by way of producing a current of air threw some water into the shaft. A sudden gush of air resulted, which, driving before it a body of fire-damp, urged the flame through the wire gauze, and the inflammable atmosphere outside took fire. One workman was killed on the spot; the other escaped with a severe burning, to tell the tale. Again, a father and two sons were burned to death through using a Davy lamp at Sutton-low-bottom pit, in consequence of their having agitated the air to clear out their working places.

In both cases the lamp was found perfect after the accident. Were it necessary, other examples of the effect of air-currents in driving flame through the gauze meshes of the safety-lamp might be cited. None, however, but the most prejudiced in favour of Davy's lamp will deny that its facility of explosion when exposed to currents is a much greater drawback to its utility than was suspected in the days of its early existence.

Are air-currents the only agencies which can interfere with the safety of Davy's lamp? Most probably not. Assuming fire-damp to be a mixture of light carburetted hydrogen and atmospheric air—nothing more—experiment would seem to justify us in saying that, while perfectly quiescent, it is not susceptible of being exploded by the safety-lamp: but it now turns out that fire-damp has by no means this one invariable composition; it sometimes contains olefiant gas, sometimes sulphuretted hydrogen and pure hydrogen; either of which is susceptible of ignition by contact with metal not raised to so high a temperature as often occurs to the cage of a safety-lamp.

Again, the contingency does not seem to have presented itself to Davy, that particles of coal are flying about in a coal-mine; and these, falling on the red-hot gauze of a safety-lamp surrounded by explosive gas, may ignite and generate a little focus of death-dealing flame.

We come now to the consideration of other lamps, starting on the invention of Davy for their basis, but modified so as to avoid the weak points of the former; and designated each by the name of its so-called inventor.

Once more I repeat, Davy shall have the credit of every lamp which has a scrap of wire gauze in its construction. No, no, gentlemen lamp-makers, it shall not be permitted for you to have all the credit that wire gauze can bring, leaving Davy all the obloquy. Take the Davy lamp, and improve it if you can; but so long as you use wire gauze, call it a Davy lamp, and yourselves its improvers.

It would be tiresome work to specify a tithe of the lamps which have sprung up from the first simple idea. The very safest of them, Roberts's, may be described as a Davy lamp surrounded by a glass, and supplied with air through layers of wire gauze below; a corresponding series of wire-gauze layers above giving issue to the products of combustion. This lamp I have never known to explode under the severest trials; but it has a fatal defect—*it is too fastidious.* Immediately the air which surrounds it becomes a little impure, it gives a puff, goes out, and leaves the miner in darkness, to find his way out of the mine the best way he can, or to *relight the lamp-wick by a lucifer!* There is the present lamp of Dr. Clanny, glass below and wire gauze above. There are the Müsler and the Eloin lamps, both well spoken of in Belgium; which, like the present lamp of Dr. Clanny, make a point of feeding the wick with air *per descensum,* so that, air being heavier than explosive gas, the latter is to some extent filtered away.

I shall make short work of this numerous fry of modified Davys. Some are worse than the prototype, under all circumstances; and some better, until the glass sheath with which most or all of them are supplied gets broken—a contingency of such frequent occurrence that, although the idea of glass appears to have suggested itself to Davy, he soon discarded it. Nevertheless the Müsler and Eloin lamps, both much used by the Belgians, have glass in their construction; and though the glass cracks occasionally, yet, like many varieties of our English glass safety-lamps, they are said not to be practically damaged by the accident.

Space admonishes me to make deductions, if such I have to make, and conclude this sketch of safety-lamps. If I have succeeded in giving effect to my convictions, the point need not be insisted on again, that whatever in the way of safety-lamps has come out of wire gauze, or *is able* to come out of the same, should stand to the credit of Davy. By taking this broad view of the matter, the question, whether the original lamp, or a modification of the same, be the better, is freed from the disturbing element of predilection in favour of or against the inventor. After examining the parliamentary evidence given on different occasions respecting safety-lamps, the conclusion, I think, will be arrived at, that a balance of testimony is in favour of the position that Davy's original lamp is more completely adapted to the miner's wants than any variety of it.

At any rate this much is clear, many qualities in addition of that of safety must be embodied in a safety-lamp. Were the latter alone to be considered, the lamp of Humboldt—in which connection with the external atmosphere is totally cut off—leaves nothing to be desired. The water-valve lamp of Clanny is perhaps quite as safe; but the weight, the complexity of it, and the limitation of combustive power in the former, are circumstances which expunge them from the list of practical safety-lamps. Amongst wire-gauze lamps, again, I believe that devised by Roberts to be safest of all; but a fatal objection to it is, as remarked, that whenever the atmosphere becomes a little impure, it ceases to be a lamp—it goes out, leaving the miner to find his way back through the dark labyrinth of galleries the best way he can.

Amongst the expedients which have been proposed of late for illuminating coal-mines, that of substituting gas for oil-wicks in safety-lamps is suggestive of good promise. At the best of times the safety-lamp gives little light; when the wick becomes foul from long burning—when, in other words, it requires trimming—the light is necessarily diminished. Now, although there are contrivances for effecting this trimming without removing the cage, yet for the most part so inefficient are they, that the miner often perforates the gauze with a sharpened wire to snuff his wick the more effectually. Moreover, oil, and the fuliginous result of its combustion, rapidly foul the gauze, and necessitate its removal; in effecting which damage is often done.

It is a subject of painful contemplation, that, since the discovery and application of safety-lamps, accidents from fire-damp explosions have become more frequent and more grave. True, coal-mines are deeper than they were, and seams of extreme danger have been wrought under safety-lamp protection, which could not have been wrought by naked candle-light. Still the painful fact remains, that the terrors of fire-damp are greater than of yore. The monster is not yet conquered, as Mr. Buddle fondly supposed; and what is worse, there seems no promise of conquering him by improvements on the safety-lamp. Better ventilation will accomplish much in the way of safety, and care in the use of safety-lamps now existing will accomplish more; but I fear holocausts offered up to the grim demon of fire-damp will be, as they have been, frequent concomitants of coal-mine explorations.

ALUMINIUM.

As life fleets on, and as acquaintance with human character and susceptibilities becomes more extended, one learns that knowledge is never so readily appreciated as when coming before us in a tangible and palpable shape. There are many, many thousand things which you and I must take for granted on authority, without the chance of being able to demonstrate them, or having them demonstrated to us. *I*, for instance, should expect *you* to believe, were I to aver that the blood which now rushes through our arteries, or steals sluggishly along through our veins, contains a large percentage of iron. In averring this, I should tell you nothing that you had not probably heard before, the existence of iron in the blood being a fact now tolerably well known; but if *you* could, like me at this instant, have before you *a coil of iron wire more than three yards long made from iron extracted from human blood*, the fact would come before you in a palpable guise of tenfold more expressiveness.

As to me, though the presence of iron in the blood has been no novelty for the last thirty years at least, nevertheless I sit and gaze at my three-yard specimen of blood-extracted iron wire, ponder over and contemplate it, until my mind is lost in a region of abstractions. I view it with the interest of a cherished relic. I would not sell it for many times its weight in gold, valuing it as I do for associations. It brings tangibly before me the existence of an old friend in a strange place;

presenting to me the knowledge of a fact in a tangible, concrete form.

So, having justified in your eyes, as I would fain hope, my partiality for rough corporeal demonstrations—leaving as little for the imagination to supply as may conveniently be—do me the favour to take from yonder dust-heap a brick. I am not particular about the sort of brick; any sort will do. You cannot find a brick; good, that broken tobacco-pipe will perfectly answer my wishes.

Having withdrawn the broken tobacco-pipe from the seemingly ignoble materials of a dust-heap—having attentively regarded it as to weight and size—suppose I tell you this, that from the very tobacco-pipe shank you there hold in your hand—that coarse, ugly tobacco-pipe—the chemist can extract a lump of beautiful white metal, more resplendent than silver, more unalterable than silver when exposed to air, more musically sonorous than bell metal; ductile, laminable, fusible, and tough; then what will you say?

Suppose that, proceeding, I furthermore tell you that the metal in question does not exist in the material of the tobacco-pipe in a mere minute proportion, but that when extracted it will occupy something about two-thirds the bulk of the tobacco-pipe itself; that in addition to its being the chief constituent of all clays, it exists still more largely as to percentage quantity in the ruby, the sapphire, corundum, and adamantine spar; you *may* believe me—I think you *will*—but, naturally enough, you want proof.

A tobacco-pipe is composed of baked, or more correctly speaking *burnt*, white clay. Practically we may regard all clays as identical in composition. Some contain mineral colouring matters, especially iron oxide, or rust, and this is the reason why building bricks are red, whilst others, like pipe-clay, are devoid of colouring matters. Practically, however, we may regard all clays as identical in composition.

To illustrate this subject by reference to brick, one might state that it is the white material of the brick, not the red colouring matter, which is concerned in the production of the beautiful metal aluminium. What, then, is clay? I mean, of course, white clay, inasmuch as we have already agreed to consider all colouring materials existing in certain clays as so many impurities.

Clay may be stated to consist of a mixture of two chemical compounds respectively known as silica and alumina. Various clays hold these materials in varying proportion, but in general terms we may say that clay is made up of equal weights of silica and alumina. Let us banish silica from the account at once. Though a most extensively diffused and important agent, we will have no concern with it here, because it does not contain the precious metal of which we are in quest—the beautiful metal *aluminium*; *that* is got out of alumina.

Fifty-three parts and three-tenths exactly of the metal alumi*nium* exist in every hundred parts of alumi*na;* say, therefore, almost exactly fifty per cent.

Now this alumina belongs to the class of bodies called *earths:* and if you ask me what earths are according to a chemist's notions, I answer in my own homely way, they are *rusts of metals.* Yes, lime is the rust or oxide of a metal termed calcium; magnesia is the rust or oxide of a metal termed magnesium; and alumina is the rust or oxide of *the* metal termed aluminium.

Leaving the earth alumina for a time, I will say, what occurred when a bright piece of iron was exposed to moist air? The iron under these circumstances lays hold of, or, in chemical language, *combines with,* the element 'oxygen,' becoming changed into oxide of iron, or, as one generally calls it, *iron rust.* The point I want to establish is, that the terms rust and oxide, as applied to iron, are one and the same. A person does not usually say *rust* of copper, *rust* of lead, and so forth, but a writer may employ these designations. At any rate *I* take that liberty; and being taken, proceed to impress the fact, that the earth alumina bears the same relation to the metal aluminium that rust of iron does to the metal last named.

Immense magazines or storehouses of the earth or *rust* alumina are furnished in beds of clay; nevertheless, he who desires to procure alumina in moderate quantities may obtain it far more readily from the crystalline material alum than from clay. If alum be dissolved in water, and hartshorn added, the alumina will fall down in a somewhat gelatinous form, because it is combined with water; but on being collected, washed, and heated, it assumes the characteristics of a white powder, which sticks to the tongue just like a piece of new tobacco-pipe. This white earth, alumina, is the basis or stock material of all clays. Porcelain clay, which is usually regarded as the type of purity for this class of bodies, is made up of 60 parts alumina and 40 of silica in every 100 parts.

There is yet another circumstance which conduces to a similar result. Extremely minute quantities of materials are often, in his researches, taken cognisance of by the chemist.

For instance, when De Candolle tells us that gold is contained in the roots of violets and in the stems and tendrils of the vine, and copper in tobacco and coffee; when Dr. Percy tells us that silver exists in sea water; and that every specimen of lead examined by him was found to be charged with a portion of silver—half the startling effect of such assertions is lost to the mind, because of the confessedly minute portions of the precious metals discoverable. It is with feelings of real wonder, however, that a person listens to the statement for the first time, that about fifty per cent of the pure matter of clay consists of this strange metal *aluminium*.

It is the fashion to speak of aluminium as a metal newly discovered. This is a mistake. Aluminium was first obtained by Sir H. Davy so long since as the year 1808; but he obtained it in quantities so minute, that many of its leading characteristics were only imperfectly known until within the last few years; since, in point of fact, a French philosopher, M. St. Claire Deville, devised a means of producing it in large, and one may almost say *commercial*, quantities.

As regards the method of producing or eliminating aluminium, to generalise, it is got from chloride of aluminium by the agency of sodium.

The metal aluminium is never met with naturally in its metallic state. It always exists in the form of oxide, and mixed with a few extraneous bodies. This rust is alumi*na*, and alumi*na* is oxide of alumi*nium*; and oxide of aluminium is alumi*nium plus* oxygen; and therefore, according to the chemical Cocker, it follows that alumi*nium* is alumi*na minus* oxygen. Pardon this round-about tale.

But it so happens in practice, that we cannot obtain aluminium in this direct and straightforward manner. Chemists sometimes gain their ends by the most tortuous courses (I use the expression in no bad sense); and the process by which aluminium is gained furnishes us with an example. The element oxygen keeps such vigilant look-out over the safety of the precious metal aluminium, which it has in charge, that no force or agency yet known to chemists—no strong hand—exists competent to take the oxygen away and leave the metal behind.

It so happens, however, that the chemist, by a somewhat refined process of substitution, which need not be described just now, can induce the sentinel oxygen, vigilant though he be, to change places with another element, chlorine by name, thus giving us chloride of aluminium in place of oxide of aluminium; and it furthermore so happens that the element chlorine, though a sentinel vigilant enough and powerful enough in his way, is by no means so difficult a fellow to deal with as oxygen; and it furthermore so happens that a sodium (of which, by the by, soda is the rust) has such an extreme desire to lay hold of chlorine and generate common salt, that we have only to bring it in contact with chloride of aluminium under proper circumstances, when it takes away the chlorine, and leaves aluminium behind.

None but those who study chemistry, and, studying it, admire it, can perceive the beauty of alliance between causes and effects which an acquaintance with that beautiful science discloses. Had we not the powerful agent sodium at our command, we could not—at least, not by the method now followed—have educed the metal aluminium from its hidden lurking-places. Had not an Italian anatomist, Galvani by name, chanced to remark that some frogs, which he was engaged in dissecting, twitched and jerked their lifeless legs under the excitement of minute streams of electricity, we might not, in all probability *should not*, have discovered the very existence of sodium, much less should we have succeeded in extracting it. So wonderfully evident in the progress of scientific discovery are the golden links of causation.

The study of this alliance between truths and their results cannot be recommended too forcibly. There is no better means of mental discipline for awakening us to the intrinsic value of truth. It teaches us to respect, and foster, and cherish truth because *it is true*, and not to measure our estimation of it by the immediate value it can be made to bring.

Think, O ye sordid ones, who see no beauty in the golden radiance of truth, except it at once disclose some treasure in your path, that the very existence of the beautiful aluminium would have been now unknown to us, had not a certain Galvani, in the year 1783, observed the electrical kickings of a dead frog!

We have got aluminium, and now *cui bono*—what good is it?

Let us see. Aluminium is a white resplendent metal, capable of assuming a higher polish than silver, and does not tarnish when exposed to the air, as silver is apt to do. Though alumina, or oxide of aluminium, so obstinately refuses to give up its oxygen, yet once given up, it manifests no great desire to lay hold of that element again. To speak more plainly, it does not rust by exposure to the air, even though the air be moist. Some chemists assert that contact with boiling water causes it to rust a little, whilst other chemists aver the statement to be unfounded. From an impartial review of which evidence one may safely arrive at the conclusion, that the tarnishing of aluminium under these circumstances, if it take place at all, must be exceedingly slight.

Aluminium is a very light metal, its specific gravity only amounting to 2·6; or, what will be still more comprehensible to some people, supposing a vessel to be made large enough to hold exactly one pound of water, it would hold one pound and six-tenths of a pound of aluminium. This extremely low specific gravity of aluminium, superadded to toughness and malleability, renders it applicable to many useful purposes. For example, watch-wheels have been made of it, and instrument-makers talk of using it for the construction of arms or beams of delicate chemical balances. Services of plate have been made of it; and no doubt when aluminium is capable of being produced in still larger quantities, the latter application of this most beautiful metal will be greatly extended.

Perhaps, however, the most extraordinary consideration in reference to aluminium, is the enormous amount of it this world of ours contains, and its ubiquity. So far as we can ascertain, about one-eighth of the earth's crust consists of alumina; and alumina, as we have seen, holds more than fifty per cent of aluminium.

At this rate, no less than one-sixteenth of the solid mineral portion of our planet consists of this beautiful metal.

Clay, or the matter of clay, may be said to exist everywhere; and wherever clay exists, there is a storehouse of aluminium. Do we wish to collect gold or silver? we must proceed to certain favoured localities—to Australia, California, Mexico, Peru; and though iron be almost everywhere, yet that metal, except as iron ore, exists in quantities so small, that for all practical purposes it is absent. Not so with aluminium. Wherever there is clay or the matter of clay, native or manufactured, diffused or aggregated, there we find a magazine of aluminium; and as if not satisfied with this ubiquity in some of our common things, aluminium must needs enter into the composition of gems, for in the adamantine spar, corundum, ruby, and sapphire, it still is there. How enormous, then, the total quantity of aluminium existing in the world must be!

CERAMIC WARE.

When Archimedes ejaculated, 'Give me whereon to stand, and I will move the world,' he merely clothed in words a thought that, aroused by many promptings and from a variety of causes, presents itself, occasionally, to every thinking mind. We rarely analyse that thought into its elements; but when so analysed, it is found to express the general proposition, that the condition of duality is necessary to the existence of force—to the manifestation of power.

The Corsican Prometheus, lingering out his life on the Atlantic prison rock, bore curious testimony to his appreciation of the dual condition as indispensable for the exercise of power. The circumstance is recorded by Barry O'Meara, and may be shortly stated as follows:—There had been a question of submarine boats, of navigable balloons. Conversation turned upon the latter. 'It will never be possible to navigate air-balloons,' observed Napoleon to his doctor, 'never. For that to be possible, two mediums would be wanted; and Nature furnishes but one—the air—to aëronauts. Ships are navigable,' continued he, 'by reason of the two mediums—air and water.' He paused and gazed upon the ocean, assuming one of those contemplative attitudes which painters have made familiar. Napoleon seemed to be mentally scanning some long array of thoughts associated with balloon navigation—thoughts that, like captives chained and following their leader, marched past the great captain's fancy. 'No,' ejaculated the Emperor, starting at last from his reverie and addressing himself to O'Meara; 'without two mediums there can be no power, no government.'

Considering that we are to treat of Ceramic Ware anon; of China ware and Majolica; of old Sèvres ware; of bricks and tiles, and all and everything that has been fashioned, or may be fashioned in time to come, out of fictile clay;—considering this to be our theme, then 'wherefore, O errant scribe, all these transcendental sublimities about the condition of dualism as inseparable from power?' Pooh, pooh, Zoilus!

I do not seek to conciliate any man: the very philosophy of dualism herein set forth prevents it. As a male creature—sensible of and sensitive to all the soft influences that radiate 'in lines of force,' as Faraday might say, from ladies' eyes—I beseech the lovable fair sex to bear with the roundabout vagaries of this rambling scribe for a season: I pray them to grant me the delightful conceit, that—out-Briareusing Briareus—I had as many arms as there are agreeable ladies in the world, and an agreeable lady on each arm. I beseech them to put confidence in this errant scribe, trusting him in all things; following wheresoever he may lead. That concession made, this errant roundabout scribe, on the faith of a true knight, promises to lead his trusting fair ones to far Cathay and Japan; thence back to Dresden, calling at Majorca *en route*, to see how the Majolica potters advance in their work. Then, time and space imposing no restraint, we may just as well flash away to Babylon, while yet that city still is young. Samian potters, too, we will see at work, not omitting to get *cartes de visite* of the artists who decorated Samian vases. Yes! by and by, patience and confidence extended, everything that is proper for us to see we will see, that can illustrate the progress of the beautiful Ceramic art, the creations of which the fair sex admire above all earthly objects—next to jewels and pretty bonnets.

Yes, trust this errant guide! he knows whither he will take you, and whither he will not. Not to the courts of Louis Quatorze and Quinze, for example—not to the Petit Trianon; for, notwithstanding the old Sèvres manufacture arrived at its zenith of perfection then, that period must be passed by trippingly. Quite well I know that a lady would no more continue to admire the lovely old Sèvres bequeathed to her mamma, if she knew how much Rose du Barry and other *hetairæ* had to do with encouraging the manufacture and bringing the ware into vogue, than she would follow the fashion of a riding-hat set by one of our pretty horse-breakers, sit out *La Traviata* or *La Grande Duchesse*.

And now very seriously to the point.

Our thesis is Ceramic Ware—clay ware, that is to say—in all or any of its varieties. Of course we shall need some preliminary words about clay itself: clay in the abstract, so to speak. To imagine in one's own mind a tithe of the dignities, beauties, and utilities of clay is difficult enough: to convey the notion to any other mind is, perhaps, impossible. Clay!—it is such a vulgar, a common thing. We tread it under foot, and call it dirt! Contempt springs out of our very familiarity with it. The contemplative mind cannot attain to a knowledge of the poetry of clay, whilst lingering here in the midst of it. Even the clear eye of Science herself fails to see the poetry of clay whilst gazing upon it nearly. As mountains of grandest form and of fairest outline are but as ranges of unhewn rock until we gaze upon them from afar, so even the man of science only attains to a knowledge of the grandeur and beauty of clay when feigning for himself some ideal position—some second world—whence, looking down, he may gaze abstractedly upon this. Before speeding to this second stand-point of observation, this other world, it will be well to take passing cognisance of the elements which compose our own.

Of course, human investigation cannot attain to the knowledge of the materials that lie hid towards the centre of the earth. The limits of human observation called into play by the sinking of mines and quarries are very soon reached. After that comes speculation. Nevertheless, our globe has been weighed in the aggregate, so to speak; and with the result of demonstrating that, were it composed wholly of water, it would only weigh between one-fifth and one-sixth of what it does now. This is almost confirmatory of the opinion that the interior portions of the earth must be mainly composed of metals. Metals, taken all in all, are the heaviest bodies in nature; but some metals are extremely light—potassium and sodium, for example—so very light, that they swim in water. Aluminium, concerning which I have already spoken, is also a light metal. As for lithium, it, though unquestionably a metal, is the lightest of all known solid bodies; and, wonder of wonders!—hydrogen, the very lightest of known material things—an attenuated invisible gas, of which an imperial pint weighs not quite a grain and a half, is actually considered by most chemists to be a metal.

In respect of the materials which constitute our planet's accessible crust, philosophers have acquired tolerably accurate information. That crust, together with all the beings, animal and vegetable, it bears—together with the atmosphere which surrounds it—is known to be composed of no more than sixty-five or sixty-six elements in various states of mixture and combination; about fifty-three of them being metals.* The number seems inconsiderable. Even were these elements in equal portions distributed throughout our globe, it would seem a marvel that Nature's myriads upon myriads of manufactured results (not to speak irreverently) should be produced out of so few raw materials. But they are not equally distributed. It has so pleased the Almighty Architect, that out of three simple bodies, at least four-fifths of the accessible crust of this globe shall be composed. The three elements which have been appointed to this high dignity are oxygen, aluminium, and silicon. Let the names of these three chosen elements never be forgotten. I shall have a

* The *exact* number is not agreed upon by chemists.

good deal to state about each of them in connexion with Ceramic Ware by and by.

Thus, having given heed to the elements of our own earth, closely, narrowly, let us now speed away to the imaginary world, whence looking down, we may value as we ought certain materials that are too common to be valued whilst among them. Gazing from this second stand-point of our own choice, let us imagine the metals, uncombined as the chemist can yet obtain them, and as perhaps they once might have been. Down yonder we see them glowing:—gold resplendent in its yellow beauty; copper and titanium red; iron, zinc, tin, bismuth, antimony, silver, platinum, and many others, white; aluminium white too:—let us not forget this.

Oxygen now, as we may fancy, comes upon the scene! Immediately this element begins its work of combination and change. With every metal perhaps, save gold and platinum, oxygen would unite; and uniting, yield bodies, termed by the chemist 'oxides,' but what we may popularly denominate 'rusts.' Still looking down, this world of ours, glittering like a jewel a while ago, seems less resplendent now. All its metals, save gold and platinum, continue to rust; each rust or oxide having its own distinctive colour and character, but no longer metallic in appearance. All its erst brilliant iron oxidising would change either to black oxide (a material something resembling the scales of a smith's forge) or red—common iron rust, in point of fact. Copper, glittering red just now, would gradually oxidise, changing to compounds of red and black; which, combining again, would yield other colours, green being prominent. Potassium would change to rust of potassium, or, simply speaking, 'potash;' sodium to soda; and aluminium (mark this well) to alumina.

Having tarried long enough in our second or ideal world to acquire a just conception of the grandeur of the scene; having impressed the mind with an adequate respect for alumina, proportionate to the enormous amount of it just revealed, and the marvellous change effected upon it by oxygen; descend we now to earth once more, with the intent of scrutinising, as a chemist would scrutinise, the changes that have ensued. The chemical scrutiny over, let us classify our materials; as it behoves those who, waiting humbly and reverently upon Nature, implore her to reveal her mysteries. This chemical scrutiny over, the result will be made apparent that the metallic 'rusts,' as I have called them, but which the chemist terms 'oxides,' will admit of division into the three following classes:

1. Those which are alkalis, as potash, soda, lithia.
2. Those which are earths, as lime, magnesia, alumina, &c.
3. Those which are neither alkalis nor earths, in which list are comprehended the majority of metals.

Proceeding thus, our scheme of investigation begins to unfold itself clearly. We soon perceive that every metal admits of reference to one of three classes, viz.:

1. Kaligenous (alkali-making).
2. Terrigenous (earth-making).
3. Calcigenous (calx-making).

The next important point to which attention should be directed is this, viz.: the rusts or oxides of all metals comprised in the first and second classes are always white; whereas calcigenous rusts or oxides are in most instances coloured. To impress this fact on the mind, let the point be remembered that potash and soda (both rusts or oxides of the first class) are white; that lime, magnesia, and alumina (exemplars of the second class) are also white; but as for metals of the third class, their oxides present us with a variety of colours, either of themselves or in their compounds: as is sufficiently testified by the tints displayed on the surface of china. Each one of these lovely colours is produced by oxides of the third or calcigenous class of metals.

'Earthenware' is a household word. Each and every one of us knows that clay holds some immediate relation to crockery. But what is clay? That is a question I will now proceed to answer. Chemically, pure clay may be said to be nothing more than alumina combined with water: in chemical language, 'hydrate of alumina;' alumina being, as we must not forget, the rust or oxide of the not very rare metal *aluminium.* But absolutely chemically pure clay—that is to say, pure alumina in combination with water—does not occur in nature. If we want it, we must produce it; separate it from one of the many compounds in which it exists. For present necessities, that compound shall be the crystallised material alum.

If, then, a portion of alum be dissolved in water, and hartshorn (ammonia) added to the solution, down goes alumina. By a filter it may readily be collected; and when washed, it may be regarded as the type of all clays that are to be found existing in nature. As already stated, however, nature gives us no absolutely pure clay, in the sense of pure hydrate of alumina. Nature's very purest clays always hold a portion of silica, or the matter of flint. And what is silica —what are flints? Why, silica is an oxide or combination of oxygen with something; that something, whether non-metallic or a metal, chemists are not yet agreed upon among themselves. Those who choose to regard it as a metal, call that something *silicium;* whilst, on the other hand, those who believe the something to be non-metallic, denominate it *silicon.*

No matter. The courteous reader, who, not being a chemist, may choose nevertheless to procure a specimen of silica, can take a piece of rock crystal, then making it white hot, throw it into cold water, and powder the shattered fragments. The product of these operations may be regarded as pure silica. Silica has many wonderful properties. Flints are almost pure silica; and insects are occasionally found in the very middle of nodules of flint. How did they get there?

When the statement is made, that not only can the matter of flints be dissolved and converted into a liquid, but can actually be attenuated into a light invisible gas, some portion of the wonder vanishes.

Pure alumina combined with water (or, if we prefer to call it so, pure clay) is almost infusible: for which reason no sort of crockery could be manufactured out of it. The fusibility of alumina, however, is promoted by mixture with almost any mineral oxide, and also certain compounds not being mineral oxides, of which borax is a familiar example. In this way silica or flint promotes the fusibility of alumina; and pure silica being absolutely white, the mixture presents the farther advantage of yielding a fictile ware upon which colours may be deposited with facility. The very purest natural clays are all mixtures of alumina with silica, in varying proportions. Beds of such pure clay are, however, remarkably rare. Most frequently some calcigenous oxide is found present; as evidenced by colour. Whoever takes the trouble to pass mentally in review before the mind such clays as he may remember to have seen, will not fail to be struck with the fact, that by far the majority of them are tinged with a brownish or reddish hue—an iron-rust hue, in point of fact—and this circumstance may raise the suspicion, perfectly just, that the colouring matter is rust or 'red oxide' of iron.

It is commonly known that, from time immemorial, the Chinese and Japanese have manufactured a very exquisite sort of Ceramic Ware: a material exquisitely white and perfectly translucent, as if (which is the fact) partial fusion of the body of the material had been effected. Not the slightest tint of red, indicative of oxide of iron, is present in Oriental China ware. This is dependent on the happy chance that in China and Japan there were discovered, at very remote periods, beds of aluminous and siliceous materials wholly free from oxide of iron.

The inhabitants of India, to whose art-labours Europe owes so much, did not possess these pure white materials: or at least, if they possessed them, never discovered and made them available. The Assyrians and Babylonians were similarly circumstanced; also the Egyptians, Greeks, Etruscans, and Romans. Observe, then, the inevitable result. Not possessing the raw white materials naturally, and chemical art not being sufficiently advanced for producing them artificially, Babylonians, Assyrians, Hindoos, Egyptians, Greeks, Etruscans, Romans, all were limited in the progress of the ceramic arts to the production of vessels more or less coloured; that colour playing upon the various changes of yellow, brown, red tints, all dependent on the presence of iron oxide.

Those wonderful races of antiquity, the Assyrians and Babylonians, merit a few passing words of notice here. They too, as I have said, had to content themselves, for the most part, with iron-stained fictile wares: but the fragments of a Babylonian brick now treasured in the Museum of Economic Geology bears curious testimony to the fact that, by these people in those remote days of hoary antiquity, the secret had been discovered of varnishing brown or red fictile ware with a white glaze. In this manner there was produced a white surface, admitting of colour ornamentation. Slightly anticipating a future part of this narrative, it may be well to state, that in this process of glazing coloured fictile surfaces consists the secret of the ware now called 'Majolica.'

That the Babylonians should thus have turned the flank of a difficulty which they had not the power of meeting face to face and conquering, is curious enough; still more curious is it, that the very glaze now existing upon the surface of the fragment of Babylonian brick is oxide or rust of tin—the very same material subsequently employed, after the lapse of many long years, by the Saracens and Italians for their Majolica; the very same material employed by Bernard Palissy in the reign of Henri III., for the surface-glaze of the fictile material now known as Palissy ware. The discovery of the use of the oxide-glaze by the Babylonians is one of those facts that, when contemplated, makes us look with reverence on the technical knowledge of antiquity; disposes us to think more humbly than we are sometimes wont of the revelations of modern science.

The secret of the use of oxide of tin was not communicated to Bernard Palissy. He discovered it, and that under many disadvantages. Ignorant of chemistry, he could not call in the power of analysis to his aid. Poor, his numerous experiments were prosecuted under circumstances of severest deprivation. The husband of a lady gifted with tremendous eloquence of a certain sort, but no preference for art, and no faith in the beneficence of Nature to those who question her humbly by experiment; a Huguenot into the bargain, at a time when adherence to that faith involved danger of torture and death—Palissy followed out his experiments under a host of difficulties. Despite of them he discovered the secret of the glaze, and from the discovery resulted his own beautiful variety of Majolica.

Palissy's glaze never attained the whiteness recognisable in the Saracenic and Italian specimens of Majolica; nor were the varieties and excellence of his tints equal to theirs; but Palissy was a genius, and struck out a path for himself. The surface of this crockery is modelled into the most elaborate alto and basso-relievos of plants and animals, all characterised by singular fidelity to nature. Indeed, Palissy always modelled from nature. If he had occasion to model the form of an extinct shell-fish, such as are to be seen in geological remains, he procured a specimen and modelled it; so that a geologist has commented on the identity of these things, as seen in Palissy's relievos, with the geological specimens now discoverable in the Paris clay. Palissy's indomitable resolution was illustrated by his religious life, no less than as a potter. Capable of sacrificing so much for white enamel, he was equally willing to sacrifice to his persecuted Huguenot faith. Neither threats, nor cajolements, nor promises of advancement, could turn him from the honest expression of his religious convictions. Then, as an example of energy, and progress of knowledge under difficulties, few men have existed so preëminent in these respects as the estimable Palissy. Like many other enthusiasts, he was thought to be deranged, before his success removed that impression. Mrs. Palissy was very much of this opinion. Palissy ended his days in the Bastile, when more than eighty years old.

At periods of the remotest historical antiquity the Chinese manufactured porcelain in all respects as good as now; in many respects better: but with the exception of the Japanese — who certainly equalled, perhaps excelled the Chinese — ancient potters, for want of a raw material absolutely white, had to content themselves with coloured patterns; and not only coloured, but void of that character of semi-transparency so characteristic of porcelain, or real China ware.

Nevertheless, much of the ancient pottery is extremely beautiful. Samian and Etruscan vases are imitated by modern manufacturers, and that but imperfectly. In regard to colour ornamentation, the ceramic artists of India, Egypt, Greece, and Etruria were hemmed in by narrow limits. Red, yellow, or brown upon black, or black upon red, yellow, or brown—mere outline figures in either case, without tint-gradation—this was all they could effect. Debarred the charm of colour, the Indian, Samian, and, in a minor degree, the Etruscan artists revelled in beauty of form. Nothing can be more exquisite than the shape of Samian vases and amphoræ, generally speaking. Though the appellation '*Etruscan vase*' is so commonly employed, yet the Etruscans did not bear the palm of excellence in the manufacture of vases, or other vessels of beautiful form and finish. Their specialties were funereal urns and coffins. In regard to the black pigment used for the ornamentation of ancient red and yellow ware, there is much dispute; in fact nothing certain is known in respect of it.

Debarred, as the Greeks, Etruscans, and Romans were, from the manufacture of real porcelain (China ware), or indeed any variety of white pottery, they were in one sense more determined potters than the world has seen. Nor will this be marvelled at when we come to reflect upon their condition and necessities. Firstly, they loved good wine; and had no glass bottles to keep it in. The resource was vessels of earthenware. Then, the art of cooperage does not seem to have been well understood and followed. Of casks they had few, or none, and *pari ratione* tubs. Hence, the want of those had to be supplied by enormous jars, called by the Greeks 'pithons,' vessels identical with the Spanish wine ollas of the present day; and of which some magnificent specimens were displayed in the Hyde-park Exhibition of 1851. Enormously large these Greek pithons must have been, considering that the tub of Diogenes was really no tub at all, but a gigantic earthenware pot. The pithon house of Diogenes must have, at the least, been large enough for two, if not three. History testifies that the lovely Phryne frequently called upon the philosopher—and the probability is, I fancy, that she would hardly have done so without the escort of some discreet duenna. There is nothing peculiar in this platonic affection between a genius like Phryne and a philosopher like Diogenes. He was not married, I believe; but had he been, a *tête-à-tête* with a clever young lady would have seemed in no wise inconsistent with the usages of ancient Greece.

Socrates, though so great a philosopher, sometimes preferred the society of clever young Grecian ladies to that of Xantippe his wife. In fact, the social relations of the ancient Greeks were peculiar, and would not be tolerated nowadays. The marrying ladies were never accomplished; mere housewives, no more. They remained at home to keep things in order, and make the pies and puddings. Poetry, music, painting, all suchlike delightful accomplishments, were restricted to the unmarrying young ladies, who did not live with their mammas. Under these circumstances it was not only a necessity, but, in some senses, a virtue, and much to be commended, that married gentlemen (especially if philosophers) should seek the society of such ladies as Phryne and Sappho. Had the Grecian married ladies been so fascinating as English married ladies, why, of course, these *liaisons* would have been no less wholly unknown than they are now.

Necessity, mother of invention, perpetuated the manufacture of rough pottery by the Greeks and Romans, long after the art of making these exquisite vases, tinted red and black, had died out. At the very beginning of the Christian era that manufacture had declined; and in the third century the secret of the manufacture had been so utterly lost, that vessels of this material were called ancient, eagerly collected as now, and deposited in museums.

To the conquests of Alexander, in the fourth century before Christ, must be ultimately attributed the decline of this beautiful art. Prior to these conquests, ornamental fictile vases had been highly cherished; held to be fitting prizes for victors in the national games; honoured associates of sepulchred great ones. When once the Macedonian legions had gazed upon the gold and silver vessels of luxurious Persia, they longed to have vessels of the same. Thenceforward the manufacture of fictile vessels fell from its once high estate. Made of inferior materials and ornamented by inferior artists, they soon ceased to attract connoisseurs, so tremblingly alive to beauty as the ancient Greeks.

And now we enter upon a curious speculation. Did the ancient Greeks and Romans ever acquire specimens of ancient porcelain, of real China ware? Between north-eastern Asia and southern Europe the means of communication must have been slight—indeed, rare and difficult. Nevertheless, some sort of knowledge of China there was in Europe. Traditions there were of the land of the Seres, whence came the highly-cherished seriacum—in other words, silk. Unquestionably silk textures occasionally found their way from China to Greece and Rome; then why not specimens of porcelain? On this latter point, however, no certain testimony can be adduced. Various classical authors treat of a material called 'murrha' or 'myrrha,' out of which murrhine or myrrhine vases were made; but what was this material, and what were the myrrhine vases? The question is much disputed.

Some authors would have us believe them to be nothing else than Oriental porcelain; but Dr. Thomson, in his history of chemistry, holds strenuously to the position that myrrhine or murrhine vases were made of fluor or Derbyshire spar. Some little time ago the opinion partially gained acceptance, that the secret of porcelain manufacture was known to the ancient Egyptians, the evidence adduced being certain small porcelain vases, inscribed with Egyptian hieroglyphics, and discovered amidst the ruins of Thebes. At the present time, however, these same vases are believed — I may even say known—to be spurious; known to have been deposited amidst Theban ruins, on purpose to be dug up and sold as genuine to travellers. I am informed that a thriving business is, or at any rate was, driven in little Etruscan gods here at home by certain of our Staffordshire potters. A gentleman (thus was the anecdote related to deponent) once upon a time came home from Italy with some queer little deities of fictile ware in his pocket. Displaying the small images to a Staffordshire artist on his return, the traveller expatiated on the ceramic knowledge of the ancients. His reasoning had a flaw in it. 'Bless you,' the English potter is reported to have said; 'why, I made the gods myself—made them to order and for export!'

Arrived thus far in our chronicle of Ceramic Ware, it will be well to review the chemical technology of the case, previous to explaining what next happened in the progress of fictile manufacture. The proposition, be it remembered, is to obtain a white material. The simplest, the most obvious, and, it may be said, most legitimate way of solving the problem is by the use of pure white clay, as the Chinese and Japanese had done from time immemorial. The Babylonians, as already stated, had arrived at a sort of spurious result, by varnishing a red-clay surface white by means of fused oxide of tin. Whether the traditions of that art completely died out, or the contrary, we have now no means of knowing. At any rate, the world received no farther benefit from the tin-glaze process until about the fourteenth century, when the Balearic Saracens began to manufacture a sort of pottery, of which this white tin-glaze upon a coloured ground was the specialty. The manufacture was chiefly prosecuted in Majorca: whence the distinctive term 'Majolica' given to this sort of fictile ware, and which it has ever since retained.

No sooner had Majolica ware sprung into being, for this the second time, than the Spanish Saracens began to lavish upon it their utmost powers of ornamentation. Moreover, they applied it to purposes other than mere vessels of use or luxury. They made slabs and tiles of it; and with these adorned the interior of their buildings. The Alhambra was profusely ornamented with these Majolica slabs and tiles; and, because of the prevalent blue colour, the Spaniards call them 'Azulecos.'

Very soon after the discovery of Majolica, the Italian school of painting rose into eminence; and painters of the highest Italian renown deigned to work upon the ornamentation of Majolica. In point of fact, this variety of fictile ware came so near the mark of satisfying people's aspirations for elegant pottery, that it held its own contemporaneously with the manufacture of a white material throughout.

Reference has already been made to Bernard Palissy. Prior to about 1560 the secret of the tin-glaze had not been discovered in France, though Catherine de' Medicis had established a Majolica factory, conducted by Italian artists. Palissy set himself the problem of effecting the discovery, which he accomplished, at length, after years of assiduous experiment. The troublesome eloquence and objectionable irritability of Madame his wife has already been adverted to. Justice to that lady, however, compels the historian to remark that she received *some* provocation. Her husband was very poor, and his experiments were somewhat expensive. I have no doubt that Madame had to go without many a bonnet and many a crinoline (or the sixteenth-century representatives of these feminine appurtenances, whatever they may have been) because of the narrow means of her lord and—no, *not* master.

Nor is this all. On one occasion it is recorded that Palissy, not having the means to purchase fuel for his furnace, thrust into it chairs, tables, and other articles of wooden domestic furniture. These consumed, he forthwith began to pull up the wooden floor of his apartment and commit it to the flames. It is recorded that Madame, happening to return just at the moment when her spouse was thus engaged, gave herself some unpleasant airs, and spoke very frankly.

The provocation was considerable, we must own. The fact is, Madame was the wife of a man of genius; and, not aware of that fact, she had not learned to put up with the vagaries of genius. Whether representative men have any business to marry, may be a question permissible. Look about you, my fair friends; scan the domestic life of the married ladies of your acquaintance. Put the mediocre married men on one side, and the clever married men on the other. This done, tell me now, in which class you will find the most comfortable husbands?

Had chemistry been a trifle more advanced than it was in the sixteenth century, Europe would not have had to wait so long and so unavailingly for a revelation of the secret of porcelain, similar in nature to the Chinese prototype. It would have sufficed to analyse a fragment of real China ware, and the secret would have been revealed. That, however, was far in the future. Experimentalists continued to work on empirically. Pure clay — in other words, pure hydrate of alumina—will not make porcelain, as I have already stated. Not only must there be some flinty matter, or silica, present, but present in a certain due proportion. There should be also a minute amount of alkali (potash), a little of which is actually found in first-class raw porcelain material.

Pending the discovery of the secret of true porcelain in Europe, a device was adopted which, though it did not eventuate in producing China ware (hard or true porcelain, as chemists term it), originated a material nearly as beautiful in every respect, and even more beautiful in some. This material is soft, or false porcelain. Old Sèvres ware was of this kind; so was our Chelsea and Bow ware, not to mention others.

The material employed in the manufacture of soft porcelain has varied at different times and in different factories. Speaking generally, it may be described as white clay tempered with powdered glass; but occasionally numerous extraneous materials were added; for example, white arsenic and soap. The chemist will be at no loss to perceive that the result of such admixture is a somewhat fusible compound—a sort of incipient glass, so to speak. Soft porcelain, moreover, was not glazed with the same materials as real porcelain. All the old fictile productions of Sèvres were made of this material; and exquisitely beautiful some of the fictile productions of old Sèvres are. In some respects, soft porcelain is more susceptible of colour ornamentation than hard. As an illustration, the fact may be mentioned that, until quite recently, turquoise colour could not be given to hard porcelain. I am informed, however, by Messrs. Rose and Daniell, whose English productions constituted such a magnificent display in the Exhibition of 1862, that the difficulty of tinting real porcelain with turquoise has been surmounted.

At length, as time advanced, the secret of true porcelain manufacture was discovered in Germany; discovered, too, as the result of a curious accident. It so happened that Augustus II., Elector of Saxony, about the year 1708, came to the conclusion that, if his pecuniary resources were more considerable, it would be, all things regarded, desirable. Alas, what iniquities may not come about, if once the human conscience accepts the pernicious doctrine that the end may justify the means! Thus, about the ninth century, the Russians having determined to relinquish idolatry and become Christians, sent men-at-arms to Constantinople and kidnapped a bishop. Thus, too, Augustus II., having resolved to make himself rich in a hurry, kidnapped poor Böttger, the chemist. This latter wise man, as it seems, had acquired much fame as an alchemist. To him the secrets of Hermes, it was said, had been revealed, or were about to be revealed. He had transmuted, or was going to transmute, a considerable amount of base materials into gold. Now Böttger was the Elector's liege subject, who, therefore, thought it would be sound policy, if not strict justice, to lay forcible hands upon the man of Hermes, and lock him up. The proceeding commends itself very ill to us Britons, who entertain such exaggerated notions about liberty of the subject and Habeas-corpus. Upon the whole, however, Böttger's captivity was gentlemanlike and courteous. The best of eating and drinking were at his command. A well-appointed laboratory was placed at his disposal. All his expenses being defrayed, even to the farthing, his captivity was not so objectionable after all. Böttger does not seem to have pined under *duresse*. He did not grow slovenly and mope in unkempt locks. Locks! he wore a wig, after the fashion of the time. On stated days a Figaro came to dress the wig, and make it otherwise respectable. Now it happened, one day, that the wig, frizzed, powdered, and placed in position—as artillerists say of their guns—it happened one day, that the extraordinary weight of the wig prompted Böttger to demand of Figaro what it had been powdered with. Then followed a revelation to which the discovery of true porcelain in Saxony is due.

'Galloping from my house to your honour,' replied the man of powder and pomatum, 'my horse struck his hoof into something, and stumbled. Alighting to discover the cause, I found a white material clogging his shoe. Digging, I found more of that white material. It seemed good for powder, and for powder I used it. Sorry the weight of it has incommoded your honour.'

Böttger pardoned the weight. The idea suddenly occurred to him, that though bad for wig-powder, it might be good for pottery. He procured some, and trying, found it good. At Meissen, near Dresden, a manufactory was forthwith established. The celebrated Dresden china sprang into being. From that day to this, the Saxons have continued using up the stores of porcelain materials revealed by the barber's horse.

Dresden manufactured hard or true porcelain from the first. This was not the case at Sèvres, as will be remembered. There, soft porcelain continued to be made up to the beginning of the present century. Then the process was abandoned; and true porcelain has been made there ever since.

At the present time, white ceramic material is less difficult of access than formerly. Immense quantities of china clay are now made artificially, so to speak. The rock, granite, is a mixture of three different minerals—viz. quartz, mica, and felspar. In all specimens of granite these three materials can be perceived by the naked eye on examination; but in certain granites the commingling of these materials is far less intimate than in others. Near St. Austell, in Cornwall, the granite is remarkably coarse-grained; that is to say, the quartz, mica, and felspar which compose it occur respectively in large lumps. Looking now at the composition of felspar, chemistry reveals potash, lime, silica, and alumina as its constituents. Potash being soluble, is washed out by exposure to air and water, leaving a white compound of silica, alumina, a little lime, and potash; the whole chemically combined with water

—a very pure clay, in point of fact. Much of our porcelain clay is obtained in this very manner.

And now a very natural question is the following. What sort of porcelain is that for which England has become so celebrated? What is the material out of which our Rose and Minton and Copeland fashion their most exquisite services? The proper designation is almost wanting. We English can make real porcelain if we like, and make it beautifully, in proof of which some cups and saucers as thin as an egg-shell, made by Mr. Rose, may be appealed to. Be the fact known that 'egg-shell porcelain,' as it is called, from its thinness, was long regarded as the *ne plus ultra* of Chinese art—not to be manufactured in Europe. We English can make true or hard porcelain if we please, but it is not our specialty. We have invented a white ceramic material of our own; one the peculiar characteristic of which is the presence of bone earth. Objects of this material are more easily made than of hard porcelain body. Surfaces of it not only take colour better, but the tints wear longer. Hence it happens that nowhere can be found such exquisitely beautiful household pottery as here in England, of our own national manufacture. Germany and France produce magnificent ceramic articles *de luxe;* but as regards the pottery of domestic life we immeasurably surpass them. But for the historical interest which attaches to true porcelain, there seems no reason wherefore our own bone-earth ware should not be substituted in all cases. The material is equally plastic, and lends itself, perhaps, better than hard porcelain to the necessities of colour ornamentation.

These are points, however, which most persons who read this sketch have had repeated opportunities of judging for themselves. If a dispassionate comparative survey of any foreign and British ceramic wares creates any other impression than pride for British art, I shall be surprised. The French have larger articles than British manufacturers:

granted. But our manufacturers could have made articles equally large, were there a demand for them. In the department of coloured ornamentation our manufacturers have made immense strides since 1851.

Two branches of the process of ceramic manufacture have yet to be noticed in detail; viz. painting (or enamelling) and glazing. To make the nature of these branches more comprehensible, let us just review the processes a piece of china ware (say a dessert plate) has to undergo. First, the raw staple—clay, let us call it—has to be fashioned into shape. If the desired shape be such as can be developed by rotatory motion, the fashioning is accomplished by a wheel. Fancy a small round table on a pivot, which being caused to rotate by a band, the table turns with great velocity—much faster, indeed, than a spirit has ever been known to turn one. Upon such a revolving round table, the potter, having deposited his lump of clay, begins to model it with the fingers until the intended shape is given. As for handles and other little appurtenances, they are stuck on with a mixture of clay and water, technically called 'slip.' This being done, the piece is set aside to dry. If the desired shape be such as is not within the competence of turning to produce, moulds have to be employed. So far as my own individual opinion goes, if moulding were altogether abolished and turning universally had recourse to, by so much more beautiful would be the resulting forms.

The piece made absolutely dry is now subjected to furnace heat, the effect of which is to reduce the material to a condition of incipient fusion; whereas the elements of the pottery material were, previous to burning, mechanically mixed, they become, after burning, chemically combined. The piece of crockery rings bell-like when struck, begetting the notion of increased strength, due to intimate union. Arrived at this stage, the piece is called 'biscuit, or biscuit-ware,' the condition adapted for glazing.

The admirer of painted pottery, not being a chemist, little knows the difficulties under which the painting of Ceramic Ware has to be accomplished. The artist in oil- or water-colours, operating on canvas or paper, sees his colours all before him. He lays on these colours as he wishes them to remain. Less favourable are the conditions under which an enamel or porcelain painter works. He has to paint away, so to speak, in the dark. Not one of the colours he lays on is such as, after burning, it will be. His pigments, at the moment of laying on, are either no pigments at all, or their colours are very different from what they will be when the labours of his pencil are committed to the furnace. These being the conditions under which he prosecutes his art, the wonder is that the tints ultimately produced are so true to nature. Even on canvas or paper, flesh-painting is the most difficult of all. On Ceramic Ware the difficulties of flesh-painting are, of course, much greater; nevertheless, the results leave but little to be desired if a competent artist has been employed. All the higher varieties of colour ornamentation on pottery are effected by the pencil; but the process of transfer is adopted when results of moderate excellence only are aimed at.

I have referred to glazing. This is accomplished by dipping into the glaze material, whatever the latter may be —at least, usually. The result of dipping is as follows: the surface of the piece is covered with a thin film of glaze material, which, on burning, distributes itself all over the piece in a transparent glassy film.

In regard to the glaze, that employed for the finish of hard porcelain is nothing else than finely-levigated felspar; but the glaze of soft porcelain and English bone earthenware always holds a portion of oxide of lead, a material which fuses at a lower temperature than felspar alone.

In treating of the general process by which glazing is accomplished, the reader was given to understand dipping is not always had recourse to. Thus, for example, the Lambeth stone-ware acquires its glaze in a very peculiar fashion. Whilst glowing hot in the furnace or kiln, a little salt is thrown in, and a glazed surface results. The effect is very curious. It depends on a certain reaction between one of the elements of common salt and silex; a reaction that, involving as it does a rather abstruse chemical function, need not detain us.

The beautiful Parian ware, of which little statuettes are made, deserves a word of notice. Generally speaking, the material of Parian ware may be described as clay, the fusibility of which has been increased by mixture with borax, or other equivalent substance.

Borax *was* universally employed, but some of the Parian statuettes now made do not contain borax. Parian statuettes are very pretty as to material, but they are apt to be deformed. Not only do they shrink amazingly in the process of burning, but they sometimes drop. The result of this dropping is, that small Parian Venuses sometimes come out of the furnaces with crooked spines, like young ladies needing gymnastics and a backboard.

Thus has the history of Ceramic Ware been sketched from antiquity onwards. The honour and dignity of alumina, silica, and oxygen have, it is assumed, been vindicated. When Monsieur St. Clair Deville succeeded, a few years ago, in extracting aluminium, in commercial quantity, from alumina, its rust, he awakened popular wonder. The surprise has passed away. We turn aluminium into toys, buttons, and trinkets, ceasing any longer to look on it with reverence. Clay we despise. Fragments of pottery we kick out of our path, as awakening no thought of poetry. But if there be ladies in the moon, and if no clay be there, and if the lunar ladies, peering earthward through a sufficiently powerful telescope, can steal a glimpse of our beautiful crockery, they must deem us the happiest creatures alive to be gladdened with so much beauty.

SUGAR.

SOME of us are aware, and some of us probably are not aware, that British Chancellors of the Exchequer find trouble in regulating the sugar duties. Mankind and womankind are getting better and better, no doubt, as the world gets older and older. The time will come, everybody knows, when the lion and the lamb, starting hungry from the common lair upon which they have lain, will arise in the morning, shake off the morning dew, and then, side by side, begin to pull wisps of hay for breakfast out of the same haystack. The time will come when there will be neither wars nor rumours of wars; and then, of course, there will be no war expenditure.

It will come; but we shall not live to see it, nor probably will Mr. Lowe. Pending his life and ours, the British Chancellor of the Exchequer will have to raise by annual taxation a sum varying from sixty to seventy millions sterling, I fear; and until men and women can be made honest enough to put themselves on conscience with the chancellor, and pay him by way of direct tax the sixty or seventy millions he is in want of—why, there must be such things as duties levied by customs and excise.

There are not at present so very many articles of food upon which duties are leviable; but sugar is one. Very few minds that have not been specially trained and educated can rise to the comprehension of very high figures; however, no one can do justice to the article of sugar without giving some very tall figuring, some very large sum-totalling. Considered as an article of food-merchandise, sugar only takes rank second to corn; whilst the difficulties it presents to the finance minister in the way of levying a fair and equitable taxation are enormous. First, as regards the sum-total of sugar produced in various parts of the world, that cannot be got at. As regards the amount of sugar, however, which finds its way into commerce in various parts of the world, the aggregate amount of it has been taken as equal to two millions of tons. Of this sum-total more than a quarter finds its way to these islands, either for consumption or export, as raw or else refined.

I now come to indicate a fact of considerable interest. The value of sugar imported here rises to the enormous annual sum of twelve millions sterling, and of this the Chancellor of the Exchequer has been wont to say, 'I must have one clear half.' To put the case in another way, he has been wont to say, '*I* must raise six millions through a sugar-tax; and *you*, Materfamilias, must pay double as much per pound for sugar as you need have paid but for my financial necessities.' The result of Mr. Lowe's altered duties on sugar will be to lower the customs' receipts on this article by a trifle. He could not afford to lower it much—he did not intend to lower it much; the chancellor's great object being to distribute the duties leviable upon sugar more fairly than heretofore amongst the various classes of sugar manufacturers. '*Manufacturers*;' the word is used advisedly. The two expressions raw sugar and refined sugar have been long consecrated by usage; fostered by certain people, who found their interest in keeping up a delusion.

British sugar-refiners, though numerically small—their whole number falling considerably below a hundred—are a very rich and influential class; how rich will appear from the statement, well attested, that from eight to ten millions sterling are embarked upon sugar by refiners of this country. For a long time these gentlemen laboured, and successfully, to make successive Chancellors of the Exchequer believe that refined sugar—as the public understands refined sugar to be, namely, white sugar—could only be got through their intervention; through an operation conducted on the coloured material ordinarily known as *muscovado* or moist sugar. Now the fact is, that sugar is generated white; the cane and colonial sugar-growers imparting yellowness or brownness through the imperfection of their manufacture. Mr. Gladstone—and it did infinite credit to his sagacity—was the first Chancellor of the Exchequer who apprehended this circumstance fairly. He was brought to see that the home refiners' object was to prevent the colonial people from turning out their sugars otherwise than in a very impure condition, in order that the interests of home refining might not be prejudiced.

Is sugar a necessary of life, or is it not? Reflecting upon the enormous amount of it consumed, one might almost be disposed to call it so; and yet European people had to do the best they could without it until well-nigh our own period, historically speaking. Probably good Queen Bess indulged in the luxury of sugar from time to time; but we may very well doubt whether her majesty consumed a portion daily. Shakespeare may have tasted it—one can assume he did—but if fond of sweets, he must have eaten a good deal more honey than sugar. It was not till the reign of James I. that sugar was specially mentioned in the British tariff; and for a long time subsequently the importation of it was but limited.

At the commencement of the present century the quantity of sugar imported was four million hundredweights; it gradually increased to about six million hundredweights towards the middle of the century, and now amounts to no less than eleven million hundredweights. We get it from a variety of places; the fact being that sugar-canes flourish well anywhere under the conditions of good soil and a mean temperature of 76° to 77°. The native land of the sugar-cane was some part of Eastern Asia, probably Southern China, Cochin-China, and Siam. The West-India islands and America had no sugar-canes until there conveyed by the Spaniards: such, at least, is the opinion of persons who have most fully and carefully applied themselves to the question; and much probability is impressed on this belief by the circumstance that sugar-canes rarely, if ever, blossom in the West Indies or America, much less produce seed. Does this not appear to be a silent protest of complaint, to the effect that New-World sugar-canes feel themselves aliens in a strange land—one in which they have not been able to feel quite at home?

Soon after the Asiatic expedition of Alexander the Great, in the fourth century before Christ, notices of sugar (vague, and few and far between) were announced by Greek writers; but at no period did sugar become known to the ancient Greeks or the Romans either. When small quantities of it had been obtained, they were either put aside in museums as natural curiosities, or else used as physic; for all ordinary sweetening purposes honey being used. 'Indian salt' was the common designation applied to sugar, both by the ancient Greeks and ancient Romans; hence the sort of sugar which used to come to Greece and Rome was probably in the form of candy. Arctugenes, a Roman physician who flourished in the time of Domitian, published some casual notice of sugar. He described it as, for colour and hardness, being comparable to salt; for sweetness comparable to honey.

The first thousand years of the Christian era bear only scant records of sugar in Europe. From the fifth to the seventh century Byzantium monopolised whatever of commerce in sugar there was between Europe and Asia; and during that period, if ever a portion of Indian salt travelled so far west as our isles, it must have been obtained through Constantinople.

Probably the native region of the sugar-cane was some part of Eastern Asia, as already announced. The naturalists who accompanied Alexander the Great in his Asiatic expedition do not appear to have met with the sugar-cane; otherwise they would have furnished a more precise account of the Indian salt than they did. It would appear, however, that by the time the Eastern or Byzantine empire was founded, the sugar-cane had gradually been extending its dominion westward, even so far as Syria.

In tracing the European historical sugar-chart, the Saracenic conquests in Europe next merit attention. Sugar-canes, pomegranates, and the date palm are three chief members of the vegetable kingdom which the Moslem conquerors brought with them from the East, and naturalised in certain favoured parts of Europe.

It is a fact, though one either little known, or, if known, remembered, that various parts of Southern Europe, especially Andalusia, Valencia, Cyprus, and Sicily, grew their own sugar-canes, and produced their sugar long before even the discovery of the West Indies and America. Nor has Europe ceased to grow sugar-canes, and produce sugar from them even at the present day. In Southern Andalusia, between the Sierra Nevada range and the Mediterranean, occurs a narrow slip of land, perhaps having no more than an average width of five or six English miles, by sixty or seventy long. This tract, though small in area, is remarkably fertile as to soil, and favoured as to climate. The '*tierra caliente*' is what the Spaniards call this region; and hot enough a northern stranger finds it in the summer. The *tierra caliente* produces sugar-canes and cotton shrubs; not as mere curiosities either, but in good commercial quantities.

If some future Chancellor of the Exchequer should desire to brush away from his financial vision the last floating veil of cobweb mystification which the home refiners have spun out of their long-drawn yarns—if in applying himself to this, he should deem a sight of sugar-canes, and the process of getting sugar out of sugar-canes advisable—then, in that case, he need not dare the malice of yellow Jack, or raise the expectation of Jamaica land crabs. He need not steam or sail away to the Mauritius—though once there, he would see the process of sugar extraction conducted more neatly and philosophically than elsewhere. A far easier tour would be to the Spanish *tierra caliente*, where the sugar-cane flourishes quite as well as it does in the West Indies; and where he might find several modes of manufacture, each on a different estate—modes varying from those of almost primitive barbarism, to others involving the use of hydrostatic presses, vacuum pans, and other modern refinements.

Between the Saracenic Moslems of Europe and the Christians of Europe there was little love to spare, and but small intercourse. The Saracens of Europe kept all the sugar they grew pretty much to themselves, for their own advantage, and that of their ladies. It is a fact quite worthy of remark, that wheresoever and whensoever Mohammedanism has gained dominion, sugar has followed. The opinion I adopt may be vain—I advance no pretensions of infallibility; but to my own mind the explanation of this circumstance is simple. The typical houri of Mahomet is the reverse of sylph-like. She is a stumpy, adipose, waistless lump of sleek feminine mortality, with no more creases on her velvet skin than has an air-expanded rubber foot-ball or Monsieur Nadar's balloon. Now sugar is like milk—*a fattening thing*. Chemists furnish a reason for this; and Mr. Banting's practice lends confirmation of their theory. I am of opinion, then, that the connection between sugar and the Koran turns upon the partiality of Moslems for plump, sleek, *embonpoint* ladies.

It was the Crusades that first familiarised the sweet Indian salt to Christian Europeans. Warriors, returning from Syria to their baronial halls, did not fail to bring with them a taste for certain Oriental luxuries to which they had been accustomed—of these, sugar was one. Venetian enterprise was equal to the need. Venetian merchants imported much of the sugar required from Asia, and moreover discovered the method of refining it—producing the refined sugar as we do now, in the form of white crystalline loaves. Hence is deduced the origin of the term '*pains de Venise*,' by which loaves of sugar were for a long time known in Europe.

The whole question of sugar has been very much confused and embarrassed; sometimes designedly, as we have seen. One common error has been adverted to,—the error, namely, of assuming that white sugar could not be made from cane-juice direct. Another common error has been, the belief in certain specific differences between different samples of cane sugar. This is absolutely incorrect; specimens of *pure* cane sugar being absolutely identical, from whatever source derived.

Here, too, let me explain the exact meaning of the term '*cane sugar*.' It does not mean sugar that has been of necessity extracted *from* the cane, but sugar that, from whatever source extracted, is identical with the sort found *in* the cane. Several distinct kinds of sugar are recognised by chemists; the variation between them dependent on composition, and chemical and physical quality. Of these different sugars something may have to be written by and by; but for the present it is desired to fix attention upon that variety only of sugar which assumes any commercial importance,—the variety, namely, denominated by chemists 'cane sugar, or sugar of the cane.'

As to the physical qualities of cane sugar, the more obvious and prominent amongst them may be recognised in a crystal of white sugar-candy, or white lump sugar; the only difference between the two consisting in a variation of dimensions of crystal.* Such, then, is pure normal or typical sugar of the cane,—a material not only procurable from the cane, but from many other sources. Let us enumerate them—or at least the chief amongst them.

Having disposed of the sugar-cane proper, and stated, for the advantage of all who need the statement, that the sugar-cane is only a gigantic grass, it may now be mentioned, that

* A certain journalist, carried away by the impulsive furor of fine writing, used the expression '*glittering cubes* of crystal sugar.'—MEM. Sugar crystallises in oblique prisms or derivatives of the same, never *cubes*. It is well to be correct.

the stems of most grasses either generate cane sugar, or tend to generate it. Lately, a sort of spurious or imitation sugar-cane has been brought from China, and cultivated pretty extensively, not only in Southern France, but in various of the North American States.

This particular sugar-cane, botanically known as *Sorghum saccharatum*, does not refuse to grow in England, but here it secretes little or no sugar. In North America considerable amounts of sugar, *i.e.* crystallisable cane sugar, are obtained from sorghum juice; and also varying amounts of another variety of sugar, not yet indicated in this sketch, namely, glucose or grape sugar. The next species of grass which merits our attention as a producer of sugar is maize, or Indian corn; the stems of which, when grown under favourable conditions, are somewhat rich in sugar.

Perhaps, however, the vegetable family most rich in sugar is the palm tribe; especially the cocoa-nut and the date palm. In order to impress on the memory the saccharine qualities of the palm tribe, it is only necessary to call to mind the numerous accounts published by travellers of the intoxicating qualities of certain liquors made from fermented palm juice. Most of us may have read how certain happy savages, when they want to get tipsy, climb up some friendly palm; then—boring a hole into the base of its spathe, or top-knot, cabbage-like expansion—tie a pipkin thereto, and wait until the pipkin has become full of palm juice; which latter, when set aside to ferment, becomes intoxicating. Now, whatever juice or liquid is capable of fermentation and generation of alcohol must hold sugar of one or two sorts, or else mixtures of the two, the sorts being sugar of the cane and sugar of the grape.

In a general way, and not to be pedantic, it may be said that sugar, and only sugar, can generate alcohol.* Literally

* Only glucose or *grape sugar*, to be scientifically precise; but inasmuch as cane sugar readily changes to glucose, the distinction may be practically disregarded.

and chemically, I know quite well, that alcohol *may* be got out of coal gas. Some fellow of late, I perceive, has been trying to get up a joint-stock company for extracting alcohol out of coal gas—*n'importe.* This is a novelty, and in some sense a mystery; sugar is the only practical spirit-maker at the time being.

The palm tribe, then, is rich in sugar—rich in actual cane sugar; the juice of certain palms being even richer than cane juice itself. Very much of the sugar which comes to us from the East Indies has a palm-juice origin. If, then, palm juice be richer in sugar than even cane juice, it might seem probable that palm may supersede canes as a source of sugar supply in time. Such a result, however, is not likely to come to pass; and this for obvious reasons.

The great merit of canes is, that they accord well with the general necessities of systematic agriculture and concentrated labour. *You,* we will assume, possess a field of sugar-canes, and *I* a plantation of palm-trees. *Your* canes actually hold less sugar than my palm-trees; but the question now is, Who will get his sugar soonest, easiest, you or I? Let us see how the case stands between us. On *your* part, when your canes are ripe, you send your people — servants, voluntary or involuntary—into the field to cut down the canes; and these being cut, you send them to the mill and roll them; so you get the whole sugar treasure of your estate in one compact bulk, and it only remains for you to extract, by competent processes, your sugar.

How am I dealing meanwhile by my palm-trees? Every morning I should have to send out a gang of naked climbing savages, each of whom, with pipkin in hand, would work his way up a palm-tree, change pipkins, and bring down the juice. Then, saccharine juice will not keep; it easily ferments; consequently it has to be converted into sugar by detail, in small lots as collected. Thus stands the case between us; and being so, you will readily perceive that *your* canes, though intrinsically poorer than *my* palms, are a far more workable property.

Nevertheless, owing to the peculiar conditions under which India is placed—those, namely, of a teeming population and low rate of labour—enormous quantities of palm sugar can be made available, and in this way. Though it would never pay one to be collecting the juice of an entire plantation of palm-trees, yet had I one or two palm-trees growing in my garden, were I a climber by nature or predilection, and were I farther absolved from the fear lest palm-tree friction might not conduce to the immortality of my breeches (through the very circumstance of my not wearing such article of attire), then might I, without any particular tax on my time or trouble, collect and boil-down the exuded palm juice. This is just what happens in India. Millions of natives do this,—boil-down their own rough sugar, and sell it to proprietors of European refining establishments. Practically, there is good reason to believe that, but for a certain legislative protection afforded to British refiners, the bulk of white sugar consumed by England and her colonies would come from India.

Regarded as a commercial source of sugar supply, the beetroot should undoubtedly come next; but as the nature of this disquisition has led me to take cognisance of the saccharine juice of stems and trees, here would seem the most proper place for adverting to the white maple (*Acer saccharinum*) as a commercial source of sugar supply. The juice of this tree is obtained by boring into it, collecting the juice which exudes, and manufacturing it into sugar by evaporation and crystallisation.

In some parts of North American Canada, as well as the United States, maple sugar is extracted by the farmers, and made to take the place of cane-extracted sugar, with which it is in every respect identical.

At last we come to that very interesting branch of our subject, the beetroot-sugar manufacture; so interesting, that it shall receive a separate notice.

Here the point is worthy of remark, that the sugar-cane is the only sugar-containing plant, the fresh saccharine juice of which is agreeable to the nose and palate. One would find no great pleasure in munching a slice of white beetroot; but I know few gustatory dissipations more pleasant than to loll in the shade under the rustling fronds of some palm, and masticate a length of fresh-cut sugar-cane.

Many of us there may be who prefer moist sugar to white sugar for certain purposes, if only the moist sugar be good; and some of us may have become aware, during the past few years, that good old-fashioned yellow sugars have hardly been attainable. Mr. Lowe's budget will alter the state of this. Yellow sugar, to be good, ought to be made from cane juice direct; but by far the largest amount of yellow sugar lately attainable has not been so made. The practical effect of legislation, for many years, has been to keep all yellow sugar above a certain scale of purity out of the British market, and to encourage the production of coarse, dark, almost black sugar. This, when imported, could not well be eaten in its raw state; so it was purchased by refiners—not so much to make white sugar out of, that branch of the trade being not very profitable. What they did was, to convert the dark coarse muscovado into a sort of light-coloured looking muscovado; pretty enough to look at, but reeking of the odour of putrid blood used in refineries. If housekeepers would purchase their moist sugar more by smell than by taste, they would make better bargains.

Since we are here taking a politico-commercial glance at the relations of sugar, and are by no means pledged to go very far into the science of it—since we are chiefly concerned in the study of sugar as the historian, the political economist, the natural historian, would study it—so in close association the whole tale of negro slavery in America comes suggestively — especially that black episode in the history of mankind, trans-oceanic negro slavery; a deep problem; a page of the world's history full of portentous questions! Whether a race of people, depraved enough to kidnap each other—sell each other—have all the right and *all* the justice on their side in raising the plaint of deportation and forced servitude, this is what I question.

Has there not been a set-off in the blessings of Christianity conferred to many a dark soul, that but for the middle passage and slavery would have winged its last flight to the mumbling of a fetish man? It is a dark problem—a *very* dark problem. Whether the abolition by law of slave trading, the brand-mark of piracy attached, has enhanced or diminished the sufferings of the negro, may still be an open question. The records of commerce through all time have gone to prove the futility of endeavouring to suppress any trade on which there happens to be an enormous premium. If not legitimately carried on, it will be prosecuted by way of smuggling, of contraband; and contraband negroes are packed like herrings. O, it is very horrible! Behold the isle of Cuba on a map; consider how small it is; and then marvel as you may, that such a little island produces nearly one-fourth of the sum-total of sugar entering into commerce. It is all produced by negro labour, by *slave* labour; and negroes are not over-prone to work except driven. There must be some driving in Cuba, some sacrifice of negro life to the Spanish sugar Moloch. Despite the fiction that the negro slave-trade has been suppressed, the Spaniards import the blacks they need —they even prefer importation to raising. With special reference to this may be mentioned the fact, that the Spaniards not unfrequently impose on their male negroes the same discipline that St. Origen imposed on himself; the latter, in order that his mind might be absolved from many cares, and troubles, and concerns, that withdraw from piety the minds of ordinary men.

An Englishman who has been to Paris, and witnessed the furious consumption of *eau sucrée* by persons of both sexes and all ages; who has learned from experience, perhaps, the amount of demolition a young French lady can achieve on a *corbeille* of *bonbons* in a given time, may well be excused for coming to the conclusion that the French are a more sugar-eating race than ourselves. Statistics do not prove it. While English people consume — on an average, per mouth per annum—no less than thirty-four pounds of sugar, French people only consume fourteen.

Sugar did not attain its conquest of British affection without some trouble. There was a strong opposition to its use at first. It would destroy the teeth, corrupt the body, weaken the intellect,—I know not what besides. Amongst medical men there were saccharine and anti-saccharine declaimers. Conspicuous amongst the former was a Dr. Slare, who flourished in the beginning of the last century. He vindicated sugar from all the aspersions that had been cast upon it. He not only ate sugar, but took it as snuff, finding advantage therein. He recommended sugar as a diet peculiarly appropriate to ladies. The only disadvantage attending the use of it by the fair sex, according to Dr. Slare, is a tendency to fatness; but, as a set-off, he bids the doubting fair ones to take no heed of that; inasmuch as such defect, if any, is more than countervailed by an excellent sweetness of disposition, very charming and delightful.*

* Vide his book, entitled 'Experiments and Observations upon Oriental and other Bezoar Stones, which prove them to be of no Use in Physick. Gascoin's Powder, distinctly examin'd in its Seven Ingredients, censured and found imperfect. Dedicated to the Royal Society. To which is annexed a Vindication of Sugars against the charge of Dr. Willis, other physicians, and common prejudices. Dedicated to the Ladies. Together with further Discoveries and Remarks. By Frederick Slare, Fellow of the College of Physicians and of the Royal Society. 1715.'

Amongst the most violent declaimers against sugar we must number the celebrated Dr. Willis; he wrote of it as follows: 'Saccharo condita, aut plurimum imbuta, in tantum vitupero, aut illius inventione ac usu immodico, scorbuti in nupero hoc seculo immani augmento, plurimum contribuisse

I will finish this notice of cane sugar with some description of the processes used to obtain it from natural juices, also with some details of the process of refining: it will be the merest sketch. First, then, in regard to cane juice, it is first heated with lime, to coagulate much foreign matter that, forming on the surface in a crust, is skimmed off. It is then evaporated in a series of pans to such a condition of thickness, that when set aside crystals form in masses, with fluid matter between. The moist crystals, being allowed to drain, yield a liquid that, when flavoured with the rats and mice, the cockroaches and centipedes, which get into it, is known under the name of molasses.

Treacle and molasses are sometimes confounded; nevertheless there is a certain difference between them—one more of flavour than anything else. As the process of sugar crystallisation in the colonies yields a liquid, so does the process of refinery crystallisation at home. In either case the liquid drains away; and divers living things, ready to court certain death in gratification of a sweet taste, step in and are done for. There are no scorpions in England—no centipedes, no giant cockroaches, as in the West Indies. Treacle, therefore, lacks their flavour; but as a set-off, acquires a smack of putrid blood mingled with the extractive of black-beetles. Herein consists the chief difference between treacle and molasses.

As regards refining specially considered, it mainly turns upon the washing of yellow sugar white by means of a saturated solution of white sugar poured upon it. In India alcohol

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existimem: enimvero concretum istud sale satis acri et corrosivo, cum sulphure tamen delinito, constat, pro ut ex analysi ejus spagiricè facta, liquido patet. Quippe saccharum per se distillatum, exhibet liquorem aquâ stygiâ vix inferiorem: quod si ipsum in vesicâ plurimâ aquâ fontanâ perfusim distillaveris, quamvis sal fixus non adeò ascendere prodibit, tamen liquor instar aquæ vitæ acerrimæ urens ac summè pungitivus. Cùm itaque saccharum quibusvis ferè alimentis mixtum ità copiosè à nobis assumitur quàm verisimile est ab ejus usu quotidiano, sanguinem et humores salsos et acres proindeque scorbuticos reddi.'

is sometimes used for washing coloured sugar crystals. In England we could not afford to do this.

There is no specific difference between the manufacture of colonial sugar and home refining. The distinction is one of degree only, refining processes being carried a few stages farther than colonial processes. A sugar refinery! Picture to the mind a large building, many stories high, having steam pipes laid on throughout to keep up the temperature, and over the floors of which a number of half-naked Germans are sprawling about, struggling painfully, as if to overcome some inevitable destiny that would stick them to the floor—very suggestive of birds on a limed twig.

Feign to yourself an odour compounded of a dog-kennel, and a stove over which a pan of preserves stands simmering; fill up the mental presentment with a never-ending chorus of strange noises — roarings like that of angry bulls, hissings, splutterings, all the myriad sounds, the steam escaping from imprisonment ever made or can make. Imagine a number of steamship funnels let through successive floors without apparent object; this all accomplished, you will have some sort of notion as to what a sugar refinery is like. In a refinery, dispositions are so made that the series of operations may take place from the uppermost floor downwards. To this uppermost floor the sugar to be refined is raised, and there turned out upon the floor like so much worthless clay. Then come half-naked Germans with spades, and, exactly like navvies on a railway cutting, they fall to work upon the sugar and turn it into an iron tank, holding water. There is no weighing of the sugar; proportions of it to water being regulated by specific gravity of the solution.

And now would I counsel an inquisitive investigator of sugar-house processes to grasp his nose between thumb and forefinger, and hold that organ tight. There is about to be enacted the sugar refiner's great mystery—a sacrifice, a true blood-offering. Into the tank one of the half-naked Germans throws something — red, clotty, gory, a mass of tremulous sanies, floating in an unhealthy, jaundiced-looking whey. What's in a name? Something, evidently believes a sugar refiner, else why should he call this gory horror 'spice'? In goes the spice — plump! then follow some sharp cracking sounds, as if some volunteers were deep down underneath the fluid, keeping up a running fire of skirmishers. Soon the character of noise changes, the sharp rifle-cracking ends; and upon that there follows a dull hollow bull-like roar. Meanwhile a crust forms on the surface, and from time to time is skimmed off; and when the skimming, the skirmishing, and the roaring, have gone on long enough, a tap is turned, and the liquor runs away. Such is the first process of sugar refining. It is called 'blowing up;' and the peculiar crackings and roarings I have been endeavouring to describe are caused by the passage of steam through water.

Dr. Slare, of revered memory, attributes two especial qualities to sugar, as we already know. First, he makes it out to be a great fattener; in testimony whereof consult Mr. Banting. Second, he credits it with the quality of 'benignification,' so to speak, of those who use it. According to Dr. Slare, a sugar diet is a great improver of ladies' tempers. This may be so; but if sugar really do exert a corresponding influence over the tempers of men, the virtues of it are not conferred by absorption. Mostly, sugar-refiners are an ill-tempered race; and I hardly ever met with one who did not fall into a passion on the mere mention of the word 'spice.'

What I have yet to write must be brief. Stage the second consists in filtering the 'blown-up' liquor through a multiplicity of cotton bags, each like a bolster-case, sewed up at one end, and then thrust into a long cabbage-net. Stage the third,—filtration through burnt bones, packed in those steamship chimneys to which we referred. Stage the fourth, —vacuum boiling (a very pretty process); then stages five, six, and others too numerous to mention here.

A word to the wise:—white sugar *is white sugar*, no matter how prepared. Should the refiner see good to temper his blow-up with the contents of Macbeth's witches' caldron, well and good—so long as we don't eat the foul things therein, but only the things that some wizard-working of the witches' broth has purified; but the sugar-refiner vends certain coloured, soft, and sloppy goods, that, perhaps, the less we say about the better. Smell moist sugar, my friends, before buying it!—and leave the luxury of treacle to the children; whose stock of sentiment, poor dears, lies upon their palates and deep down in their little stomachs.

I now write 'finis' as to sugar of the cane. There are other sugars, as we know—all fat-makers, none flesh-makers—enemies to the undertakers* all—as chemists have proclaimed and Mr. Banting has made manifest. To treat of them at this time would be impossible; nor does that signify much.

I do not pretend to instruct people. Personal diffidence, in the first place, rebels; second, people rebel against instruction. People are right.

Pain and unhappiness have ever been the fruit of the tree of knowledge, and ever will. Literally as well as figuratively it is all the same! From Eve's knowledge of the flavour of her stolen apple, to your knowledge, or mine, of molasses and treacle—it is all the same! Blessed be ignorance, then!—a reprobation to popular lecturers, who go about illustrating the ways of nature, on black-boards, in cabalistic signs drawn with chalk. Condemnation to middle-class education; to peripatetic philosophy of all sorts—especially the sort taught in ladies' schools! Bad luck to female doctors! Blessed the memory of dear poet Cowper, and the memory of his cud-chewing hare! Utterly reprobated and contemned be that

* Because the fatter the corpse the bigger the coffin *for the same price*. That consideration induced Mr. Banting, himself a maker of coffins, to write his book.

greatest of bone-scrapers, Professor Owen; and that most contumacious of bishops, J. C. Natal! Long life to pure literature; perdition to the rest! Confusion to Euclid, Laplace, Legendre, Newton, Arago, Shakespeare, Milton, Homer, Virgil, Goethe, Œrsted, Döbereiner, Descartes, Faraday, Liebig, Cuvier, Buffon—all and everybody who ever tried to make human beings wise!

BEETROOT SUGAR IN FRANCE.

A CERTAIN animated controversy arises from time to time about the profitable manufacture of sugar from English-grown beet. The profit-and-loss question would not constitute a matter of pleasant reading. The Mincing-lane gentleman who has planted certain broad acres with Silesian beet, with the intent of ultimate sugar-extraction therefrom, will, in course of due time, tot-up his nett profits or losses, as the case may be, thus removing the topic from the domains of controversy. Another aspect of beetroot-sugar manufacture claims our present regards: I will review it as one of the triumphs of science, accomplished under difficulties.

Draw on your imaginative faculty: picture to yourself the desolation that would overspread the gallant and lively French nation — men and women alike, but especially the women—if wholly deprived of those little bits of sugar which, under so many protean forms, they eat; and, not content with eating, drink. Rob Gallia of her sugar and her *bonbons* —atrocious! As well rob Britannia of her plum-pudding and beef. The attempt was once, however, made; and, I blush to record, by us English. War is confessedly an ungentle art; but never did Bellona show herself in more ungentle guise than when we strove to deprive our neighbours of their sugar. The case stands thus: *La grande armée* made capsized skittles of emperors and kings on land; but the British fleet made laths and match-splints of French ships at sea. After Trafalgar, the French merchant service found itself in sore straits; French colonial trade declined almost to nothing; for which reason sugar, being a bulky article, was difficult to obtain. Out of the pressure thus caused, the practical manufacture of beetroot sugar in France originated, though it was not brought to remunerative point until some years later.

Everybody who has eaten a slice of red beetroot, even though saturated with vinegar in a salad, must have remarked that it is sweet. White beets are not used in salad-making, being unattractive to the eye; but they are even sweeter than the red. Now, the existence of sweetness does not of itself prove the existence of sugar, as the public understand sugar; by which I mean *crystallisable* sugar, such as can be manufactured into loaves. In the case of beetroot, however, the sweetness is due to the very same chemical species of sugar extractable from the cane. To determine the presence of sugar in beetroot is no difficult matter; to *get out* the sugar economically and in commercial quantities is, if not a difficult, a very delicate matter. Having minutely examined some of the chief beetroot-sugar factories of France and Belgium, I can testify that the ingenuity of the apparatus used, the delicacy of the operations, and the philosophical application of principles to ends, are beyond what the public imagine. This is hardly a proper field, however, for enlarging on such topics.

A Prussian chemist, Margraff, was the first to demonstrate the existence of crystallisable commercial sugar in white Silesian beet. So long ago as 1747 he read a memoir before the Academy of Berlin, making this announcement. Although Margraff called attention to the importance of the discovery, no practical application was given to it for more than forty years. Achard, another Berlin chemist, took up the thread of experiment at the point where Margraff had dropped it. To him we owe the first practicable, though still very imperfect, means of extracting sugar from beetroot on the commercial scale.

The Prussian government extended to Achard a patronage that had not been awarded to Margraff. In 1789 he grew beetroot on an estate named Caulsdorff, near Berlin; in 1796 he took under his care another estate, Kunern, in Silesia. The produce of these two estates having furnished results which were satisfactory at the time, two others were put under beetroot cultivation, from which time the manufacture of beetroot-sugar took a firm stand in Germany.

In 1797 Achard published the results of his labours, and two years later he sent a letter to the *Annales de Chimie*, containing farther particulars. In this letter he made full communication of the processes followed; he enlarged on the general advantages of the scheme; he drew a favourable account of profit. In short, the purport of his letter was so satisfactory in every way, that it caused a great sensation amongst the French. Every French newspaper of importance gave extracts from the memoir. Political circumstances at the time favoured the occasion. The Institute organised a commission of inquiry to go through Achard's experiments, and check his results.

This plan of proceeding is one that will not recommend itself to practical Britons. In this country the usage is, for operations commercially conducted to be adduced to check the laboratory experience of chemists: the French proceeded in reverse order, and with an unsatisfactory result. The French chemists forgot altogether—or at least ignored the fact—that Achard had been for many years a beetroot manufacturer on the large scale. He came before them, not in his capacity of chemist, but of fabricant; and they had yet to learn that the difficulties of beetroot-sugar extraction are the more considerable as the quantities operated upon are less. French chemists came to the conclusion that Achard must have made some mistake in his calculations of expense; that instead of the cost of manufacture being sixty francs the kilogramme, as represented in his memoir, it must have amounted to at least eighty. Two beetroot factories were, however, established near Paris: they failed, for reasons easy to understand.

Farther essays would probably have been made, had not the national attention been diverted to the contemplation of a rival scheme of sugar manufacture suggested by Parmentier. It was believed by this chemist that sugar might be more economically extracted from grapes than from beet; whereas the fact is, that grapes, however sweet, hold no sugar—in the sense of commercial crystallisable loaf-making sugar—at all. Crystalline sugar Parmentier did not succeed in getting out of grapes, for the simple reason that they do not contain any. He established factories, however, in the centre and south of France, for the production of syrup, owing its sweetness to a variety of sugar different from cane sugar, and known to chemists as *glucose*, or grape sugar. The very same kind of syrup results from the boiling of starchy matter, or even saw-dust, with oil of vitriol and water. Large quantities of this syrup are at this time made in Germany from potato-starch. The chief use of it when made is, I believe, to fabricate the pernicious stuff sold as Hambro' sherry.

The French public at length grew tired of looking for the crystallised sugar promised them by Parmentier; and when intelligence came to hand that beetroot-sugar factories were springing up in various parts of Germany, messieurs the philosophers began to put to themselves the question whether the scientific commission of inquiry might not have made some trifling mistake. In 1810 another Frenchman, Monsieur Deyeux, resumed the inquiry. He communicated a memoir to the Academy of Sciences recording the results of some newly-made experiments. He maintained that not only could the manufacture be economically conducted, but that the beetroot was the most natural and advantageous source for the yielding of sugar identical with that of the cane.

Having resolved that the attention of the French government should be drawn to the matter, he presented two loaves of beetroot-extracted sugar to the then Emperor Napoleon, who at once took the matter in hand, hurrying it to demonstration as he hurried battalions to the charge. On the 25th of March 1811 came forth a decree that 32,000 hectares of land should be put at once under beetroot cultivation; a considerable sum of money being placed at the disposal of the Minister of Agriculture for that purpose. On the 15th of January 1812 another decree was issued, establishing five schools of chemistry to develop the best means of extraction. In the harvest-time, as we may call it, of that same year, four imperial factories were completed, ready for the extraction of 2,000,000 of kilogrammes of sugar.

Private enterprise was not slow to follow in the wake of imperial example. All over France an indiscriminating superabundance of beetroot-sugar factories sprang up,—indiscriminating in the particular that neither fitness of soil nor specialty of climate was heeded. The result was partial failure; nevertheless, a branch of industry had been originated which was destined ultimately to expand.

Political circumstances were unfavourable. Our historical record has brought us down to the year 1814, to the shattering of imperial rule, to the political revulsion of Germany. 'I had no sooner put my fields under beetroot cultivation,' wrote Monsieur Dombasle, 'as one of the pioneers of this new enterprise, than our army entered Moscow; and soon after, when affairs turned, I found a detachment of Cossacks quartered in one of my sugar-factories.' The same vicissitudes were suffered by another pioneer in this great cause, Monsieur Crespel-Delisse, one whose name is inseparably associated with this branch of industry. Up to this time the notion that some essential distinction existed between sugar of the beet and sugar of the cane was not altogether abandoned. The fact was, that chemistry had not sufficiently advanced to separate the last trace of beetroot impurity, and thus bring the liberated sugar up to the condition of first-rate quality.

Notwithstanding the manufacture of two loaves for presentation to the Emperor, the quality of these loaves was not very good. The usual result which manufacturers had aimed at hitherto was the production of raw or yellow sugar. Now it happens that, whereas raw or yellow sugar produced from the cane is *not* disagreeable to the palate—is more agreeable even than white sugar to *some* palates—yellow beetroot-extracted sugar is disagreeable to the taste, not to say offensive. It follows, from the very nature of the case, that the sugar of beetroot must be absolutely freed from all colouring matter before it can compete on equal terms with sugar from the cane. Now, and for a long time past, that complete purification has been accomplished: which accounts for the fact that a traveller may go through the whole of Belgium and France without once meeting with a sample of yellow sugar.

It was about 1812 that Monsieur Benjamin Delessert commenced a series of experiments, having for their object the production of beet sugar in a state of absolute purity, in his factory at Passy. On the very day that success had crowned his efforts, Chaptal the chemist made it known to the Emperor, who without delay made a personal visit to the Passy refinery to assure himself of the fact.

On the day following, an official announcement appeared in the *Moniteur*, the purport of which was to state that a great revolution in French commerce had been effected. How great the revolution was, may be inferred from an announcement in the *Moniteur*, that the French beet-sugar produce of the season 1865-6 amounted to no less than 274,000,000 of kilogrammes, a quantity more than enough to emancipate France from dependence on the colonies in the matter of sugar produce.

It will be seen from the purport of what has been stated, that in this interesting manufacture the promises of scientific men have been fully borne out. France, in possessing the beetroot, has become the rival of the most flourishing sugar colonies. Some idea of the present prosperity of French beet-root-sugar manufacture may be acquired from consideration of the fact that between 1855 and 1867 the production in that country had more than doubled.

In 1856 France numbered 265 factories, the aggregate produce of which was 92,000,000 kilogrammes. In 1866-7 there were 440 factories, turning out 216,854,677 kilogrammes. Neither must the circumstance be forgotten that the quantity last stated was considerably below the aggregate yield of the season preceding—a season celebrated not only for the abundant growth of the beet, but, what is quite another matter, for its saccharine richness. Viewing the ratio of past increase by the light of present circumstances, it is the opinion of many French commercial statisticians that by the year 1877 the production of beetroot sugar in France will have doubled the amount recorded for 1867.

Prominence has already been given to the fact that, in the early days of this manufacture, beetroot was grown in many parts of France where the soil and climate were unadapted to its cultivation. The error having been discovered by experience, a tendency to centralisation was soon manifested; so that, whilst the aggregate yield of sugar increased, the number of sugar-yielding French departments diminished. In the year 1836 the manufacture was prosecuted in 37 departments. The aggregate number of factories was then 436, but the aggregate sugar-yield did not exceed 40,000,000 kilogrammes. In 1865-6, there being only an increase of five factories, the sugar-yield had risen to 274,000,000.

In tracing the progressive development of a manufacture so chemically interesting as that of beetroot sugar, a chemist naturally restricts himself as much as possible to chemical points of view. He regards with impatience, almost amounting to disgust, every form of artificial restriction, whether excise, customs, differential duties, or otherwise, which Chancellors of the Exchequer or their foreign equivalents have been induced or have felt themselves constrained to impose, either for purposes of revenue or to maintain what may be called an artificial balance of commercial power between co-existing vested and rival interests.

This is a matter that will have to be deeply considered by tentative English capitalists, who, jealous of the inundation of French- and Belgian-made beet sugar, are now taking measures to establish that branch of manufacture here. In the present state of English public feeling there may be no considerable ground for apprehension lest a differential charge favouring colonial produce should swamp British beet sugar; but it must not be forgotten, that the distillation of spirit from beet-refuse is an important item of profit wherever beetroot extraction is profitably carried on.

Our fiscal restrictions in respect of alcoholic distillation are beyond anything known on the Continent. British capitalists would, then, do well to look upon their new enterprise from a point of view not too exclusively saccharine, otherwise they may reckon without their host, and come to grief in the reckoning.

Resuming the sketch of beetroot-sugar development in France, I have now to state that in 1837 our neighbours burdened the home manufacture with what they called the *loi d'impôt*—it is what we should call an excise or inland-revenue levy—of 15 francs on every 100 kilogrammes. Omitting consideration of the policy which dictated this charge, regarding it solely as an index of prosperity to which the home manufacture had arrived, the circumstance of the levy is expressive, showing as it does how considerable the home yield must have been to stimulate legislation in favour of the colonies. The immediate effect of this legislation was to suppress 66 factories, and to banish the growth of beet from 66 departments. The manufacture only continued to exist in the north of France, where the climate is best adapted to the growth of beet, the soil is favourable, and there is an abundance of labour and coal at a cheap rate. To this region it was long restricted. The rapid establishment of railroads and canals which followed lowered the cost of transport, and in some measure altered this state of things. Still, however, the north of France is, and, through its specialties of soil and climate, must remain, the principal seat of French beet-sugar produce.

We come now to consider the agricultural statistics of beetroot cultivation in France. In 1857 only 52,000 hectares were devoted to this crop. Ten years later there were no fewer than 110, this being about the two-thousandth part of the entire French territory, of which the arable land may be considered as amounting to 26,000,000 hectares.

From this statement it will be seen that twice or thrice the breadth of land now under beetroot cultivation might be devoted to that crop without interfering with national sustenance from agricultural produce. This is on the supposition that the growth of beet for any particular region must necessarily displace a proportionate amount of corn; a supposition not borne out by experience. In proof of this take the following example.

In 1854 the number of hectares under wheat-culture in the arrondissement of Valenciennes was 14,804, but in 1867 there were no fewer than 16,000; nevertheless the land cropped with beet for the corresponding years was 6,963 hectares against 9,035. The crops which have ceded to beet in the district of Valenciennes are barley and colza. The meadow-land taken under culture is considerable. Woods have been reclaimed, and the system of fallow has in the north of France been wholly abandoned. In respect to wheat, it has been found that a beet-crop conduces to a subsequent heavy wheat-crop, of which the agricultural records of Valenciennes again give proof in the following returns. In 1861 this arrondissement yielded 23 hectolitres of wheat per hectare, which was considerably above the rate for other parts of France; but in 1866 the yield was 27 hectolitres. The number of sheep and oxen has also increased for the same arrondissement.

Thus would it seem that tracts which yield the most beet yield also the most wheat, oxen, and sheep—are those, in short, which contribute most largely to public alimentation. In the arrondissements of Lille and Valenciennes the agriculture of beetroot has attained a high state of perfection, yielding sometimes from 70,000 to 80,000 kilogrammes per hectare. In the other parts of France the yield is by no means so great, the general average being probably from 35,000 to 40,000 kilogrammes.

The saccharine contents of good beet may be taken at from 5 to 6 per cent, and 2,000 kilogrammes of sugar per hectare may be set down as a fair average. Beet-refuse, or the dry mass from which the juice has been extracted, is a material of great value for cattle-feeding. 300 kilogrammes of refuse, after being subjected to a preliminary fermentation, may be considered equivalent in nutritive value to 100 kilogrammes of dry hay.

A draught-ox can be kept in perfect condition by a ration of 40 grammes of pulp in addition to 2 or 3 kilogrammes of hay; and on the calculation that beet-refuse amounts to one-fifth of the original root, it follows that with an aggregate mass of 900,000,000 kilogrammes a herd of 55,000 oxen, or a flock of 550,000 sheep, yielding 600,000 kilogrammes of flesh, could be kept in condition for the space of one year. In this calculation it must not be forgotten that the herd of oxen would furnish manure enough for the service of about 12,000 hectares of land.

Beetroot is a crop eminently conducive to the fertility of a soil, and this for many reasons. In the first place, its cultivation is necessarily accompanied by the presence of a considerable live-stock. Next, the green leaves cut away on the spot and left on the soil are of themselves a valuable top-dressing. They are rich in potash salts, and their manure value is seen in the vigorous crops of wheat grown on those lands. The beets when drawn are accompanied with 5 or 6 per cent of earth; which being removed at the factory, together with small roots, mixed with scum, &c., and returned to the land, have a farther fertilising influence. Neither as a valuable constituent of manure must spent bone-black be forgotten. Animal charcoal, as it is generally called, but more properly bone-black (seeing that about 20 per cent of the material is *not* animal charcoal), is an important aid to the beet-sugar manufacture. From time to time this bone-black is revivified and brought to a proper condition for manufacturing use; but this cannot be done indefinitely, and so a considerable quantity of this material finds its way into the mass of general manufacturing refuse, and eventually as manure to the land.

Reference has already been made to the importance of alcohol as a collateral result of beetroot manufacture, and to the high importance of giving heed to this part of the case previous to any large expenditure of captal on beetroot cultivation for sugar-extraction in this country. The source of alcohol from beet in the sugar-factory is twofold; a portion being obtained from the fermented refuse, while another portion results from the fermentation of beet molasses, or treacle. Some idea of the importance of alcohol as a beetroot collateral product may be gleaned from the following comparative statement of total French alcoholic produce for the year 1865-6:

	hectolitres.
Alcohol from wines	1,010,166
" " beetroot	283,022
" " molasses	307,409
" " other sources . .	178,877
	1,779,474

Any statement of economic particulars relative to beet-sugar manufacture would be incomplete that failed to include the alkaline salts isolated and made available for use when the fermented molasses from which alcohol has been distilled are burned and lixiviated. Beetroot molasses may be taken as furnishing about one-fourth its own weight of pure alcohol, and of the residue some 10 or 12 per cent are made up of the salts adverted to. Evidently this saline mass has been extracted from the ground, and can be returned to the ground if such disposal be deemed most economical.

To these remarks may be appended some notice of the employment given by the manufacture. Twelve years ago it was calculated that in the beetroot factories—not fields—40,000 men, women, and children found occupation. This number has not since increased proportionately to the increase of result, owing to the more perfect adaptation of machinery. The conclusion may, however, be accepted, that each existing factory gives occupation to a number of workpeople—between 180 and 200—of which three-fifths are men, one-fifth women, and the remaining fifth children. The aggregate pay of this staff may be taken at 24,000,000 francs. As regards beetroot culture, the annual wages expenditure for the whole of France may be set down as from 10,000,000 to 11,000,000 francs.

From the outline of particulars already given, it will be seen that the art of sugar-extraction from beetroot has attained a high grade of perfection; indeed, I know of no manufacture in which the refined indications of science have been in practice so nearly brought up to the mark of laboratory absolutism. Still something remains to be accomplished: mostly in respect to obtaining the amount of crystallisable sugar that is known to be in the molasses, but which cannot practically be extracted. It is to be remarked, that beet molasses is so offensive, that it cannot be used as food or condiment like cane molasses. Disposed of some other way it *must* be, otherwise the margin of necessary profit on the general manufacture fails.

Fermentation and distillation come as a ready resource, and must in any case be adopted; still the manufacturer never willingly resigns any portion of crystallisable sugar to alcoholic fermentation. One chief cause that operates against the extraction of crystalline sugar from molasses is the presence of various alkaline salts; and some ingenious experiments have recently been made, with the intent of determining whether separation cannot be effected by an application of the laws of dialysis as recently developed by our own countryman, Mr. Graham. To this ingenious process I can only now advert.

An important consideration is the following: the largest beetroots grow in rainy seasons, and contain the *least* sugar; in very rainy seasons, almost none. Are these islands celebrated for rain, or are they not? Think of this, messieurs the Mincing-lane capitalists, and don't forget to talk over the matter of alcoholic excise with the Right Honourable the Chancellor of the British Exchequer, before committing yourselves too deeply.

Though it is not intended to go fully into the manufacturing details of beetroot-sugar extraction, yet it seems desirable to present an outline. In drawing the roots care is taken not to wound them, as doing so would induce rapid decomposition. They next have to be freed from adherent dirt, which is effected by placing the roots in a cage, rotated under water. After this operation they can be stored away for a time without damage, though it is nevertheless a precept in this manufacture to get through successive operations with the practical minimum of delay. Mashing is the next operation, and is accomplished in a manner so similar to the mashing of apples for cider-making, that farther description is needless.

Being mashed, the pulp must be pressed, and pressed without delay, otherwise fermentation sets in and the sugar is destroyed. Pressure is variously applied, hydrostatic pressure being most important and most general. To this end the pulp is enclosed in bags, and the latter subjected to pressure; at least this is the process commonly adopted. In 1867, however, being commissioned by a city firm to visit a beetroot-sugar factory in Cambrai, wherein, as had been represented, some new and elaborate appliances of pressure and chemical treatment were adopted, I was gratified beyond expectation. I saw a wholly novel mode of applying hydrostatic pressure, to describe which would necessitate mechanical details foreign to the scope and intent of this notice. If by chance, however, some exceptionally practical reader should desire to be made acquainted with mechanical particulars, he may do so by reference to two special journals, in each of which at the time I wrote an article; they are the *Engineer* and the *Grocer*.

We have now arrived at the beetroot juice itself—colourless and liquid enough to view, but offensive to smell, and loaded with an amount of nitrogenous and other foreign matters, the bulk of which must be seen to be appreciated. By one means or another these impurities must be separated, the greater part of them at least; otherwise no evaporation would crystallise the sugar out. This separation is now invariably effected by heating with quick-lime, which has the double effect of neutralising acidity, and so far decomposing the nitrogenous impurities that a large bulk of them separates as scum, separable by skimming and filtration. As regards the mode of filtration adopted, it is twofold—partly through cotton bags of peculiar make and texture, partly through bone-black which has been exhausted as to its bleaching or chemical effects, but which can still act mechanically as a very efficient filter to effect separation of albuminous flocculi which may have come through the weft and woof of a cotton bag. The fact may here be indicated, that although beetroot juice is nearly colourless when first extracted, the process of heating with lime imparts colour, which deepens with every subsequent evaporative stage.

The use of lime as a defecator in the way described is almost a necessity, but is attended with the grave disadvantage of a certain amount of sugar being destroyed as well as impurity separated. This being so, it will be obvious that every trace of lime, over and above the quantity that has expended its chemical virulence in effecting albuminous separation, should be either separated or neutralised. In the Cambrai manufactory I saw this accomplished by the very elegant and, chemically speaking, unobjectionable experiment of forcing carbonic-acid gas through the lime-charged solution. The result is chalk, a perfectly harmless substance.

The evaporative devices used in these factories are various. They mostly culminate in the vacuum-pan; but evaporation in its earlier stages, up to the density best adapted to promote the bleaching action of bone-black, admits of much variety. To describe them comprehensively would need a treatise.

MODERN MYSTICISM AND MODERN SCIENCE.

In after times, when the characteristics of this century shall have been reflected upon and chronicled, the mystic tendencies of it will assuredly not be forgotten. Not that proneness to mysticism is any novelty, seeing that under one form or another it has ever existed; but the curiosity in regard to modern mysticism is, that it has co-existed with the march of scientific discovery. Modern mystics even arrogate to themselves the character of scientific men, claiming for their revelations the dignity of science.

It is important for this pretence to be considered; that the truth or falsehood of it should be made apparent. Science, in its largest sense, is, after all, no more than experience acquired by such means of investigation as may be deemed most void of fallacy. Mankind are not born into the world, like beavers, impressed with the mere instinct of race, capable of deriving no truth from the teachings of their ancestors. To humanity a nobler privilege is given.

We begin life, as to knowledge, at the point where our ancestors left off; advancing thence to other goals for the benefit of those to follow us. It is of importance that the truths be winnowed from the fallacies of each successive age; otherwise seekers after truth in coming times will not know where to begin or what to believe.

The leading truths of science may be remembered, learned by rote, and applied to common purposes, without bespeaking, on the part of such as remember and apply them, the requisitions necessary to constitute a scientific frame of mind. The knowledge that gravitation is a universal force, keeping the planets in their spheres, drawing terrestrial bodies towards the centre of our planet—these are elementary facts. Not to know them familiarly would imply unusual ignorance to scientific knowledge.

Investigation of the laws of nature, to which these conditions are due, is another matter quite. Few are they who would care to try, and not all of those who trying could succeed: yet of this sort alone is the mental discipline which rises to the dignity of science.

It has been well observed by Liebig, that the quality most essential to scientific inquiry is perfect honesty of mind and judgment. The imputation of dishonesty is so abhorrent to one's apprehension, that few would like to admit the possibility of it as regards themselves: nevertheless—understanding the term as Liebig understood it—each and every one of us may accept the imputation without laying any moral delinquency to his charge; the fact being, that no absolutely honest judgment ever yet influenced any human being, or perhaps ever will.

The true philosopher knows this to be so, and strives to oppose the influence. It is difficult, if not impossible, to enter upon any branch of investigation concerning which the investigator has either not formed some preconceived opinion, or concerning which premature and unreliable views have not arisen during the course of experiment.

The true philosopher is so conscious of this tendency, that he is ever on the watch to reveal the dishonesty of his own judgment. If some inquirer more fortunate than himself should devise some new and unexceptionable form of experiment, through the revelations of which some original hypothesis is made invalid, then by so much the more is the true philosopher gratified. Whilst the pretender to science resents every imputation on his judgment, every criticism on the merits of evidence—whilst he is prone to regard all laudable hesitation as a sort of imputation on personal honour—the true philosopher gratefully accepts the doubt. He tries to convict his own judgment of that sort of dishonesty to which the great chemist adverts.

Should these remarks meet the eye of any beginner in the practice of scientific inquiry, one so over-arrogant in his or *her* conceit as to believe in the possession of that absolute honesty of judgment which Liebig deems impossible, the following anecdote may not come amiss. It is a medical anecdote; and being such, it will not only serve to illustrate the general proposition, that a certain amount of latent dishonesty can lurk in well-regulated minds, but to introduce a few remarks touching that somewhat prevalent form of modern mysticism—*homœopathy*. All educated persons, and a good many of the uneducated, are aware of the quality of Peruvian bark by virtue of which it cures ague or intermittent fever. Furthermore, it is pretty generally known, that the remedial agency of Peruvian bark is attributable to the alkali *quina*. The latter substance is now, indeed, so usually employed, that the administration of Peruvian bark in bulk is rarely had recourse to.

Mark, now, the following episode in the history of vegetable chemistry. It so happens, that if tincture of gall-nuts be poured into decoction of Peruvian bark, a peculiar sediment deposits; and farther, that if decoction of oak bark be poured into a solution of isinglass or gelatine, a deposit occurs similar to the former in all external characteristics. Hence, from the teaching of this evidence, the inference was prematurely drawn, that Peruvian bark contained the matter of isinglass or gelatine; farther, that gelatine might be the constituent of Peruvian bark to which the antifebrifuge agency should be attributable.

This hypothesis, if borne out, could not fail to have a very great medical importance. Peruvian bark is costly; the supply of it irregular and uncertain. Gelatine is a home product, of which every nation possesses enormous stores. Why should we explore, under difficulties, the dense forests of Peruvian cordilleras for an antifebrifuge, so long as old bones at home might be made to furnish us with unlimited quantities? Why indeed, if farther testimony should prove chemical science not to have been false in its teachings?

The question remained to be determined whether gelatine as isinglass, or under any other form, *would* cure intermittent fever. The experiment was tried of course. For a considerable period, Parisian doctors waxed eloquent about the cures effected on ague patients who had been dosed with gelatine. Alas for the *dénouement.* Pelletier and Caventou, in the year 1820, proved by more delicate experiments that not an atom of gelatine existed in Peruvian bark; proved, moreover, that the substance formerly mistaken for gelatine was neither more nor less than quina.

Of course it followed that all the philosophers who had helped to promulgate the announcement that gelatine existed in Peruvian bark, and to demonstrate that gelatine would cure ague, had to revoke. They had committed an error; misled by that self-dishonesty adverted to by Liebig.

Of all scientific experience, perhaps none is more difficult to sift from error than medical experience. Many circumstances conduce to this difficulty. First, the subject of experiment—the human machine—is subject to endless variations. Constitutions are no more alike than complexions or mental characteristics. The physician is never sure that he operates consecutively on two constitutions in every respect identical. Second, the physician is placed at the double disadvantage of not merely having to guard against the dishonesty natural to his own judgment, but the farther dishonesty natural to his patient's.

Dishonesty is an ungraceful word; but after the limitations imposed, nobody need contemplate it with any great antipathy. Such of us as have been blessed by the chastening hand of illness (and all who have not lack much of the teaching most proper to make us know ourselves, our friends, and the frailty of the tenure on which we hold our strength) need only reflect, to be convinced, that it is almost impossible for a patient to proclaim his case impartially to a physician. Hope and despondency—rival influences—dispute for the mastery. The patient either proclaims himself better than the fact, or worse; ever mystifying his ailments. The balance of judgment is subverted; chimeras abound. Likings and dislikings, without reason, proclaim intellectual weakness. In proportion as reason wanes, senses are distorted, and sentiments are exalted. Light is unbearable; sound so agonising that the veriest breathings cause anguish. Odours not perceptible in health now become intolerable. Meanwhile Death steps trippingly by; marking with the *facies Hippocratica* the growths he is soon to fell: as the woodman marks his trees.

And after that a change! The senses, so acute awhile ago, fail one by one; taste and smell the first. To one upon whose features Death has impressed his signet-seal, as revealed by the Hippocratic face, things mostly taste alike, and odours are well-nigh odourless. As sounds of music on the strand fall weaker and weaker upon the ship's crew departing, so weaker and more weak fall mortal voices upon the death-stricken ear. Touch, the only sense not ministered to exclusively by some special organ, fails gradually onwards from the extremities to the chest; an icy coldness, unknown to the dying, marking its departure. Then comes that craving for more light, so sure a sign of speedy dissolution. Next the gurgling and choking spasm—and then the mystery.

It would be hard indeed that a patient should drive from his sick couch the antagonist influences, hope and despair, both of them tending to make his natural dishonesty of judgment still more dishonest. Small marvel that patients have committed so many errors, not being aware of them: for example, the following. No man of very highest special acquirement in any of the sciences appertaining to physic ever yet became a successful physician. The reason it boots not here to inquire; the fact is conceded. No wonder, then, that Sir Humphrey Davy is said to have had so little confidence in the safety of a supposed remedy sent by him, when a boy, to a patient, that he sent a messenger in hot haste after the physic, requesting that it might be tried on a dog. To make a successful physician out of a boy who had so little confidence in the safety of a remedy as this anecdote implies, would be most improbable. Nevertheless Davy, at a subsequent epoch of his life, wrought an extraordinary cure; one vaunted by him thereafter. Had he been of royal blood, more could not have been accomplished. He actually cured by the touch!

The circumstances were as follows: Dr. Beddoes had opened an establishment at Bristol for curing diseases by inhalation of various gases. Davy, then a very young man, was his assistant, and one not putting faith in the resources of physic over much. Prior to the administration of nitrous oxide, or laughing gas, to a certain individual affected with pulmonary disease, Davy had to note the temperature of his patient's tongue; this of course involving the need of touching that organ with the bulb of a thermometer. The patient, not learned in these matters, confounded the preliminary with the essential. No sooner did he feel the thermometer bulb in contact with his tongue, than he proclaimed himself better. Davy, appreciating the full force of the joke, day after day repeated the process, until, strange to tell, a perfect cure was wrought. Of this result Dr. Beddoes was proud. He published the case, amongst others, to demonstrate the remedial powers of gas-inhalation.

Nothing can well be more pregnant with fallacy than an opinion concerning the remedial powers of any agent, or any system, arrived at by the patient himself. The conditions necessary to the collation of evidence are not present; hence cannot be forthcoming. Nevertheless, partly on the faith of evidence of this sort, and partly on the faith of anterior conviction in the minds of others, people in all ages and in all countries have adopted the wildest medical mysticisms, dignifying these with the names of 'systems' and 'sciences,' designations to which they can lay no claim.

Next to the fear of being deceived by the latent dishonesty of judgment—from which not even the strongest, the best-regulated, and most highly-cultured minds are exempt—there is no source of error more necessary to be guarded against than the paralysing influence of great names. It has been stated in respect to authors, that so soon as a writer has made for himself a name, it matters little what he may write; the public will feign merit, even if there be none. Most apophthegms are exaggerations. The above is confessedly exaggerated; but it fairly represents a human tendency. It has ever prevailed, and the prevalence of it is nowhere more remarkable or more embarrassing than in the paths of science.

History teems with the records of truths postponed, and errors disseminated, because of this tendency of the human mind to raise up idols to be worshipped. The Aristotelean philosophy maintained an undisputed sway over the minds of men for more than 1800 years; and in medicine the writings of Hippocrates and Galen, up to the time of the madman Paracelsus, exercised an authority only second to that of Holy Writ. The world defends its idols as a South-Sea islander defends his wooden deities—to the utmost. The Brahmin who dashed to pieces the microscope that showed him the myriads of animals he consumed in his vegetable food, could not be more irate than one who, having set up an idol of belief, witnesses its sudden dethronement by evidence adduced. Lest so great a calamity should befall one of its idols, society will resolutely give evidence the cut-direct, as though truth were an evil. To illustrate this position by the much-worn history of Galileo would be trite. Rather let us come nearer home, and treat of matters that have a present import.

Nearly one thousand coal-miners are lost to the country year by year; killed by explosions of fire-damp. But Davy invented a safety-lamp: the instrument won him much of his fame. Mining statistics record the fact that fire-damp explosions have been far more fatal since the use of Davy's lamp than previously. This is a significant revelation. That it has not been practically recognised seems referable to the paralysing influence of Davy's great name. As is common, the public attribute to the Davy lamp a greater power of safety than Davy himself attributed. It is commonly assumed that a Davy lamp, in good order and untampered with, cannot explode such gaseous mixtures as occur in coal-mines. Davy himself knew better. He knew of at least one condition under which the safety-lamp, on his construction, was no longer safe; namely, the condition of currents. Nay, he positively, in his book on flame, enjoins the miner, armed with his lamp, and coming near one of those emanations of inflammable gas termed 'blowers,' to ward-off the current by sheltering the lamp under a hat. The truth of the case is, that, even under the best of circumstances, Davy's lamp is only safe when in a perfectly tranquil atmosphere. Given a current of sufficient velocity, it may be caused to explode at once. Explosion may also be determined by the deposition of coal-dust on the wire-gauze jacket; and under various other contingencies, too numerous here for indication.

It is a characteristic of the true scientific mind, never to yield allegiance thus blindly to the authority of a name. Here, again, care is required, lest needless objections be raised, merely to demonstrate the possibility of raising them. Experiment is always better than testimony: but in this, again, honesty of judgment is needed, to satisfy—each questioner for himself—the query: 'To what extent am I qualified as an experimenter?'

Scientific testimony, if worthy the name, is ever based on experiment; the conditions, limitations, and successive steps of which are fully set forth. All science is based upon the belief — justified by experience — that Nature's laws are immutable. If two and two should be capable of making four to-day and five to-morrow; if sulphuretted hydrogen should be proved capable of blackening lead to-day and whitening it to-morrow: if — not to multiply illustrations — Nature were found to be mutable in her operations, there would be an end to science; there could be no unerring and invariable truth.

It follows, from a consideration of this immutability of Nature's laws, that, the steps of a scientific investigation being recorded, it is competent for other experimenters to retrace them, and check their issues. If the precise condition be not given — if the steps be *not* recorded — then, depend upon it, some pretender to science is in the field, and not the true philosopher. By this test shall this form of dishonesty be known.

Applying the test to Homœopathy, what does it reveal? Firstly, studying the records of this faith, we learn that Hahnemann, the originator, elected to take his stand, not as a prophet professing a new religion, but as a philosopher whose teachings should be based upon the result of inductive experiment. He professed to have based the 'system,' so called, of homœopathy upon facts elicited during the course of long-continued experiments; and he seemingly was most precise in recording all the symptoms educed by the administration of different agents.

But mark this — Hahnemann rarely affords information concerning the dose he administered. His readers are left in the most complete ignorance on that point: wherefore the conditions are not put in evidence for enabling subsequent experimenters to test the accuracy of his conclusions.

In sober truth, none of the effects chronicled by Hahnemann ever have been educed by subsequent experimenters; but then the rejoinder lies: 'You may not have administered the physic in proper doses.' Consideration of this fact is quite enough to show that homœopathy fails in the first requisition necessary to constitute a science. It imposes difficulties; whereas, in its affected character of a science, it should have removed them. Homœopathy has acquired much of its hold upon the minds of certain people in consequence of the unreasoned ridicule that has been directed against it. Laughter is the usual resource when pure unreason is paraded. Thoughtful people, competent to analyse the postulates on which homœopathy is based, and the recorded experiments to which its supporters point, can see in it naught but unreason. Still, ridicule without argument is a sort of persecution; and persecution never yet was attended with any other result than promulgating what it had been intended to suppress. The persecution of ridicule has certainly done much to foster the belief in homœopathy; and—interests of truth regarded—it is perhaps unfortunate that the recorded experiments of Hahnemann, if quoted literally, are so exceedingly ridiculous, that even the most literal transcript of them is prone to raise the suspicion of travesty or exaggeration.

Not heeding the distinction between subsequence and consequence, Hahnemann records every manifestation subsequent to the administration of a medicament as a symptom. He is led to testify (and the testimony could not well be more provocative of laughter), without argument, that charcoal ingested produces loss of cuticle *after riding*. That cayenne pepper causes itching at the roots of the hair *after scratching*. Why in these cases the riding and the scratching are to be held as *non ad rem* Hahnemann has not thought well to explain; and the rules of ordinary ratiocination fail to inform us.

This insufficiency in setting forth the conditions of experiment is ample enough to deprive homœopathy of the character of science to which it aspires. It is a shortcoming not to be palliated, much less explained away. Thus, based as it is upon dishonesty, the philosopher, the believer in the immutability of Nature's laws, the experimenter, is forthwith prepared to find, that the more he examines into the propositions of this so-called system, the more untenable will the so-called system be. Its propositions are found not only unsupported by experiment, but adverse *to* experiment. Testing the pretensions of this form of medical belief inductively, the experimenter soon arrives at the issue, that if homœopathy be true, the whole of chemical science must be false. At this point, if the judgment be honest to its keeper, the believer, in spite of himself, will be driven to confess that he accepts homœopathy as a religion—a faith—not as a demonstrative science.

It is because beliefs are not thus roughly followed up to their issues, that the revelations, real or assumed, of table-turning and spirit-rapping hold a position so unsatisfactory as to evidence. Is it pretended that these phenomena are only some new revelation of the laws of Nature, or that they are wholly supernatural—lawless? Is it pretended that they are a science, or that they are a mysticism? A compound of both they *cannot* be: the choice has to be made.

If a science, they must have their immutable laws; there must be no caprice as to their manifestations. Let us have no shrinking from inquiry. Men of science, on their part, have assuredly good right to press for this candid election. It is their privilege to foster, knowingly, no delusion. They profess to open the book of Nature, and reveal her truths. They desire to be assured that, under shelter of the confidence begotten by a name, quacks and cheats do not assume the attributes of scientific men—do not promulgate deception under the name of science.

Perhaps it is an unconscious tribute to the scientific character of our age, that the designations 'scientific man' and 'science' are so lightly assumed on behalf of people who have no claim to them. Surprisingly little need be done to acquire this title, under certain conditions of favour and position. The boldest use, or misuse (no matter which), of scientific terms often suffices. That admirable work of fiction, the *Last of the Barons*, contains—as few who read this need be reminded—some allusion to a primitive steam-engine. The illustrious author, in delineating the character of Adam Warner, endeavours to accomplish the difficult task—(one, by the way, in which no author has yet thoroughly succeeded)—of illustrating the mental abstractedness of one deeply merged in the boundless ocean of physical discovery.

With true artist's perception, Bulwer felt the need of dealing less vaguely with this case than is the common habit, the common need of authors. He desires to create, as best he may, a primitive steam-engine. He knows that the function of latent heat *in some way* has reference to steam; so incorporates the words *latent heat* with the weft and woof of Adam Warner's discourse.

Pausing now to analyse the effect which this delineation conveys, the result will be curious and instructive. To the uninformed in the matter of steam-engines and physical science, the cleverness of intent will alone be apparent: the whole will pass as a good scene of word-painting. To the student of physical science, the entire misapprehension of the very nature and meaning of latent heat appears as a blot on the fiction. To his apprehension, the harmony of constructiveness is violated.

His shock is comparable to what would be generally felt, had the author, in some delineation of scenery, represented oak trees as producing apples, or cucumber plants blooming with roses; or had he depicted the Horatian monster—

> 'Humano capiti cervicem pictor equinam
> Jungere si velit, et varias inducere plumas,
> Undique collatis membris ut turpiter atrum
> Desinat in piscem mulier formosa superne,
> Spectatum admissi risum teneatis amici?'

The following question may be propounded: Has Science not her own mysteries? Are there not, in every branch of science, hundreds of revelations, the explanation of which has not yet been vouchsafed? Assuredly; Science teems with mysteries, but is devoid of mysticisms. None know so well as men of science how slow the march of induction; how limited the grasp of human reason. But the mysteries of science are of this sort: often *beyond* reason, but never *opposed* to reason. They are, moreover, fixed, unerring, and invariable. In their mystery they ever proclaim the cheering truth, that the God of creation is not a capricious God; that his physical laws are unalterable.

The broad distinction between Science and Mysticism, which I have thus been endeavouring to convey, was insisted on by Faraday some years ago, when he demonstrated, by the issue of experiment (the issue agreed upon), that the turning of tables was ever an effect of force unconsciously applied.

If phenomena be reducible to a law, their investigation constitutes a science: if *not* reducible to law, they must belong to the supernatural. Believers must choose their ground of belief; and it cannot be a mixed ground. If an individual should choose to say, 'I have been made conscious of supernatural manifestations by the evidence of my own senses—it is impossible that my senses would have deceived me;' or if he should say, 'Though not having myself experienced these revelations, I implicitly trust in the testimony of others,'—then argument is thrown away, and experiment useless.

Let us not quarrel with any faith; rather look tenderly upon it, considering faith to be an index of the humility of a mind (whatever its errors) not over-proud in its own conceit. The adoption of a faith, *as a faith*, is tantamount to the adoption of a new religion; and heaven forbid that, however false, a faith should be persecuted.

What scientific men object to, and with reason, is the debatable ground on which such faith as that accorded to homœopathy and spiritualism is held. Accepted each, partly as a science, partly as faith beyond science, there is no satisfactory way of committing them to the keeping of history. If spiritualists, if homœopathists, will boldly choose the scientific arena, electing to stand or fall by the issue of experiment, prosecuted according to a scheme agreed upon as best calculated to elicit truth, well and good. Physicists would soon grapple with the issue, and truth or error, as the case might be, would soon become apparent. Or if (repudiating this), they would say, 'Leave us alone; we deal with mysteries; we are as priests dispensing a religion, we brook no reasoning;' then, again, the position taken would be clear before the world. The evil comes of a double stand-point, half mysticism, half science.

By those who are willing to investigate modern mysticism as a science, refusing to bow down to it reverently as to a religious belief, the circumstance can hardly fail to have been remarked, that, subsequently to the experiment performed by Faraday to demonstrate the fallacy of table-turning, that sort of spiritual manifestation has here, in England, at least, fallen very much into decadence. Occasionally do we hear of a table turning, ostensibly without the aid of mechanical force, but rarely. Summoned spirits would seem to avoid a manifestation that has been polluted by the touch of the hands of a philosopher. The spirits now prefer to rap, but the rappings may be fully accomplished without supernatural agencies. Some operators can produce these rapping sounds by one or more of their joints at pleasure. Perhaps the knee-joint affords the greatest facilities. The knee-cap, or patella, is lubricated underneath by a fluid termed by the anatomist *synovia*. Some operators have the faculty, by assuming a certain position, of preventing the flow of *synovia* upon the surface lying between the patella, or knee-pan, and the bones constituting the knee. The flow prevented and the knee moved, a sharp crack results, which may be repeated by an operator at pleasure. Equally facile of solution is the occurrence of raps against the table—an agile foot will accomplish all.

One great feat of summoned spirits, according to the spiritualists — or rather, perhaps, I should say, of the spirit-mediums—is the manifestation of a luminous hand; another, the inscription of the name 'John' in red letters upon the human arm. If Mr. Foster's 'sperrits,' in the fulness of their knowledge, should look upon these demonstrations as sufficient for their needs—sufficient, that is to say, for mystifying the general public — then can I only regret the shallowness of public intelligence. The apparition of a luminous hand could be represented optically in a darkened room—the condition required by mediums; and as for the red-letter writing on the arm, I could accomplish that trick, in better caligraphy than Mr. Foster's 'sperrit' clerk, with a little cantharidine, regulated as to its action by a perforated oil-skin stencil-plate.

Amidst the cloudy doubts wherewith the popular mind is oppressed in regard to modern spiritualism, some general reflections may be pondered on with chance of consolation. If the proverb, 'By their fruits shall ye know them,' be not grown obsolete by time, how low and mean will the votaries of modern mysticism appear by comparison with modern men of science!

Granted the reality of what the mystics proclaim, how low and grovelling, how mean, the intelligence of spirits thus commanded! How incomplete the education of a ghost that writes spirit 'sperrit,' and cannot read 'Goethe' if written in German!

Are *such* the destinies of the never-dying soul? Is *this* the highest intelligence to which the portals of death give entrance? Why, at the very best, the ghosts by modern mystics summoned are lower in the scale of intelligence than the goblins of a German fairy-tale. In evil-doing, the utmost power of modern *table-rapping* spirits does not seem to transcend the ability to make mischief in families by publishing scandal. The utmost good ever claimed on behalf of these summoned immortals is only comparable to the small acts of petty benevolence attributed to elves and fairies. The mighty grandeur of eternity; the rapt beatitude of its blessed; the torments of its condemned; all that is solemn and soul-stirring in the teachings of revelation or the promptings of science—all fleet away, in the presence of a belief like this!

The meanness of spiritualism, even in its most exalted pretensions, cannot fail to strike a mind moderately honest and unprepossessed. Science and scientific men have at various epochs been severely handled by professors of dogmatic faith for wildness of statement and arrogance of pretension. Even at the time being, an acerb, not to say a violent discussion is maintained in regard to the question of the antiquity of man upon the globe; but Science has never been accused of degrading the subjects she handles to a point of meanness lower than the lowest existing standards. On the contrary, it has been the invariable result of Science to exalt whatever she has dealt with.

How small and mean were the notions of Pythagoras, or any other ancient sage, as to the universe, by comparison with those the progress of astronomy has revealed to us! What visions of surpassing beauty has not the chemist disclosed! Before the scrutiny of his art, matter seemingly torpid and motionless is resolved into myriad forms of life and movement. Flowers and trees are more lovely for the botanist. A stone-quarry becomes a temple of adoration, or a poetic fane, at the will and bidding of the geologist. No! Science, with all her arrogance, all her pride, has vulgarised nothing that she ever touched; and in respect to professions of belief, scientific men are bound, by the very tenure of their office, to give full expression to them. Again, whatever the errors a science may inculcate, they have no quality of perpetuity, like those of dogmatic faith. Based upon evidence, the creeds and pretensions of science are bound to adopt modifications according to the lights by evidence disclosed.

Errors of science hold their empire on a precarious tenure: the wilder they are, by so much more frail the holding. They have come under the obligation to abdicate the very instant experiment has shown them to *be* errors. It matters nothing by whom inaugurated, or with the memory of what great name associated. Experiment, in matters of science, is all in all. Authority has no weight, save in so far as it may be accepted as guaranteeing the accuracy of experiment.

Errors of mysticism, once accepted, tend to grow stronger and stronger by time. Errors of science ever tend to wither under the sunshine of experience, and, withering, pass away. Such is the difference between Modern Mysticism and Modern Science.

BARON REICHENBACH'S THEORY OF KISSING.

THE writer of this has long since discovered by experience that the surest way to perpetuate an imposition or a deceit is to affect to consider it wholly beneath argument or refutation. Regarded in the aggregate, there is a large amount of rough popular justice in the world, and the popular voice insists that pretensions shall be refuted, not dogmatically condemned. With this principle of action I do not quarrel; though, in common with many others accustomed to elicit truths by experimental research, I sometimes feel, and acutely, the painfulness involved in that waste of time occasioned by the performance of frequent demonstrations in a matter already brought to an issue.

It would be impossible, even did I so desire, to conceal from my readers the fact that the present allusion to Baron Reichenbach, and the so-called odic force, is in some way suggested by the presence and the operations of so-called supernatural or preternatural manifestors amongst us: and if it be demanded of me, wherefore I return to this subject again, when the public are getting tired of it; when rivals to the Davenport Brothers, performing in open light, accomplish most of the results these persons accomplish in darkness, and Redmond, whom I have seen, more adroitly; when a north-country editor has made plaint to a magistrate that he has been defrauded by the Brothers Davenport, they having received money under false pretences; when members of the first or initiatory audience of the Brothers Davenport, slinking back, are content to let those who pronounce the manifestations to be a sheer imposition, lodge a protest, and make no rejoinder; when, on the 15th of November 1854, I myself *saw* the confederacy hissed off their stage, and not allowed to resume; when I *heard* them designated by the audience with the names of 'swindlers,' 'rogues,' and 'vagabonds,' names which they have not dared to resent: if, in the presence of all these circumstances, I once more approach the subject, the explanation is not difficult, and will soon appear.

There is no issue more feared by philosophers—under which designation we are to group all those who love knowledge and devote themselves to the task of investigating truth—than an indeterminate issue. Every human mind, seriously occupied in the contemplation of the higher objects and aspirations of human existence, yearns after some perfect and complete conviction as to the truth or falsehood of propositions that come upon the arena of its scrutiny.

The true philosopher is never ashamed to own that he has been mistaken; inasmuch as opinions in regard to any subject, at any given epoch, must necessarily depend upon the evidence accumulated and available up to that epoch. Not being ashamed to own himself mistaken, the true philosopher may be always distinguished from the pretender to philosophy by the solicitude he manifests in submitting his proposition to any test that dissentients may elect.

There may be persons who will interpret reasoned preliminaries of this sort as a proof of half conviction. Dealing with a current form of mysticism, as I have already professed to do, why not (some over-enthusiastic champion of truth and reason may say) brand the *thing* as an imposition at once, the *professors* of preternatural philosophy as rogues and vagabonds, even as fortune-telling gipsies are branded as rogues and vagabonds? Simply, I reply, because experience has taught that there is no surer means of perpetuating a deceit than that of eliciting a sentiment of martyrdom on behalf of deceivers.

When the record of extraordinary manifestations first appeared in the newspapers, I will freely admit that I was stimulated by a certain feeling, the precise nature of which I need not expatiate upon here. That matters not; enough to state that, without departing from any form of good breeding, I sent a polite note to the Brothers Davenport, soliciting an invitation to one of their *séances*, to the end that I, as a scientific person, might endeavour to satisfy myself as to the conditions and limitations under which the phenomena were manifested. This note, written on the officially-headed paper of a magazine, bespeaking an audience on the part of *St. James's*, and subsequently adverted to in a note signed by me, and published in the *Morning Post*, constituted a missive that no philosopher would have wished to evade, and no charlatan durst treat with contempt.

Not the slightest notice was taken of this missive; whereby the Brothers Davenport put themselves in a situation exactly parallel to that in which a witness once convicted of felony has placed himself, when asked a question relative to some unpleasant event of his past life, he declines to answer it. True, by the Brothers Davenport's own election, I have not had an opportunity of firing a charge of small shot at the reputed preternatural hand. I have not been enabled to strew the ground with iodide of nitrogen, which would have exploded beneath the lightest footfall; nor have I had the opportunity of grasping at any reputed phantom with hands clad in gloves internally studded with fish-hooks. That is their election, not mine; and by the result of it I am enabled to affirm of them, as Professor Dumas affirmed of the atomic theory, viz. 'There may be atoms, or there may not be,' said this great philosopher; 'but in respect to this matter, all I can say is, that if atoms really could be proved to exist, matter must behave exactly as it does now.'

A parallel statement is the following: 'The Brothers Davenport may have been impostors, or they may not have been impostors; but assuming them the former, they must have behaved exactly as they did.'

Enough of these individuals; let me pass on to the consideration of Baron Reichenbach's testimony in regard to what he believed to be a newly-discovered physical force. The existence of such a new physical force he himself imagined to have discovered about 1845. What the baron may think about it now, or whether even the baron be alive, I do not know.

It is a circumstance, a fact, the explanation of which I willingly delegate to those who especially study the mental characteristics of the age, that no form or phase of mysticism prevalent during the present century, in civilised portions of the world at least, has been completely divorced, by those who most fully believed, or still believe in it, from association with science. Probably this circumstance may be fairly regarded as an index of the appreciative hold science has taken upon the minds of individuals belonging to the present century. Whatever the explanation, the fact is undoubted. Thus, the phenomena of attraction, or presumed attraction, adverted to by Mesmer, and which since his time have been designated as 'mesmerism,' or 'animal magnetism,' were not —as their second designation implies—complacently referred to the category of things purely supernatural, inexplicable; but were referred, with what justice remains to be seen, to the operation of one of the physical forces, *i.e.* magnetism; or rather, perhaps, it should be said, a modification of magnetism, a species of this physical force appertaining to animal bodies.

This modifying concession is one that will strike the philosopher, accustomed to physical inquiries, as being vague in form of expression. Undoubtedly this is so; and the modifying concession is only made in deference to those who have agreed to use it. Science is shocked at the very idea of a *sort* of physical force—a *modification* of physical force. Nature is so clear and sharply cut in all her primary divisions, that such words as 'nearly,' 'a modification of,' 'a sort of,' in reference to a physical force, imply the existence of an imperfection—an indecisiveness, such as there is no example of in the laws of nature.

The operation of a law of nature differs from the result of moral operations in the circumstance of its absolute and utter perfection. The operation of a physical law of nature is never *nearly* perfect, but ever *quite* perfect: wherefore, returning to the point whence we started, it at once arouses the suspicion of a philosopher when he hears or reads of such an expression as a 'modification of magnetism'—'a sort of magnetism.' With this animadversion let the case pass. I am only at present interested in calling attention to the fact that, whether the alliance be natural or whether it be strained, whether founded on truth or the result of pure imagination, the fact nevertheless holds good, that mesmerists have not referred, or perhaps have not felt themselves justified in referring, their phenomena to the domains of the supernatural—repudiating science, experiment, induction altogether,—but have feigned or proven, as the case may be, an alliance between the phenomena adverted to by them, and the ordinary phenomena of magnetism. This assumption of the agency of a physical force involves consequences that are not foreseen or understood by those persons unaccustomed to scientific modes of investigation, who nevertheless believe in the actual occurrence of the phenomena referred to. The first consequence is, that, once received into the domains of science, once admitted to belong to the category of things amenable to law and open to investigation, the phenomena alleged must stand amenable to any course of experiment, any severity of cross-examination, that the ingenuity of philosophers, bent upon investigating the subject, may suggest or devise. A knowledge or branch of knowledge once conceded as belonging to the category of things demonstrable by experiment, can lay no claim to the position of being accepted as a tenet of dogmatic faith. This is a matter in which no middle course can exist; as will be obvious to every candid mind addressing itself to the question.

Whatever the explanation may be, the fact remains the same, viz., as already remarked, that every form of modern mysticism professes to be based upon the testimony of experiment; and it seems to be a great point in the estimation of modern mystics to gain acquiescence in the postulate that a physical force or physical forces may yet remain to be discovered other than those already known.

In what way the granting the existence of a physical force as yet unrecognised can promote, or can be assumed to promote, a belief in such manifestations as table-turning, spirit-rapping, rope-knot delivery, and what we may call phantom fiddle-flying, it is not easy to understand; save and except on the sole assumption that the laws of such physical force have been studied and mastered, just as the laws of gravitation, electricity, and magnetism have been studied and mastered; that, moreover, the phenomena developed are reconcilable with such laws. In any other case the credence of one in the phenomena lately called 'preternatural' would be no more advanced through the concession, for the sake of argument, or even the *demonstration* of a new physical force, than it would through the concession, or even the demonstration, of sea-serpents.

Nevertheless, inasmuch as the demonstration of a new physical force is considered to be so important a matter in relation to phenomena lately termed preternatural, I shall proceed to set forth an outline of experiments conducted not many years ago by Baron Reichenbach, a somewhat distinguished chemist. By way of introduction it should be remarked, that this one quality of good may be traced throughout all the investigations of the baron relative to the supposed newly-discovered physical force — since his time called the odic force—viz. that at the very beginning he resolved to take his stand as a man of science, detailing the records of scientific investigation, and repudiating every tincture of superstition.

It follows, then, that—as Reichenbach would have been the first to own—the results witnessed and chronicled by him should be noticeable by all other investigators of adequate competence, and *working with instruments of adequate delicacy*. Let it be here observed, that the instruments our philosopher worked with, in order to demonstrate to his satisfaction the existence of the force since termed the 'odic force,' were certain hysterical and extremely sensitive young ladies. He operated upon *their* nervous systems just as the Italian Galvani operated upon the nervous systems of frogs; but whereas frogs are everywhere available, and one frog is as good for the purpose of experiment as another, it always admits of being said—in regard to hysterical and extremely sensitive young ladies—that, in the event of phenomena recorded as *having* happened by Baron Reichenbach *not* happening in the experience of other philosophers, the young ladies operated upon in the latter case were not sufficiently sensitive to respond to the influences brought to bear upon them.

I am not aware whether the baron commenced his physiological experiments in a suggestive state of mind; I am not aware, that is to say, whether he had entertained a predisposition to the belief of mesmerism and animal magnetism. It would be desirable that the record of every investigation or discovery of importance should be accompanied by a statement as to the circumstances that suggested it. Philosophers who take highest rank in the honoured class to which they belong, are always careful to make this announcement; and a certain degree of doubt and faltering faith results—and inevitably must result—from the omission of this particular.

What, for example, should have suggested to the preternatural philosophers Davenport the conditions of darkness, ligature, the peculiar clothes-press structure, the peculiar class of instruments, &c. &c.? I cannot give any account of what the consideration was—what the suggestion that induced Baron Reichenbach to commence trying experiments upon the nervous systems of Mesdemoiselles Reichel and Nowotny, Maix, Sturmann, and Atzmannsdörfer. Whatever they might have been, the baron came to the conclusion that, according to the testimony of five individuals — four delicate young ladies and a boy—magnets—that is to say, steel magnets as ordinarily understood—evolved continuously from their poles a pale flickering light; not perceptible, indeed, to ordinary eyes, but recognisable to the vision of those individuals whose organism was sufficiently delicate to become subject to the impression conveyed. The baron, after setting forth a detailed account of the experiments performed by him — using the nervous systems of the four young ladies and the boy — comes to certain conclusions, and makes a certain summary, of which the following is an abstract. He writes that—

'Mademoiselle Reichel was, therefore, the fifth, and at the same time the clearest, witness for the luminous appearances at the poles of magnets. The sixth was Mademoiselle Maria Atzmannsdörfer, aged 20, who had headache and spasms, and walked in her sleep. She looked well, and walked alone in the streets. She was highly sensitive, and saw the magnetic poles flaming vividly. She drew the appearance larger than Mademoiselle R., but in all other respects her descriptions were the same. The light dazzled her eyes by its brilliancy.

'The following were the general results obtained with the horseshoe magnet of nine elements in regard to the magnetic light:

'(*a*) Mademoiselle Nowotny, far advanced in her recovery, saw a kind of shining vapour, surrounded by and mixed with rays half to three quarters of an inch long, shining fitfully or shooting white with a play of colours.

'(*b*) Mademoiselle Maix, in the normal state, saw a white flame a handbreadth in height.

'(*c*) Mademoiselle Sturmann, a flame as high as the length of a small hand, with play of colours.

'(*d*) The lad, a flame a hand high.

'(*e*) Mademoiselle Maix, while in a spasmodic condition, saw a general luminous appearance over the whole magnet, dazzling her eyes; largest and brightest at the poles.

'(*f*) Mademoiselle Reichel saw a flame, with play of colours, shooting out rays as large as the magnet—that is, about ten inches high; also side flames, as from each plate of the magnet, and a general weaker light over the whole surface at the junctions of the plates.

'(*g*) Lastly, Mademoiselle Atzmannsdörfer saw the same phenomena still more distinctly, and with such brilliancy as to painfully affect the eyes.'

Here, then, in the results of these experiments, do we find the beginning of a series of very curious investigations, conducted with all the seeming fairness that characterises the investigations of men of experimental science. Every now and then the baron, in the course of the thesis in which the results of his observations stand recorded, felt himself constrained, by the necessity of claiming his readers' acquiescence, to admit the postulate that, in matters of experiment, the result is all in all—the antecedent probability or improbability nothing. However well timed such an announcement may be in the interests of general readers, special readers—philosophers—will not need it. The result, however, is just what philosophers, who demur to the accuracy of the records communicated by Baron Reichenbach, have doubt about.

The baron's testimony needs confirmation, to say the least. Never in the experience of any philosopher who has endeavoured to go over the same ground as Baron Reichenbach, is it even pretended that the results testified to by him have happened in their entirety; and for the most part, and to by far the majority of investigators, his chronicled results have not happened at all.

So intimate is the connection between a suggestion and its issue, so delicate, and to the human individual so imperceptible, that the practice is generally most fallacious of putting faith in results acquired through the instrumentality of human perceptions immediately referable to the judgment. By 'immediately referable' is meant, not acquired through the unbiassed record of instruments. For example, physicists well know that the feeling—the sense of touch—can by no means be trusted to pronounce concerning temperatures, absolute, or even relative. When correct information as to this matter is needed, we use instruments—thermoscopes, thermometers, and pyrometers. Now the record set forth by Baron Reichenbach, so far as I have already adverted to it, deals wholly with the question of luminosity of magnets, on the evidence of his four hysterical young ladies and a delicate boy.

Testimony of this sort—without imputing any dishonesty or desire to mislead to the witnesses, or perhaps I should rather say the instruments—is, as every investigator knows, fallacious in the extreme. The feminine temperament, however healthy and strong-minded, is ill adapted to the purposes of philosophic investigation and unbiassed judgment thereon. It is too imaginative, too sensitive, too ideal. Every medical man knows that if a male individual in whom a woman takes pride—a philosopher, we will say, with all the glamour and mystery of his superior learning as shadowed forth to the fair one about him—if such an individual gets (for purposes of experiment) a delicate and impressionable young lady into a darkened room, she will generally see, or believe she sees, any possible thing he may wish her to see.

Women are delicately nerved; they move to instincts deeper, and influences more ethereal, than our coarse natures can respond to; but they have not the faculty of induction; and heaven forbid they ever should! When a lady thinks she has a call to unravel a tangled skein of facts through experiment—believing it a duty—she makes a mistake. All this is no part of the duty of woman. I remember, when a boy, poring over a good-sized quarto, liberally illustrated with copper-plate engravings, and finished up with a ghost-story at the end. It was called the *Whole Duty of Man.* It never fell to my lot to read the Whole Duty of Woman; wherefore, as, according to my views, it admits of being given in few words, I shall give it accordingly. The whole duty of woman, then, I humbly submit is this, *videlicet:* that whilst unmarried she be always amiable, and that she look as pretty as she can; farther, that when married she add to these the crowning virtue of obedience to her lord. Love we need say nothing about—it being natural to the sex; and as for honour, it comes as the result of following the maxims just laid down.

If the baron had testified to the issuing of a light from magnetic poles by the evidence of his four young ladies and the sickly boy alone, then undoubtedly his testimony would be accorded far less ready credence—or rather, disposition towards credence—than one now tends to accord to it. He has furnished the particulars of certain indications concerning the light from magnets, as made known through physical instruments, mediately or immediately. As a mediate experiment, the following was tried. Let it be premised that a faint light admits of being concentrated by a convex lens, as most of us will have seen on different occasions. It occurred to the baron, then, that he might succeed in concentrating the magnetic light in such wise, by transmitting it through a lens, that being thrown upon a screen in a focus, it might become to ordinary eyes recognisable. Trying the experiment, the result was a failure, so far as the evidence of his own or any ordinary eyes were concerned; but a success when the more delicate eyes of Mademoiselle Maix and his other experimental young ladies were called into operation.

These sensitive individuals described the magnetic light concentrated into a focus, as retaining its primitive and normal image; and a remarkable fact was, that whereas the lens's focal length for ordinary wax-taper light was only 12 inches, the light being 18 inches distant, the focal length of the same for magnetic light amounted to $4\frac{1}{2}$ feet. The immediate physical testimony recorded by the baron was more remarkable still, and it should be the more conclusive, inasmuch as whatever of uncertainty might belong to the indications of his four young ladies and the delicate boy was eliminated. The baron states that a metallic plate having been made sensitive by Daguerre's process, then placed in a box, the box enveloped in flannel—a double treatment whereby all ordinary light must necessarily have been excluded—still, after exposure during some hours to magnetic influence, the plate, being removed, was found to have a daguerreotype picture upon it.

I pause here to demur to the baron's logic. He affirms that no *ordinary* light can get through a deal box enclosed in a blanket. Granted. We will all of us admit that much, and I think even more. Light, to have found its way through such an envelope, must have been *very* extraordinary. How could the baron have known that his extraordinary light *did* get in, except he had put one of his young ladies or the puny boy in the box to see it? Admitting the correctness of all he said about the development of a picture on the daguerreotype plate, the result only shows that the development was referable to some cause unexplained; not by any means that it was attributable to light.

If I have paused to make this objection, it has not been through captiousness; indeed, the baron, as a scientific man, could not help admitting that, in matters of scientific debate, no possible objection founded on reason is ever regarded as emanating from a bad motive. *Quasi*-scientific people—men and women who, having committed to memory a jargon of scientific terms, mingle them with cloudy idealisms spiced with Scotch metaphysics—do not seem to understand, do not seem to have the faculty of being able to understand, that in matters of scientific investigation there is no such principle recognised as concealment of a part of the truth for politeness' sake—*for peace and quietness' sake*. The assumption, not to say the proof, that such were done, would be hateful to a philosopher. He thenceforth would regard with loathing and contempt the individual who should so demean himself. Non-scientific people cannot be made to understand this. All that seems to them like a whale must be *very* like a whale in the testimony of everybody.

To return to the baron: his experiments led him to conclude that the peculiar light which emanated from the poles of magnets revealed the existence of a force hitherto unrecognised; in which particular—even granting all his postulates and preliminaries—most philosophers would *not* feel called upon to agree. He proved, or rather his young ladies proved, that the light in question was a sort of flame resembling ordinary flame, in the respect that it could be deflected by a transverse current of air. This testimony, if borne out, should have surely given hope that a more intimate acquaintance by ordinary mortals with this extraordinary light would be possible. That the magnetic flame should be impressible by such a gross material thing as atmospheric air, would seem to place it out of the category of *very* attenuated essences. In the course of time, Baron Reichenbach proved to his own satisfaction, that the light spoken of as emanating from magnets did not emanate exclusively from *them*. He satisfied himself that, though always accompanying magnetism, it was distinct from magnetism; and that it was in virtue of the operation of the force, indicated by the manifestation of the flame (he strenuously defended the hypothesis of a new force), that magnets produced certain effects on the human organism.

What are the effects? or, rather, what effects did the baron claim on behalf of magnets? Certain very extraordinary ones; amongst others the following. He testified that Mdlle. Nowotny, one of his experimental young ladies, lying in bed, he no sooner applied the magnet to her hand than the latter was attracted; and so powerfully, that, by passing the magnet towards the young lady's toes, she not only sat up, *but would have turned head over heels, had he not desisted!* If this curious faculty of a magnet be proved by farther experiment, then society will owe apologies not only to Dr. Petetin of Lyons, who affirmed that the human hand was affected by the magnet, but also to Mesmer, who maintained the same proposition. Here again, unfortunately, the experimenter who might wish to repeat the baron's experiments, and by the issue of their testimony satisfy himself, encounters a difficulty in finding the necessary bevy of sensitive young ladies.

Reichenbach was soon led (as I have already stated) to infer the presence of the peculiar agency he believed he had revealed, in many other things than magnets. But we shall do well to exhaust the magnetic part of the subject before going to others. It would seem that the baron's mind was one singularly amenable to the turning of suggestions to account, by way of strengthening his hypotheses; accordingly, the singular custom a friend of his had, of taking his first sleep at night lying north and south, then on waking turning heels where head had been, and thus enjoying his second nap in the reverse polar direction, set the baron speculating as to whether the earth's magnetism, or rather the something associated with the earth's magnetism, might not furnish the explanation of his friend's sleeping vagary. Wherefore, prompted by this thought, he caused his friend to reverse the polar direction of his bed in such manner that on lying down his friend's head should point due magnetic north. The result was, he tells us, that his friend thus newly circumstanced never woke till morning; whereby the suggested hypothesis was, to his mind, already half confirmed. Not to found a theory, however, on insufficient testimony, the baron again availed himself of his experimental young ladies; and I fear, from the record given, poor Mademoiselle Nowotny must have had some unrefreshing sleep. For some nights the baron seems to have been doing little else than turning about this poor young lady's bed, she being therein. No sooner would Mademoiselle fall into a quiet doze—lying magnetic north and south—than the philosopher would come and turn the bed about, watchful of consequences. We are gravely informed, that when mademoiselle's heels were brought where her head had been—pointing to the magnetic north, that is to say—she experienced a disagreeable sensation; but the latter amounted to positive horror whenever her bed was caused to lie in the direction of east and west!

According to Reichenbach, his sensitive young ladies could at once and infallibly distinguish a glass of water over which a magnet had been passed from another glass of water; but this class of experiments took him away from the domains of magnetism altogether. Pursuing this collateral path of investigation, his first chief discovery was, that *the* force—call it what we will—existing in magnets, mingled with magnetism proper, existed pure and unmixed in crystalline bodies, manifesting itself in polar hues corresponding to the crystalline axes. His young ladies testified to the emanation of flame from the axes of crystals similarly as, according to them, it emanates from magnetic poles. The most extraordinary part of Reichenbach's statement is, that whereas the new force, from whatever source emanating, attracts the human hand, and, as we shall hereafter find, other parts of the human body, the attraction is not reciprocal; so that although a magnet—and not a heavy one—could be made to attract Mademoiselle Nowotny from a recumbent to a sitting position, and might have caused that young lady to turn head over heels; still, conversely, Mademoiselle Nowotny's hand manifested no attraction whatever upon the magnet!

The baron next establishes a large generalisation, by the consummation of which he brings himself *en rapport* with Mesmer, Perkins, and the whole tribe of animal magnetisers. It so happened that Dr. Heygarth, about the commencement of this century, had referred the constitutional effects resulting from the use of Perkins's metallic tractors to imagination acting upon the system; and he based his hypothesis on what seemed to him the conclusive evidence, furnished by the use of bars not metallic, not therefore ostensibly endowed with the function of tractors. Reichenbach's next experiments were of the character to rescue, in his opinion, Mesmer and Perkins from the ridicule which the experimental demonstrations of Dr. Heygarth had involved them in. If, reasoned the baron to himself, it admits of proof that the human body is itself a source of this newly discovered force, and if it farther admits of proof that the force can be transmitted through rods of materials such as the factitious tractors of Dr. Heygarth were made, then do Mesmer and Perkins stand absolved from the obloquy into which they had fallen. Forthwith this demonstration was made out to the baron's satisfaction. He believed that chemical action was the originative cause of the force when manifested by the human body—the chemical action of digestion and respiration, that is to say; and—generalising still—he was ultimately led to conclude that such force accompanied the manifestation of chemical action howsoever, whensoever, and wheresoever effected.

I bespeak the reader's most serious attention now to my record of the baron's next investigation. He set himself to discover, by experiment, what parts of the human body evolved the new force most strongly. Very potent were the hands, but not so potent as certain other parts—the lips, for example; and not even these in the very highest degree. He thereupon—and, mind me, I am not joking; only quoting soberly and seriously the baron's own record—the baron thereupon, I say, hints, he does not venture to do more, at a rational theory of kissing!

According to the testimony of his *sensitised* young ladies —to borrow a photographic term—the magnetic or crystalline fire was often perceptible to their eyes, coruscating on human lips—*the baron's lips?* His young ladies had previously borne testimony to the fact that the sensation of contact by this sort of fire, even when emanating from magnets or crystals, was to their organisms most agreeable; wherefore the baron shrewdly suspects that the recognisedly agreeable sensation of kissing may be due to a purely physical cause, viz. to this newly discovered force acting upon the ramifications of the fifth pair of nerves, and thence conveyed by contact and transference to the sensorium!

Once more, I am *not* joking. This is what the baron *does* say; and anybody who disbelieves my statement need only refer to the baron's own book, where the author may be seen to express himself just as I have put it. Although the odic force has been greedily laid hold of by spiritualists, table-turners, spirit-rappers, phantom fiddle-fliers, and other varieties of that sort of mystic people, it would be hard to determine why. The baron was assuredly no mysticist, or anything approaching one. A man who tries to reveal the holy mystery of kissing, and refer the operation to gross physical conditions, is anything but a spiritualist. The baron did not restrain himself to the task of destroying the mystery of kisses. He next addressed himself to the task of unravelling the mystery of ghosts! Most materialistic in his tendencies does Baron Reichenbach seem to be; so that I wonder how spiritualists can like to hold communion with him. According to the baron, churchyard ghosts, grave-hovering spirits, have no existence. Visions formerly referred to their presence are nothing else than flickering luminosities of magnetic flame, visible to no ordinary eyes, but plainly perceptible to the eyes of sensitive young ladies.

This grand discovery of the baron, the *finis* that *coronavit* his *opus*, was again the result of a suggestion. At Colmar it would seem there once lived a certain blind poet, called Pfeffel. That blind poet had an amanuensis, whose name was 'Billing,' and, as befitted the amanuensis of a poet, this young man was endowed with a very delicate organisation. Now it so happened that one day, as the poet and his amanuensis were walking side by side in the poet's garden, Billing manifested great unwillingness to step over a certain spot. On explanation being required of him, he confessed that he felt a repugnance to walk over a spot where human remains lay buried: that human remains were underneath he knew—so he explained—by the testimony of a flickering light which shone on the earth's surface. For a season Billing's words remained unheeded; at length, however, people, acting upon his advice, dug down until they arrived at a skeleton of a body that had been buried in quicklime. Owing to this proximity of chemical materials, an action was set up; and as one result of this action, the flickering light Billing had seen upon the surface of the ground. The mouldering remains having been exhumed and scattered about, the concentrated light that was, changed into a diffused light, corresponding with places wherein the remains had been strewn. Profiting by this hint, Baron Reichenbach induced one of his sensitive young ladies to take a series of midnight rambles with him in graveyards and cemeteries; the object being to discover whether she could recognise flickering grave-lights comparable to such as the man Billing had seen in the poet Pfeffel's garden. She did so, easily. Not every grave was illuminated to her eyes with this magnetic light, only certain graves,—those especially where corpses had recently been laid. Here then, in passing, do we find some little discrepancy between the testimony of the poet's sensitive amanuensis and the sensitive young lady, Mademoiselle Reichel. *His* ghost-light emanated from a dead body very far gone indeed, a mere skeleton, that had been deposited there at a time beyond the memory of the oldest inhabitant; but Mademoiselle's corpse-candles burnt over very recent corpses.

The baron expresses some sort of regret at the necessity which compelled him, so to speak, acting in the interests of science, to apply the clairvoyant talents of Mademoiselle in such an unpleasant occupation as that of wandering through graveyards and cemeteries at dusk, in quest of what in future must only, for courtesy's sake, be called 'ghosts.' He explains, however, that the occupation was not so dreadful as it sounds, or looks on paper; for the reason that his young lady had been accustomed to see those ghost-lights, those flickering corpse-candles, from the days of her babyhood. The baron, not to leave his vindication of Mesmer and Perkins, and all antecedent mesmerists and animal magnetisers, half accomplished, explains collaterally how it happened that patients sitting round a magnetic tub, as it has been called, each grasping such a conductor in his or her hand, should derive profit from the treatment. Such had been a practice of Mesmer; and the agency liberated had by him been referred to magnetism. Now Reichenbach showed, to his own satisfaction, that the results were altogether incompatible with the assumption of a magnetic origin; but that the tub in question, or rather the varied contents put into it, established a chemical action, from which in consequence came the new force, the subject of his investigation.

In this short narrative I have endeavoured to give a fair and reasoned abstract of Reichenbach's labours in this walk of investigation. Here and there a certain element of the ridiculous will have made itself manifest; and readers may be excused for assuming that the writer has gone out of his way for the sake of a joke, in order to make a statement look ridiculous in the deductions of which he does not believe.

The assumption would be incorrect. There is no matter of fact in this abstract placed in a more ridiculous light than that in which Baron Reichenbach has left it. What, then, are we to make of all this? What conclusion are we to arrive at in regard to the baron? This is a matter in which I come under no obligation to express all that I believe, or even any part of it. Some sort of opinion for myself I have formed; and some sort of opinion every reader for himself will form. Sufficient to the end is every one's own private notions as to this matter. Regarding the testimony as a scientific monograph, to be investigated as other scientific monographs are, by the evidence of its own showing,—the point which most strikes the scientific mind is the inconclusiveness of it, the non-necessity of the deduction arrived at by the baron from the premises he started with, and the experiments on which he relies. Granting all the phenomena that he describes; granting the flickering lights, the attraction of hands without reciprocity; granting all his explanation of kissing, of the non-existence of churchyard ghosts,—still it does not follow that he has revealed any new force; it may be only some function of a force already known. Lastly, it seems the greatest wonder of all, how mystical people could ever have attached themselves so pertinaciously to the idea of Reichenbach's odic force, in explanation of their own assumed phenomena.

THE SENSES, THEIR LIMITS AND THEIR FALLACIES.

THE present is not an inappropriate time for an exposition of facts in relation to the title. The British public has, for some years gone by, been complacently trying to deceive the senses. Popular tastes go to extremes; probably, then, the season may have come for the qualities, the fallacies, and the limits of sensation to be temperately received.

The senses whereby human beings are made cognisant of external impressions are five; and, most probably, though undemonstrated and undemonstrable, no animal, whatever its grade, is possessed of any other.

Of these senses, one, touch, is exercised without a special organ; whereas the remaining four possess each an organism fitted to its own purposes alone. This holds mostly good; nevertheless the statement is not so absolute in all particulars as at first it might seem. For example, the line is so ill defined between smell and taste, that it is impossible to aver where one begins and the other ends.

The sense of touch is simplest of all. It is endowed with no special organ, though in every animal certain parts exist more highly endowed than others. Human beings feel best with fingers, lips, and tongue; the elephant with the extremity of his trunk; grazing animals with their lips; whiskered quadrupeds with the nervous papillæ situated at the base of their whiskers; and, to summarise, that part of an animal to which the exercise of the sense is most useful is always endowed with the faculty of touch in the highest degree.

Touch is not only the most simple, but the most reliable of the senses. Vision, hearing, smell, taste, may easily be deceived, but rarely touch. Still, even this sense is not wholly absolved from fallacies. No ideas are more distinct to the mind than those of heat and cold; yet the sensations of *extreme* heat and *extreme* cold are so nearly allied, that they seem identical.

Frozen mercury imparts the sensation of burning to the surface it touches; and, less markedly, so does contact with a metal surface when the weather is very cold. The chief indications of this sense are the qualities of hardness, softness, heat, cold, levity, weight, smoothness, and roughness, in their various degrees, from pleasure up to pain.

Through touch we experience most of the ordinary corporeal pains to which we are subject; nevertheless, each of the remaining senses can beget these opposite impressions. Strange though it may seem, the limits between corporeal pleasure and pain are by no means clear. To illustrate by the sense of touch, tickling is an example. In respect to taste, experience of mustard, pepper—indeed *any* condiment—testifies.

Moderate light is pleasing, brilliant light pains; the sweetest of odours become unpleasant when too powerful; and though music in a general way be agreeable, it *may* become a nuisance: for testimony of which I appeal to Mr. Babbage.

A curious circumstance affecting touch is, that the greater portion of the brain, largest of all the nervous centres, is completely insensible. Instances are on record of the upper parts of the human brain having been sliced away, not only without infliction of pain, but without any seeming injury to the patient.

Haller proved that tendons, cartilages, and bones, whilst healthy, are quite insensible. Either, when diseased, may become the seat of acute pain. Muscle—in ordinary language, *flesh*—is far less sensitive than skin. The surgical operation called *acupuncture* consists in thrusting sharp needles deep into the flesh. In conducting this operation, very little pain is felt after the needle has penetrated below the skin.

Even the special organs of other senses are endowed with common sensibility, *i.e. touch;* and for that reason are supplied with nerves other than those belonging to their own respective special senses. The late Sir Charles Bell was first to show, that in all nerves which have double roots, one is made-up of nerve-filaments belonging to touch, or common sensation; the other, of filaments appertaining to motion.

The spinal nerves are typical of this double-root formation. In every spinal nerve an anterior and a posterior root are recognisable; of these, the latter appertains to touch, or common sensation. This has been proved by vivisectional experiments. It was found, that if the posterior root of either of the spinal nerves be cut, the common sensation of the part to which it goes is utterly abolished.

The senses are all allied; they aid and assist one another; and when one or more are abolished, then, as common experience teaches, the others become acute to an extraordinary degree. Considered as to its alliance, touch stands nearest to the sense of hearing; so near, that, in the case of certain lower animals, the point is not determined whether motion following a noise be the result of mere tremors, surface-conveyed through touch or ordinary sensation—or whether of sound-waves, the result also of tremors, but conveyed to the auditory sensorium.

Guided by the same evidence, physiologists are not agreed as to whether the sense of hearing needs, in all cases, the presence of a special auditory apparatus. The result may be feeling, or it may be hearing; the problem is indeterminate.

Considered as to its vicarious function, as to its power of standing in aid of defective or absent sensation of different qualities, the sense of vision is that to which touch is most intimately allied. Of this, blind people furnish examples. Even though the calamity has supervened late in life, the patient soon makes himself competent to the performance of *most* ordinary, and *many* extraordinary, avocations of life.

Huber, the bee-master, was a blind man, and the department of natural history he illustrated needed close observation. A certain Kendal botanist was a blind man, and his knowledge of the local flora was unrivalled. Of blind guides records are numerous. Blind girls working cleverly at the sewing-machine may be seen in plenty. In all these and similar instances, touch is the sense which mostly, if not altogether, acts vicariously for the lost sense. So well does it accomplish the extra duty, that examples are not wanting of blind people who have not only grown reconciled to their calamity, but even come to feel grateful; judging that their power of mental concentration was increased thereby. The celebrated mathematician, Euler, made some of his most important calculations after he was blind. His admirable treatise on Algebra, at once the simplest, the deepest, and the most lucid ever written, was dictated to a tailor lad, long after the mathematician could see no more. Milton was blind when he wrote his master poems, and, more extraordinary, Homer: more extraordinary, that is to say, if, as many critics allege, the use of alphabetic characters had not been discovered by the Greeks of those days. In the three last cases touch could not, it is obvious, have supplemented vision; but it seemed well to throw into one group the examples of people growing independent of so important a sense as the one ministered to by the eye.

Though the degree or the delicacy of touch varies in different species and in different individuals of the same species, I believe no case is on record of an entire loss of this sense, similarly to what happens in the case of sight and hearing. Through accident certain special parts of the body may be deprived of the faculty of common sensation; and the entire body may be made sensationless, as to touch, by a sufficient dose of aconitine, the active principle of monkshood. It is on record in professional books, that certain persons who had dug up and eaten the root of monkshood in mistake for horse-radish became completely insensible to ordinary touch.

The mind of these individuals was perfectly clear—judgment unclouded. It always *is* in these cases of poisoning. They all died; such a dose of monkshood as the complete absence of touch implies being *always* fatal. As a physiological demonstration of the power of aconite to abolish common sensation, I have more than once seen the following: a rabbit stuck all over with pins and needles without feeling pain. Proof—the animal, turned into a pincushion, ate sprigs of parsley. This benumbing quality of aconite is of great value in many cases, when physical pain cannot otherwise be alleviated. In tic-douloureux it is sovereign. I have never met with a case of toothache that was not alleviated in five minutes by the judicious application of aconite.

If it be not ungrateful and almost irreverent to say so, touch (common sensation) is the least elaborate, the most vulgar of the five; and yet, perhaps, of all the most reliable. Regarded as to its faculty of conveying external impressions, it rarely deceives us. The conjuror can make nothing of this faithful sense. Vision, hearing, he readily cheats; in proof of which the prestigiator and the ventriloquist.

We often fancy tastes when there are *no* tastes; smells when there are *no* smells: but, even in the wildness of dream-land, we rarely seem to *feel* an object. Why the words, *I've seen it with my own eyes*, have come to be such a guarantee of truth, it is difficult to explain. Far more just would the expression be, 'I've touched it with my own fingers.'

As there would appear to be a certain alliance between the faculties of touch and hearing, let us take hearing next. This sense is ministered to through special organs, the ears; save perhaps in those apocryphal cases already noticed. The hearing apparatus may, in general terms, be divided into external and internal: the former to collect and direct the tremors or vibrations, which beget sensation; the latter to receive those tremors, and bring them into relation with the auditory or special hearing nerve.

The first thing to strike an observer, taking cognisance generally of external hearing apparatus in the higher animals, is the variety as to shape and direction of the external ear. Predacious animals have their ears directed forwards; timid animals, such as hares and rabbits, backward. Oxen, horses, donkeys, and mules can point their ear-trumpets in whatever direction they like. I accept Mr. Darwin of the Zoonomia as my authority for the statement that, when horses or mules are travelling in single file, the leading animal pricks his ears forward, the rear-guard—as one may call him—backwards. The cause of this difference is obvious when reflected upon. The foremost animal is most concerned to hear sounds in advance; the rear-guard, sounds behind.

Amongst men, savages usually have projecting ears; the habit of listening to distant sounds having promoted, it should seem, the development. When a civilised individual wants to hear very distinctly, he holds his hand up in such a way as to improvise a large external ear. Deaf people increase the effective length of *their* external ears by devices of metal —hearing-trumpets; the reason obvious.

Internally the ear is subject to much variety in different animals. Assuming the internal auditory apparatus of man as typical, we find it consist of a labyrinthine maze of bony material, constituting an extensive passage, in which auditory vibrations must linger before arriving at a membrane called the *tympanum*, or drum of the ear. Behind, or internal to the tympanum, is a passage which leads to the throat. It is called the *Eustachian tube:* the chief use of it is imagined by physiologists to be equalisation of atmospheric pressure on both sides of the drum-membrane.

Some of us have descended in the diving-bell, no doubt, and then have experienced a certain unpleasant sensation in the ears. It lasts for some little time, and then ceases; the period of cessation being indicated by a crushing sound, as if something inside the ear had broken. The pain is referable to pressure of the atmosphere upon the tympanum externally; the crush results from air finding its way suddenly through the Eustachian tube. On ascending, the symptoms return, but from an opposite cause; the chief pressure then being internal, not external. Appreciation of the cause suggests an easy mode of prevention—moreover, it is always effectual. If, during the descent, the lips and nose being closed, an effort to swallow be made, thus compressing air within the cheeks, the unpleasant sensation will be absent.

In most invertebrate animals there exist no parts which can be referred to special organs of hearing, as in the higher classes. Neither can the motion of a creature under the influence of sound be recognised as a proof of existence of the faculty of hearing, as already noted.

The lowest animals in which a special auditory apparatus is recognisable are the crustacea. In them the ears are placed at the lower surface of the head, on either side, at the base of the lesser antennæ. They are very rudimentary, consisting only of a membranous sac, upon which the auditory nerve is expanded. In the cephalopoda, or cuttle-fish tribe, the special auditory apparatus is rather more elaborate than in the crustacea; but still very rudimentary.

Amongst vertebrate animals, fishes are those in which the special auditory apparatus is simplest. First, every trace of external ear is wholly wanting; internally there is no cochlea, or convoluted tube, the part in which sounds are caused to linger to the sense of higher animals. Fishes, however, are provided with an auditory labyrinth; either wholly enclosed in the skull, or else between the walls of the skull and the brain. The other peculiarities of the auditory organ of fishes could not be stated without more anatomical references than befit the occasion.

In reptiles and amphibia the auditory organ is in every case more fully developed than in fishes; but in different species to a varying extent. Thus, whilst some amphibia possess a tympanum, or ear-drum, others are not so far advanced. Most frogs and toads have the honour to represent the higher gradation. They have drums to their ears: serpents have not.

Certain amphibia—tortoises, lizards, and crocodiles, for example—not only possess drums to their ears, but the organism called by anatomists *Eustachian tubes*—trumpet-like prolongations effecting communication between the throat and internal ear, as already explained. From reptiles we arrive at birds:—creatures which, anatomically regarded, furnish the connecting link between reptiles and mammalia. In birds the hearing organs differ but slightly from those of the higher amphibia; being almost identical with the auditory apparatus of lizards and crocodiles.

At length we come to the higher grade of animated creation—*mammalia.* Here, generally, it may be affirmed that the auditory apparatus follows one scheme: that of which the hearing organs of man are typical. Exceptions exist. The cetacea—dolphins, whales, and porpoises—have *no* external ear. The presence of such an organ would probably impede the clear run of those animals through the element in which they wholly reside; just as linen hung over the sides of a ship, or weeds growing from the hull, impede her sailing qualities. The ornithorhynchus—that Australian paradox—is also conspicuous by the absence of an external ear.

Speaking of humanity, it may be said that all the senses, except touch, minister to a corporeal and a poetic life as well. This remark holds good of sound to a very high degree: appreciation of sound as mere noise representing the former;

appreciation of sound as *music*, the latter. An attempt will be made to explain in what music consists by and by. In all that relates to appreciation of common noise, man is very poorly endowed by comparison with many animals; but in the faculty of appreciating and enjoying *music* he seems pre-eminent. *Seems*, I say, for one must speak guardedly. How do we know whether the nightingale, the canary, and other feathered songsters of the air, may not have as keen a relish for the melodies of themselves and neighbours, as we for the strains of ourselves and our vocal and instrumental favourites?

Singing birds, however, have not risen to harmony. Counterpoint must be shibboleth to them; and though many have a limited power of learning new strains (I have even heard two bullfinches whistle first and second in a duet), they cannot invent. The most curious fact about bird-music is, that although different species sing together in the woods, until, on a summer day, the whole air is tremulous with bird-music, and although each singing bird warbles in a different key, no discord to human ear is perceptible.

This is a *very* curious matter—one that musicians well know how to appreciate. Shall we affirm that singing birds have very fine musical ears? or shall we put their extreme accuracy down to instinct? Certain it is, explain it as we may, they never sing out of tune. '*Ces petits coquins, ils chantent si juste*,' said poor Madame Pasta to a visitor who was listening to her canaries. Whether any animals can *like* —I will not say *appreciate*—music, as we understand music to be, is debatable. The belief has gained currency in many parts of the world, that snakes show this partiality. I do not know what to say about it from my own experience, but my wife holds to the belief. We generally have pet snakes; and my informant protests that they come near to the piano when she is playing. The main ground of her faith, however, consists in this, viz. a certain pet snake that had escaped, and hid himself some days, was found at last nestled *in* the piano, *amongst* the wires. This would rather prove too much, if anything. Ensconced so near the fountain of music, the effect should seem to have been the reverse of musical.

As sound consists of waves, larger as the sound is lower in pitch, smaller as it is more acute—so, accordingly, as different waves of different magnitudes are arranged to pass on to the ears evenly or unevenly, either a mere noise or else music results. The concordance of musical waves may be illustrated by the parallel case of a short-legged and a long-legged person walking together. The two cannot be expected to take equal strides; still, it by no means follows that they must walk unevenly. If Short-legs steps twice to Long-legs' once, the result will be even; if four times, still even; and other ratios are soon obvious. Thus is it with music—with that part of music termed *accord*, or harmony, obviously,—and with melody too, if we remember, what is the fact, that melody is nothing else than retrospective harmony—the memory of notes gone by, whose memory still lingers.

When two sound-waves are propagated simultaneously, one being half the size of the other, the small wave vibrating twice to the other's once, then the two coalesce so absolutely that the ear recognises them as one. The sounds constitute, in fact, the fundamental tone and its octave. If a tense string, which, on being struck, yields any definite musical note, be stopped half way, and either part again struck, the note produced will be an octave above the original note. This may be at once perceived on the guitar; where either of the six strings stopped upon the twelfth fret (half way) will produce the octave of the original string. The other ratios of sound most easily discriminated by the ear are of two to three; being that of the fundamental note to its fifth: next of four to five, or of the fundamental note to its third. If the fundamental note be indicated by four, then its third will be represented by five, its fifth by six, and its octave by eight.

Sound is a deceptive sense. We often imagine singings in the ears, real noise being absent, and the ventriloquist can cheat us just when he will. Still, this sense is less deceptive than vision.

From the sense of hearing we naturally pass on to that of seeing—vision; the two being nearly allied. This holds good, whether with Newton we adopt the opinion that light is the result of minute particles darted away from luminous bodies (a theory nearly obsolete); or whether we accept the undulatory theory, as it is called, based on the assumption that light consists of waves propagated through a certain very attenuated medium called 'ether.' Adopting the second theory, then will the close analogy between the phenomena of light and sound be too obvious for comment; but if the former—the Newtonian theory—the connection between the two will not be so apparent. To make it obvious, however, I need merely remark, that optical theories do not affect optical ratios. Whatever theory of light be chosen, the ratios of colours to each other are well ascertained and immutable.

As concerns the perception of light, the demonstration is almost absolute, that a special organisation, the eye, is indispensable. I say *almost*, for two reasons of diverse origin. First, mere regard for logical sequence will never warrant the naturalist in affirming conclusively that a creature low in creation *cannot* have any appreciation of light because it has no eyes. The postulate is not beyond all credibility, that mere surface relation of the skin of those animals with luminous emanations *may* constitute a sort of inferior seeing power.

The other reason is adduced as a pure matter of deference to those amiable but impressionable ladies and gentlemen—ladies mostly—the mediums, the clairvoyants and clairvoyantes. If what they allege be true, why, then it stands to testimony that some people can see with their fingers—ay, and other parts too,—with dorsal and glutæi muscles, for instance. These anatomical words are used for their brevity. Let the family doctor explain them.

I pass on to consider the question whether light can be developed from animal bodies *ab interno*, and be emitted. By pressure on our eyeballs we can produce the impression of luminous rings; and gentlemen who do the pugilistic records for sporting papers have often testified that so-and-so knocked fire out of somebody's eyes. Then, again, we have seen cats glare at us in the dark: phenomena all in accordance with the belief, old as Plato, that animals really have the power of generating and emitting light. According to that philosopher, the gods had given to the eyes just the needful amount of fire to make objects visible, but not enough to burn them up, or make them dangerous to objects their glances rested upon; which proves the inferiority of Greek to British young ladies. In the records of ancient and mediæval fable, however, one exception was recognised—the basilisk to wit, of whom more anon. In Müller's *Archives* a medico-legal case is mentioned in which a person was said to have recognised a robber by light struck from his own eyes; a statement to which the learned editor demurred.

Touching the eye-glare of cats and other predacious animals, it is enough to state that it can never be seen in complete darkness; moreover, as Prevost demonstrated, the eyes of a dead cat, even when cut out of the head, can glare as well as living ones. The conclusion, then, is obvious. Concerning the basilisk, of which I stand pledged to give account, the testimony was this: to wit, that, somewhere or other, there was some creature or another—whether dragon or serpent, not clearly made out—whose eye-glare was so deadly, that no other eye could meet his and live: no other eye save one, and that the weasel's. The basilisk destroyed every tree, plant, flower, or herb he came near save one, *the rue*. The weasel, cognisant of this, would gorge himself with rue, then go forth and hunt out and fight and kill the basilisk. We perceive a foundation for this tale. A certain East-Indian weasel-like creature serves the dreaded cobra precisely in this wise, and before going out to fight he dines on a certain vegetable, but not the rue.

Basilisk-hunting must have been dangerous sport for men, yet men were found to do it. The hunter carried a mirror in front of him, in which the basilisk met his own gaze, and fell down dead. Basilisks lived, it is written, until comparatively modern periods, only they seem to have changed their domicile from deserts and forests to mines and wells. The records of early mining abound with statements of people who, descending and meeting the basilisk's gaze, fell down dead. The explanation is plain; it was not what they saw, but what they breathed, that killed these persons. They inhaled some noxious gas; what we call choke-damp now. In respect of the poetry of vision, I can but casually note it. The painter's art, in so far as relates to colour, depends thereon; the house-decorator's, the dyer's, and calico-printer's. All that belongs to the harmony of dress is in the same category. Are these things not written in the book of Monsieur Chevreul?

Taste and smell,—we will take them together, inasmuch as they are nearly allied; *so* nearly, that it would be impossible to draw the line, in many cases, where one begins and the other ends. When one is disordered, so is the other; when one ceases to act, the other languishes in force. For example, most of us are supposed to know the difference by taste between port and sherry; yet if the eyes be blindfolded, and the two wines tasted in succession, frequent mistakes as to identity will result.

In matters of taste, *c'est le premier pas qui coûte.* Nobody who has studied the physiology of the senses, and who is in the possession of his own, would ever dream of uncorking bottle after bottle of Moët's, or Veuve Cliquot's, or Piper's champagne, at ten and six or thereabout, for the delectation of his guests. It suffices to *pitch* the gustatory key with either of these, then follow up with Swiss champagne at three shillings the bottle or so. The object is to please. The guests will *be* pleased: effect identical.

In discussing the qualities of hearing and vision, it was easy to prove the reality of a harmony—an accordance of certain sounds with certain *other* sounds, of certain colours with *others*. Exists there a condition of harmony between sounds and tastes each to each? The case is beset with difficulties, not experienced whilst sight and hearing were in debate. Whatever the subject investigated, the process of reasoning acquires precision so soon as the functions of number and quality can be successfully brought to bear. Acoustics and optics are both reduced to mathematical data and formulæ: not so the science of taste and smell.

Cooks—knights of the *cordon bleu*—will swear to the harmonies of gustation. The probability is, they are right; else why should there be repugnance to turbot with currant-jelly, or roast-lamb with soy? Perfumers, again, will tell you that the mingling of scents in such manner that they shall compose well, and come agreeably commended to the nose, involves a knowledge of smell harmonies both varied and profound. That, *too*, may be. One may accept the statement on faith; but one cannot make it the subject of mathematical demonstration.

From this, might it not seem that our Herschels and Brewsters, our Wheatstones and Savarts, are the mere plodding realists; our Udes and Soyers, our Piesses and Rimmels, the veritable poets—men inspired by an ardour they know not what? Again, *this* may be.

In all animals endowed with taste (some would seem not to have this sense), the special organism consists of the tongue and soft palate. Normally, taste is the result of soluble matter coming immediately in contact with the tasting organs: still, not invariably. Thus, electricity can give rise to the sensation of taste, as may easily be shown by many simple experiments. One of the most simple consists in bringing almost any two dissimilar metals in contact, then touching the line of contact with the tongue. Thus, if a disc of zinc be laid on the tongue *alone*, there is no taste; the same, if a disc of silver. If, however, the two be brought into contact, and then the tongue be applied to the point of contact, a saline taste will be experienced.

The organ of smell admits of much variation. Thus, in most aquatic animals there is no communication between the olfactory and breathing organs; the nasal chamber being pervious only in front. The chief difference between the olfactory apparatus of fishes and reptiles is, that in the latter there is always a communication with the breathing apparatus. In the invertebrata little is known about the organ of smell; though in many the sense is acute. The bluebottle fly, for example, not only deposits her eggs on gamey meat, but also upon a plant (the *Stepelia hirsuta*), the odour of which closely resembles that of animal putrefaction.

The mere acuteness of human smell diminishes by civilisation. Savages have the faculty in a higher degree than civilised mankind. Humboldt, in his political essay on New Spain, informs us that the natives follow up their enemies *by scent*, and that they have distinct terms for the smell of a European, a negro, and an American Indian.

According to Sir H. Davy, every individual has a different smell, and so has every road, lane, and path—to dogs. The Kalmucks are extraordinarily acute as to smell, sight, and hearing. They scent fires and camps at long distances, and have only to be near a brute to become aware of his presence by smell alone. Blumenbach, the German physiologist, testifies to the following personal experience, illustrating his own acuteness of smell. Accompanying once a London physician in his round, they came to a house where, on entering, the German *nosed* a smell like that of smoked bacon. Four mulatto children lay bedded within. The woman had married a mulatto.

Physiologists have frequently discussed the possibility of certain animals being endowed with a sense of which man knows nothing; and metaphysicians the question, What would constitute a new sense? 'The essential attribute of a new sense,' remarks Müller, 'is not the perception of internal objects, or influences which ordinarily do not act upon the senses; but that external causes should excite in it a new and peculiar sensation, different from all the sensations of our five senses. Such peculiar sensation will depend on the powers of the nervous system; and the possibility of the existence of such a faculty in some animals cannot *à priori* be denied.'

Now thus will we dismiss those faithful monitors, as they are called. Faithful—yes, but not infallible. They want close watching. Do our very best, they will often deceive—vision especially, as even the thimble-rigger can prove. Some amongst us do *not* do our best: some of us like to be cheated, taking it ill when people set us right.

Speculating on the probability of an additional sense, it is a comforting belief to cherish, and rational withal, that the same Being that gave us five might have given us more, and *may* hereafter. Then the mysteries that now perplex many will be unveiled; things seen now as through a glass darkly, as the sun manifest.

Uncomfortable, very, to hold the belief—with Mr. Babbage—in eternity of sounds. His notion is, that a sound once evolved never dies, but goes vibrating on for ever. Horrible belief! No wonder he tries to put-down hand-organs and hurdygurdies—worse still, German brass-bands!

The most remarkable instance of sense-deception that ever came under my notice, was that of a London master printer, who partook of undeniable Veuve Cliquot in my presence and on a fresh palate, believing it to be gooseberry wine! The case was as follows:—A certain barrister (a newspaper proprietor) was seated one morning over that nectariferous liquor, at chambers, in company with deponent. The printer was announced. Some little matter of finance it was that brought him there.

'If he sees us at champagne so early' (it was morning), said my friend, 'he'll press. I'll pass it off for gooseberry. —Gooseberry, sir; my mother's make; take a glass.'

He *did* take a glass—and he sipped, but spat out the wine, saying, 'Good imitation; but I've tasted better.' He was out of temper that morning.

INSANITY.

WHETHER human nature improves by lapse of time, or remains the same woof and weft of good and evil, mingled in the same proportions as of yore, is a question undetermined, perhaps indeterminate.

Optimists hold to the belief that, even on this earthly field, the clay-imprisoned soul of man, manacled and shackled though it be, can attain a goal; from which starting, other clay-imprisoned souls can onward pass, each to another landmark more near perfection. Pessimists, taking a gloomier view of humanity, believe that, considered all in all, man is pretty much as he was and ever will be: that if, in one respect, an advance towards goodness be made, in another it is counterbalanced by some compensating lapse toward that goal of evil which is the realm of fallen spirits—the 'kleine Gott der Welt' ever being and to be, partly god-like, partly satanic, else he would not be man.

Either assumption is compatible with the subject of this essay, namely, the amelioration which—of late years, far *too* late—has taken place in treating the insane.

Those amongst us who study the world's way of paying deference to humanity's better elements—to virtue, charity, pity, and whatever else of good lingers within us—must own each to his own conscience, though perhaps not openly, that the world—people, men and women—ofttimes, when seemingly most good, have achieved goodness by the propitiatory sacrifice of victims. It seems that the evil within us must have scope somehow, and upon somebody.

Could I not tell a tale about social victims—human beings on whom we vent our contumely, our scorn and wrath—to show how good we are—how great our repugnance to evil? Such a tale I *could* tell. Social victims I could muster and classify; proving my case by simple expedients of logic. However, this may not be.

Truth is a shining light. We affect to love its glow; but even as owls and bats, we mostly fear to look at it.

The world's social victims—Heaven save the mark!—are mostly taboo to print, and well-nigh to talk about.

One class of them, however, comes prominently to hand, and the specialty of its members is not of a kind to repel investigation. The special class to which my mind reverts is the one of which Mr. Calcraft, of stage celebrity, is typical. I wonder if there be anybody who will not agree without demur, that it is a base, a shabby, a *heartless* thing, to first decree an act necessary to be done, then, finding somebody to do it, make him an outcast—a moral leper for the doing.

Nobody demurs—of course not; but then, applying the general proposition to a special case, do we not see that the baseness, the shabbiness, the heartlessness, are precisely those of which the public executioner might justly complain, were he not steeled to circumstances?

It may do some of us good if we calmly call to mind what certain newspaper scribes, to show their gentle-mindedness, permitted themselves to write about the London executioner. 'That *shambling old man*,' who came 'cringing forward' to do his 'ghastly office.'

Shame upon ye, scribes! More unworthy are you than he! The sheriff is meaner than Mr. Calcraft; and, optimist believers in the improvability of human nature, I farther say, if your theory be made manifest by time, the day will come for the truth of this teaching to be also exemplified.

Obiter dicta this. To what point do I aim? whither do we drift? Simply to the treatment of insanity.

When the circumstance is narrated (and it is sober unvarnished truth), that up to the year 1770 the poor mentally afflicted inmates of Bedlam were exhibited for money to any morbidly curious individual who might choose to pay, then certain thinking people may indulge the hope that the social relations of public executioners may be improved in the course of time. Between the social status of the insane *as it was*, and their social status *as it is*, the difference is in no respect less marked than between the present case of a public hangman as it *is*, and as I conceive it should be.

Yes, up to the year 1770 the inmates of Bedlam, and other British lunatic asylums, were exhibited for money. The entrance-fee, first twopence, ultimately fell to a penny. See, then, the depths of utter degradation to which the insane had come to be subjected in this our Christian England.

Nor did we English stand alone in this matter. Foreign asylums were conducted on principles of no more humanity than ours. In some cases the discipline was even more cruel. In France, for example, it was customary for asylum watchers or attendants to go armed with heavy whips, and accompanied by savage dogs—not for show and pretence, be assured; both were used too frequently. The entrance-fee being paid, and the visitor passed within, he or she—for women would go to see the sight—had no cause to complain that little was shown for the money.

Horrors, active and passive, there were—enough to glut the most morbid mental being. Gaunt, spectre-like objects of flesh and blood, from whose sunken eyes the speculation of judgment well poised had fled, might be seen crouching and cowering on the floor of noisome cells.

Others, in whom the fire of fury burned, not only because of madness natural, but partly for reason of maddening ill-treatment received, lingered for long years together; chained and manacled so that they could assume no comfortable position.

Then there were special tortures, dignified by medical science with the name of '*remedial.*' There were *surprise-baths* and *roundabouts*, and, in some asylums, periodical whippings—whippings at the new and full moon, to be precise; the idea prevailing that exacerbations of madness were at such times to be specially apprehended. The idea of periodicity had taken firm hold on the minds of physicians accustomed to deal with the insane: it would be hard to say on what evidence. In addition to periodic whippings there were periodic bleedings, and other modes of depletion. Inquisitors' torture-chamber barely exceeded in its means and appliances of pain-infliction British madhouses—*asylums* let us not call them—of olden time.

The better to impart a verisimilitude, it may be as well to assume the case of an imaginary patient, consigned to a British madhouse even no longer ago than the beginning of the present century; and I would preface by observing that, for each item of treatment to be announced, ample testimony exists in the writings of Conolly. Take also Esquirol, Pinel, Cousin, Thouret, Cabanis, and others of the glorious band of philanthropists who have at length succeeded in bringing French as well as British, and *almost* all, if not all, European and American asylums for the insane to their present state of amelioration.

Assume the patient to have been conveyed to some asylum under the restraint of a strait-waistcoat or manacles; probably of both. He has been consigned to the authorities; his treatment is about to begin. That treatment might vary with the practice of different establishments, but it would most probably commence with the discipline of what was called a 'surprise-bath.'

The demented sufferer, being set down at one end of a corridor, was either enticed or driven towards the other end; before reaching which the surprise awaited him. Midway were placed some loose planks, or else a concealed trap-door; whichever it *might* be, the patient must step thereon. Underneath that trap a cistern of water lay yawning; and now the tale is told—the nature of a surprise-bath made evident.

Once committed to the water, the unfortunate maniac remained there for a period that might vary according to the conscience, or the behests, of the medical attendant.

Frequently the intent was, to keep the patient there until the very moment when drowning might be considered imminent; and this known, who can doubt that drowning under this presumed remedial torture has actually occurred?

Taken from the surprise-bath, the miserable patient would undergo farther discipline—variable according to the result attained, the gravity of his symptoms, and certain other circumstances. Probably the patient would be depressed for a time; his bodily strength lowered; his shattered mental faculties prostrated by terror. In that case the patient would probably be consigned to a gloomy cell, either chained to the wall or bed, or else cramped by a strait-waistcoat. He might, however, on regaining his shattered faculties work himself into a condition of fury: a state which, according to the notions then prevalent amongst mad doctors (as they were called, and as they fully deserved to be called, though for a reason not contemplated by them), needed the infliction of some greater torture.

This was ready to hand through more agencies than one, but especially through the 'gyrator' or roundabout. Most of us have seen the roundabouts with which British children amuse themselves at fairs: some of us have experienced the quality of their circular locomotion. To adults the results are a giddiness and a feeling of sickness most oppressive; and even in the case of children a very little of this circular amusement goes a long way. The common roundabout machines used at fairs are driven at very moderate speed; yet even with them forced persistence in the motion, subsequent to the period when unpleasant symptoms begin, would be intolerable.

One can readily imagine how great the torture must have been inflicted by madhouse gyrators, the revolutions of which were accomplished at velocities up to one hundred times per minute or more, and prolonged to the last possible minute next to death.

Were the associations connected with this horrible machine of torture not so repulsively painful, one might find a sort of grim humour in the fact, that the inventor of this machine was actually regarded as a benefactor to humanity in his generation. The various applications of this machine were codified into a system. It was established, that in the treatment of certain forms of insanity the recumbent position was best for a patient; in certain other forms, the prone and supine. Never, perhaps, had humanity been so grimly travestied into horrible torture.

Pause we now to indicate a fact not very creditable to those amongst mankind who profess the benignant faith in Him whose motto was 'Peace on earth and good-will to man.'

It is a fact that, in certain respects of social government and discipline, Christians have shown a degree of cruelty unmatched by Pagan, Jew, or Mohammedan.

The history of slavery proves this. Heathen nations of antiquity had mostly the institution of slavery amongst them; but they were not, as the rule, cruel to their slaves. Mohammedans neither were nor are. Every one at all conversant with the political and domestic history of Mohammedan peoples must be well aware that slavery, whether male or female, is amongst them not inconsistent with family ties of patriarchal rule.

Of women Mohammedan slaves I say nothing, inasmuch as kindness to them may be assumed by one of views opposed to mine as referable to the influence of sex and beauty. The treatment by Mohammedan peoples of their male slaves must be the ground upon which the general proposition will have to be substantiated. It abundantly suffices, examples being numerous in which male slaves among the Turks, even at this day, have outlived any stigma that might have originally attached to their condition of slavery; have risen to offices of high rank, their slave origin forgotten or unheeded. Social treatment of the insane—up to a period not long gone by—furnishes another instance of Christianity failing to illustrate the precept of good-will towards mankind, which ostensibly lies at its foundation.

Civilised pagan nations regarded their insane as individuals filled with a certain divine afflatus; and amongst Mohammedans the demented have ever been cared for with tenderness and respect. It was the sad specialty of Christians to treat their insane cruelly. The idea of demoniacal possession brought this about. Tacitly, if not openly, the belief prevailed that aberratiou of reason, by whatever name designated, was directly referable to possession by some evil spirit. This idea once engrafted on vulgar or unreasoning minds, caused much of the evil to which the insane were subjected.

Mingled with the character of even the best of mankind there exists a certain lurking germ of cruelty, ever ready to spring into life and action under favouring influence. Of the institution of African slavery in the Southern States of North America, the remark has often been made, that the deteriorative influences of the system are not illustrated by the negro race alone, but in a higher degree upon the whites. The power of inflicting pain upon the subject race is said, in this instance, to have begotten insensibility to pain. In madhouse management of olden time unquestionably this occurred. Tortures from which attendants, brought up under the milder example of recent times, would turn with loathing and horror, were, up to the end of the last century, and, indeed, the beginning of the present century, enacted with complacency, nay, under the belief that the perpetrators were doing an act of justice to God and benefit to mankind.

As though the surprise-bath were not bad enough under its ordinary form of application, one ingenious individual actually suggested, that it would be all the better for patients, could they be let fall into the water from some high tower!

Another monster of cruelty—a German, by the way—gravely stated his belief, that the weak minds of certain insane people might be brought to a fitting conviction of weakness through the discipline of letting the patient down into a pit holding snakes, scorpions, and other fright-begetting creatures! To be brief, the general treatment of insanity at the times now under notice may be described as having for its foundation the belief, that people had no right to be mad any more than they had a right to be thieves, murderers, or vagabonds.

When, and under what circumstances, did the first dawning gleam of compassion break upon the minds of mad doctors and other guardians of the insane? At a time not seemingly germane to feelings of pity and compassion, yet which will be found to have initiated ameliorations of human discipline tender and compassionate—the great French Revolution. When the thunderstorm rages, we quail before the fury of its wakening; we stand aghast at the desolation of its wrath. When the storm has cleared away, the black clouds, riven and wafted, scattered; zephyrs, sweet and refreshing, stealing by; the sun shining with tempered blaze, Nature wakening as a spirit from death—then we own the thunderstorm to have come in its wrath, that peace should follow, the fury gone by.

We too often remember the moral thunder of the great French Revolution—the blood—forgetful of the sacrificial cause on behalf of which it flowed, the many blessings which followed. Let the fact never be forgotten, that the social perturbation out of which emerged Robespierre and Marat, Cartier and Fouquier Tinville, also brought forth the decree abolishing judicial torture in criminal cases, doing away with the gabelle, and—what concerns us most here—initiating the mild or non-restraint system of treatment for the insane.

The name of him who first proclaimed that insanity was a misfortune, not a crime—that scourges and attacks by savage dogs were *not* befitting the attendants of a madhouse, was Pinel, who entered on his duties at the Bicêtre in 1792. The affirmation of a principle was indeed laid down; but vast subjects of political interest began to engross people's minds. The humane or non-restraint system cannot be said to have been fully acted upon in France until 1818.

In this country we were slow to accept the foreign ameliorations. Although British madhouse attendants had never been in the habit of groping along the wards accompanied by savage dogs, yet whips were as ordinary an adjunct to the attendants, as muskets to infantry, or sabres to hussars; nor were they seldom used.

As is not unusual, the chief cause which brought about amelioration of madhouse treatment was the culmination of existing abuses to a point at which they challenged public opinion. Certain enormities perpetrated within the walls of the York Asylum led to investigation; investigation to a disclosure of horrors that the mind of an examiner now fails to realise.

When the fact is stated, that within the torture walls of this institution several insane people died, no traces of them ever having been discovered, the gravest suspicions will arise concerning their mode of disposal. The end of this institution was worthy the iniquitous system under which it had been conducted.

A dishonest secretary set fire to the building, hoping thereby to destroy the books, examination of which might, by their omissions, stand up in silent accusation. A public scandal followed greater than any which had preceded. An inmate, a member of the Society of Friends, sent to that institution in 1791, had been subject to gross ill-treatment.

Members of that community—using the practical common-sense benevolence for which they are so justly celebrated—did not complain so loudly as many others whose concern in the matter was less direct. They did better—they established an asylum of their own, under the title of the York Retreat ;* and within the walls of this place the non-restraint system was first initiated in these isles.† Slowly, other institutions adopted the non-restraint system; until the last traces of the old *régime* vanished from amongst us. At the present time, we English have gone beyond even the most advanced continental nations in the adoption of measures of humanity to the insane. Amongst us, for example, the strait-waistcoat has been wholly discontinued in asylums; whereas on the Continent it is still used in extreme cases. Seeing this *is* so, the question will suggest itself to minds new to the contemplation of insanity and its treatment, how the violently-demented are to be treated during the paroxysm of violence. The plan adopted is simple; founded on an appreciation of the obvious truism, that no paroxysm of temper—*and raving madness is nothing more*—will last permanently, if it meet with no opposition.

Dr. Conolly draws a vivid picture of the phases of mental change which occur to a raving maniac under the system of non-restraint, which he was among the first to inaugurate in this country. He desires the reader to imagine to himself a patient brought to an asylum strait-waistcoated or strapped-down to a stretcher. The patient is furious, as well he may be, insanity or no insanity. No insanity! The poet did not err when he wrote us down *all* insane. The experience of nearly 2,000 years has neither added nor detracted by one jot or tittle from the aphorism of the Roman satirist. It is now exactly as then—

* The chief promoter was the late William Tuke, of York.

† Neither the Tukes nor Pinel wholly did away with mechanical restraint. Charlesworth attempted that; and Gardiner Hill first carried it out at Lincoln.

'Quisnam igitur sanus? qui non stultus. Quid avarus?
Stultus et insanus. Quid? si quis non sit avarus;
Continuo sanus? Minime . . . . .'

Following Dr. Conolly's description of what happens to a raving maniac conveyed to an asylum on a stretcher as just described, the first thing done is to loosen the bonds, of whatever kind, and set the patient free. He is watched, of course: quick eyes are upon him; strong hands are ready to seize him, should he abuse the liberty thus suddenly given.

The immediate effect is often marked. Frequently the patient, after gazing about, after seeing that only kind-looking countenances regard him, vindicates the aphorism that we are all insane, by acting pretty much as one of us would do. The patient frequently grows tranquil on the instant. It may be otherwise, however. It may be that the paroxysm of fury has not yet expended itself; in which case recourse is had to the seclusion of the padded room. Fancy a chamber, every aspect of which, the ceiling excepted, is an expanse of soft mattress, and the mind has presented to it the exact resemblance of an asylum padded strong-room.

Into a place of this sort the refractory patient is gently conveyed, and the lock turned upon him. High up, far beyond his reach, a small window gives entrance to a gentle light. The door, seemingly as any other door, has an ingenious contrivance provided; a sort of elaborate peep-hole, through which every part of the chamber and its occupant may be inspected from the external corridor, without the patient's cognisance of the inspection made. Within this chamber the maniac then is left to expend his fury.

Does he rush violently against the walls? No matter; they are soft and yielding. Does he cast himself upon the floor? Again, no matter. In a paroxysm of suicidal rage the maniac perhaps essays to rend the cushions, to tear-out strips wherewith to strangle himself. In vain; that has been provided for — the material is of such sort that ligatures cannot be made out of it. The end is, that the furious maniac discovers in time the padded chamber to be heedless of his fury. He calms down, and is thenceforth placed in the social state, thus to speak, to which his manners entitle him.

A difference of social state there is in every well-regulated asylum. Writers on this branch of human suffering are unanimous in recommending that the insane should be treated, to as great an extent as possible, in accordance with the position in life to which they have been individually accustomed. Dr. Conolly relates an anecdote of a gentleman stricken with insanity, who, having been treated like a brute, turned brutal, every vestige of his former refinement departing. It was at the time when the system of non-restraint was first being inaugurated. This gentleman's friends had him conveyed to one of the asylums managed under the gentle system; and, amusing to relate, even though the theme be sad, the poor gentleman's cure was more than half effected through the influence of silver forks, clean dinner-napkins, and polite attendance! The subject of insanity, interesting at all times, seeing that if indeed each of us be not insane, either of us may be, seems of especial interest to me now, having had opportunities of studying the awakenings of wandering human intellect under the influence of poetical declamation and music.

An accomplished actress has long been in the habit of delivering recitations to the insane inmates of the various lunatic asylums that she finds within the scope of her theatrical engagements. I was present at two entertainments of this sort given to the inmates of St. Luke's, and on each occasion was much gratified. The proceedings opened both times with some good instrumental music, piano and violin, the executants being patients.

The piano-player was a lady, who happening to sit next me at supper, I entered into conversation with her, not knowing at the time that she was insane, and not from the tenor of her conversation inferring it.

Music over, recitations began, and little fault would have had to be found at the demeanour of the audience, even on the hypothesis of their being sane. They seemed to be moved by points and phases of varied interest, just as you and I might have been moved. They sighed, and I think a few wept, at an impersonation of *Juliet.* They laughed immoderately at a certain humorous account of a certain auction-sale of old bachelors, whereat all the old maids attended, bidding furiously one against the other, each old maid taking unto herself an old bachelor, carrying him away across her shoulder, and disposing of him according to the teaching of the proverb, that a man, and *à fortiori* a woman, may do what he (she) likes with his (her) own.

I heard no sighs where merriment should have been; I heard no laughter at unseemly periods. Everything was peaceable and orderly; all patients and visitors alike seemed bright and happy. The most insane-looking individuals I saw there were two visitors; one, a gentleman, a mild handsome-looking blond of benevolent aspect, who, on the principle, I fancy, of like attracting unlike, which holds good of personal attractiveness, though not of homœopathy, had been drawn away from the company of a demure ancient spinster, whom he attended, by some irresistible force, down between two magnificent-looking young lady visitors. Thence his head and shoulders only just rising (like Aphrodite's from the sea-foam) above the billowy upheavings of gauze and gossamer, and God knows what, looked wildly anxious from face to face:—an evil-looking fellow, with long phiz, grizzly moustache and imperial, who sat near (a patient, I think), all the while teasing him.

The other insane-looking individual was in love, I fancy; which, if made out, will account for his behaviour. At supper he kept squirting a fluid out of one of Rimmel's tin fountains right across the table, over the hair and into the eyes of a pretty little brunette, his *vis-à-vis*. These two fellows seemed to me, calmly looking on, as madder than the mad people.

A TRIAD OF MEDLÆVAL MYTHS.

THE BASILISK.

It has been sometimes made a matter of regret, that Science, which is knowledge in its largest sense, should interfere with mythic lore, explaining one by one a number of time-cherished mysteries. In such regret I do not participate, well aware that Science opens out the existence of more mysteries than she conceals. The mathematician knows full well that two lines may continually approach yet never meet; a condition even to him a mystery. The chemist knows that one and the same element may appear under the guise of two different forms—as charcoal and the diamond, as ordinary phosphorus and allotropic phosphorus; the former poisonous, the latter not. What can be a greater mystery? Let us not disparage Science, then, because she explains certain things to our forefathers inexplicable; rather let us feel grateful that her pure light, beaming upon the field of our limited faculties, reveals some fair gems of truth.

Chemistry and zoology have both had to do with revealing the mystery of basilisks and cockatrices, things which may be regarded as synonymous. This being so, it may not be uninteresting to recite how the revelation came about; to state by what train of reasoning and experiment ancient and mediæval lore has been robbed of one of its strangest monsters, and the world set at rest concerning what, if real, would be its direst enemy.

Credence in the reality of basilisk existence prevailed from periods of great antiquity, down through mediæval ages almost to our own times. If the basilisk and the cockatrice be considered identical, then mention of it occurs in the Bible. Greek and Roman naturalists frequently mention the basilisk; indeed, the very name is Greek, and has reference to something of a kingly nature. According to the Greek and Roman belief, the basilisk was a kingly serpent, chief among other serpents; one at the sound of whose hiss all other serpents crawled away. Well they might, were the kingly serpent's chief attribute real.

The fable passed current that no living thing save one, the weasel, could gaze upon the basilisk's eye and live. Besides this terrible faculty, it was believed that the basilisk withered every living plant it might touch save one, the rue. The creature's very breath was reputed poisonous, even from afar off. I am not aware that any ancient writer described the basilisk as winged, though in mediæval times the monster gained that attribute occasionally. From the dawn of Christianity onwards to a certain period, the cockatrice type of presentment for the monster came to prevail; the creature being described, and in some cases depicted, as having some resemblance to a cock. Invariably, however, the basilisk, whether of serpent-like or cock-like type, was represented pictorially as the wearer of a kingly crown, emblematic of his regal attributes. Next came a farther mutation of popular belief as regards this creature. No longer a serpent or a twelve-legged cock, the basilisk came to be regarded as a sort of eminently poisonous toad. The habitat of the monster, too, had changed. Whereas in more ancient times the basilisk had been wont to dwell in the full glare of an African sun, basking upon desert sands that his fatal eye-glance had made a solitude, the basilisk of latest times took up his abode in wells and mines and tombs, striking down with fell eye-glance people who might descend incautiously.

Frequently, when reading mining experiences of the sixteenth and seventeenth centuries, one will meet with circumstantial accounts of individuals killed by looking upon the eyes of a basilisk; and invariably the accident has happened in the recesses of some cave, or the depths of some mine or well. So generally did the belief in basilisk-eye poison prevail in England, at least up to the beginning of the last century, that a writer on natural philosophy of that date circumstantially accounts for it. Discussing the venom of poisons generally, it was his object to prove that their action depended on a mechanical function. He would have his readers believe that poisons acted through the laceration caused by the sharpness of their particles. Taking this as an established fact, he goes on to set forth how *very* sharp the particles of certain poisons may be; seeing the basilisk-poison acts through a mere eye-glance. This author does not seem to have the remotest notion that the basilisk might be a fabled creature merely. He writes with the same confidence of this animal that a naturalist now might write concerning the rattlesnake or cobra di capello. One point of testimony more our author notes, viz. that basilisk-poison cannot act through spectacle-glasses.

After what has been stated concerning basilisk attributes, it may seem extraordinary that Greek and Roman naturalists treat of basilisk-hunting. Excitement of the chase is proverbially fascinating. In all times sportsmen have for amusement courted danger. The question is not so much whether sportsmen would now go out basilisk-stalking, were the creature really in existence, as how they would devise a way to kill him. One must needs see the prey to be brought down; but how to see the basilisk, and not be oneself brought down? I am not quite certain whether the basilisk was held to be harmless if viewed posteriorly; but even granting that to be so, the creature might turn his head. Then, too, be the fact remembered that his breath was poisonous. It does not seem easy, I repeat, to imagine a way of killing the basilisk. The ancients represent basilisk-stalking to have been conducted in the following manner: People went out into the arid deserts where basilisks did congregate, each person bearing a mirror. This was the only weapon. The hunters advanced, each holding the mirror well before him. The sands were well explored; and if, in the course of beating, a basilisk should chance to gaze upon the mirror, back came his own glances reflected. He was a dead basilisk forthwith. This system was ingenious; but it must have been awfully dangerous and most abominably slow.

There is usually some foundation for every myth, and the basilisk myth is no exception, whether we study its ancient serpent phase or its mediæval toad-like mutation. If the part of the ancient tale which relates to the immunity of the weasel in presence of the king of serpents is reflected on, the naturalist is reminded of the well-attested relations between the cobra di capello and a weasel-like animal called the mungoose. Not only is this little animal fearless in presence of the dreaded cobra, but no sooner does he meet with this serpent than he violently attacks it. If bitten, as sometimes happens, notwithstanding that the mungoose is wonderfully agile, he runs away, eats of a certain herb which acts as an antidote, then returning to the attack, does not desist from battle until the cobra lies dead. It is easy to perceive that the Greek and Roman accounts of the immunity of the weasel in presence of the basilisk have reference to this well-attested fact in natural history.

Equally comprehensible is the basis on which the fable of the cave and mine and well inhabiting mediæval and modern basilisk is reared. Occasionally it happens now that persons who enter those places are struck down dead on the instant, as though they had swallowed a dose of prussic acid; but the occurrence is now referred to the breathing of some mephitic gas. The Grotto del Cane, near Naples, has long been celebrated for this reason; and the fabled effects of the upas tree of Java are only a mingling of two distorted facts. Certainly a very poisonous tree *does* grow in Java, and its name is upas. The sap only of that tree is poisonous, not the emanations of it. However, there does happen to exist in Java a certain deep excavation or valley, about half a mile across, and it is filled with heavy mephitic gas, probably sulphuretted hydrogen.* No animal can enter that valley and live. Wherefore bones are strewn all about, and carcasses lie rotting. The accumulated mortality of ages has made this valley horrible to gaze upon.

What we now call choke-damp in mines, especially coal-mines, is nothing else than an accumulation of carbonic acid gas. If breathed, it kills on the instant; and before pneumatic chemistry had come to be what it is, the fatal result would have been charged to the gaze of some basilisk. Now it so happens that toads *will* live in atmospheres so poisonous that man breathing them would die. Putting all these facts together, the basilisk mystery stands revealed; fiction is deprived of a fable, and science has gained some facts.

VAMPIRES.

SPECULATING on the use and misuse of words, an inquirer after truth may, without equivocation, reasonably doubt whether the word 'supernatural' has any real significance. If Mr. William Howitt should see—as he so often has seen—three-legged tables dance fandangoes; if he should hear—as he often has heard—soft music discoursed by harmoniums touched by invisible hands; if Mr. Home, defying gravitation, should ascend to the ceiling and flit about—as he so often has done—I do not know that anybody has more right to call these things supernatural,

* Sulphuretted hydrogen (or hydrosulphuric acid) is *not* a light gas, as I have seen stated in more than one popular book, but a heavy gas. Its specific gravity is nearly one and one-fifth (taking air as unity), or exactly 1·1798.

than I have to doubt the facts recorded. Made cognisant to human nature by that great resultant of law and forces which we agree to call simply *Nature*, how can any manifestation to human senses be justly called supernatural?

All discovery must have a beginning. Phenomena observed before the reason of them is made apparent always seem mysterious. The question, 'how an apple'—a gross corporeal thing—a material entity, to adopt the language of science—'gets into the middle of an apple-dumpling,' provokes no nine-days' wonder now; time was when it puzzled a king. Solomon was a wise man, and so was Socrates, and so was Solon: would they not have considered it a mysterious thing, had they seen messages sent by electric telegraphy to places thousands of miles away?

When Pizarro awoke the echoes of temples of the Incas, by firing-off his Spanish field-pieces, I wonder whether the Aztec priests did not regard the case as supernatural? On consideration, I think Mr. Howitt, Mr. Home, and every other gentleman who has had visional relations with the spirit-world, who has touched that fringe of which Mr. Howitt somewhere speaks,—the peculiar fringe which, according to him, descends upon earth from some celestial upholsterer's shop up above,—will own, on consideration, that nothing has happened or *can* happen, nothing which has been seen or *can* be seen, that has been heard or *can* be heard, that has been felt or *can* be felt, that has been smelt or *can* be smelt, should be justly called supernatural.

I am one of those who have come to the conclusion, that more harm comes of believing too little than of believing too much. For my part, I believe almost everything that is recorded by a man of good repute, provided that my own experience does not disprove it; and, in a general way, I believe *everything* that is told me by a lady. It saves a world of trouble, this unlimited faith; it has the merit of being logical too, remembering how impossible it is to disprove a negation.

After making this confession of faith, it will not seem wonderful in the least degree that I have been studying the manners and customs of spirits, hobgoblins, creatures of the elements, such as undines, sylphs, salamanders, gnomes, fairies, and the like; witches, wizards, sorcerers, augurs, necromancers of various countries and of various epochs; creatures, in short, that some people denominate—incorrectly, as I believe, and have sought to prove—'supernatural.'

Yes, I have been studying them all in many a recording page; from the mouldy and worm-eaten tomes coeval with the discovery of printing, to the railway volumes with many-coloured binding, reminding one of the particoloured coat of Joseph. Yes; things falsely called 'supernatural,' I have been studying them all; and not least carefully those beings so horrible, so dreadfully curious, so dangerous withal—concerning which some few explanatory words shall presently be written—the wandering bloodthirsty vampires—Vroucolakas or Broucolakas of the Greeks.

Perhaps there never was yet an extraordinary revelation vouchsafed to the faithful, concerning which sceptics and scoffers—people of science, as they call themselves; those men of dwarfed and paralysed minds, so beautifully portrayed by Mr. William Howitt — have not suggested some mean and grovelling imputation, the acceptance of which would reduce the facts narrated to the category of mere superstitions, fostered mostly by churches and by priests. Accordingly, in respect of vampires, I have seen the statement made, that the assumption of these creatures as realities is referable to a certain pretension that an individual dying under sacerdotal ban, and being interred, could not decay after the manner of honest corpses committed to earth.

A *pretension indeed!* as if the learned Michael Raufft, who wrote a learned book *De Masticatione Mortuorum in Tumulis*, is not worthy of all credence. As if the learned book of similar title, published by Philip Rehrius, could leave the matter in doubt. I grant that the recitals published by these learned authors do not abound with such deeds of active vampiredom as form the subject of popular tradition in places where vampiredom is most rife: but they are conclusive as to the main basis of belief on which vampiredom rests; affirming that divers human corpses have been known to retain a sort of spurious life, to move in their graves, to eat whatever came within the reach of their unhallowed jaws, to be heard munching and masticating like swine,—whence the title of the book, *De Masticatione.*

Ghosts, hobgoblins, and, to be short, all other beings which certain superficial thinkers call supernatural, had been made matter of study long before tables began to speak, or even to turn. The learned Calmet gave much attention to pneumatology; vide his book in proof of it.* I think the following sentiments, enunciated in the preface to that book, will come commended to the appreciation of many; and I would humbly call attention to the highly important place the learned writer accords, in the science of the so-called supernatural, to the particular hobgoblins (if by their leave we may call them so) of which I shall have to treat.

'It is always a matter of regret,' writes Calmet in his preface, 'to have deceived one's self; and it is dangerous (speaking in a religious sense) to believe on insufficient grounds, to deny rashly, to remain in wilful ignorance, or to voluntarily continue wrapped in superstition or illusion.' A good deal will have been achieved by an individual who has learned how to doubt wisely, in such way that he does not allow his judgment to range beyond his testimony. That which has most impressed me in the matter concerning which I treat is the recitals I have met with of vampires, or 'reve-

* 'Dissertations sur les Apparitions des Anges, des Démons, et des Esprits; et sur les Revenans et Vampires de Hongrie, de Bohème, de Moravie, et de Silésie. Par le R. P. Dom Augustin Calmet, Religieux Bénédictin, et Abbé de Senones en Lorraine. Paris, MDCCXLVI.'

nans' of Hungary, of Moravia, and Poland, of the Broucolakas or Vroucolakas, so called by the Greeks;—all excommunicated bodies which, it is said, are unable to decay.

The remark has been made by the Rev. H. Christmas, translator of Calmet's book *Sur les Apparitions*, that Calmet seems less disposed to believe in vampiredom than in any other manifestation of the so-called supernatural; that receiving the attestations of almost every sort of apparition without cavil, yet the French divine, rather indirectly than directly, seems to throw some sort of doubt on the history of vampires.

The reverend translator starts an hypothesis to account for this, which probably may be in some measure correct. He says that the records of vampiredom have especially belonged to people holding to the Greek or Eastern faith; for which reason a French divine would not be unlikely to cavil at the testimony handed down in relation to these beings.

Perhaps it may be here just as well, before proceeding farther, to explain, for the benefit of all who may require the information, what manner of being *exactly* a vroucolaka or vampire is. Truly, the name is common enough; but the meaning of many names one could mention is partly or even wholly unknown, though they are in the mouths of most of us, and come trippingly enough on the tongue. Awhile ago, a very popular author, yielding to impulsiveness, wrote that he would wake the *welkin;* then presently, laughing at himself, he confessed total ignorance as to what the welkin exactly might be. A vampire, then, is—well, what shall we say? Not a ghost, certainly; except we alter most of our existing notions of a ghost. The best definition I can give of a vampire is a living, mischievous, and murderous dead body. A living dead body! The words are wild, contradictory, incomprehensible; but so are vampires.

Assuming as true the records about dead people moving in their tombs, eating therein, coming therefrom, with or without murderous intent, the learned Calmet devotes entire pages to a reasoned debate upon the case. He touches on the mysteries of life and death; he sets forth the extreme difficulty of accounting for the phenomena of a corpse rising from the tomb without disturbing the earth; of returning thereto without disturbing the earth; of the utter unmeaningness of a ghoul such as this taking pleasure in the molestation, even murder, of its once dearest friends. Lastly, he asks how it can be that a dead body, out of which the soul, the life, hath fled, can yet retain a second life? All this he asks, and more; he throws doubt on the case, but nowhere expressly denies the existence of vampires. I think he tries to make it seem, inferentially, that vampiredom is wholly an illusion, a fiction of the Greek Church; but he almost cuts the ground from under him, by presenting certain records of living dead people, which come very nearly up to the mark of vampiredom. He quotes the German authors Raufft and Rehrius, concerning whom mention has already been made, seemingly disposed to believe much they have related concerning the gluttony, the swinish munching, practised by certain evil-disposed corpses.

'Raufft takes it for a certain conclusion,' writes Cardan, 'that certain corpses have been known to devour the grave-clothes and other things within their reach, nay, even their own flesh.' He remarks, that in certain parts of Germany, in order to prevent this horrible habit of underground feasting, grave-diggers are accustomed to put a good hard packing of earth under a suspected corpse's chin: that, moreover, to make security doubly sure, *some* grave-diggers place in the mouths of suspected corpses a little bit of silver, or else a stone, taking the farther precaution to tie a handkerchief tight about the throat.

Certain of the milder and least mysterious tales concerning dead-alive people admit of a sort of half-explanation, by adopting the hypothesis of trance; as, for example, the following cases narrated by Calmet:

The Count de Salm, having been thought dead, was buried alive. As night approached, great cries were heard in the church of the abbey of Haute Seille; and the following morning, his grave having been opened, the corpse was found lying face downwards. Once upon a time, at Bar le Duc, a man having been interred, a sound was presently heard to come from the grave; being disinterred on the day following, he was found to have eaten the flesh of his arms. This man had drunk brandy to excess, and had been buried as dead. Raufft bears evidence concerning a woman of Bohemia, who, in 1345, had eaten, whilst in the grave, about one-half of her shroud.

More extraordinary, and trenching more nearly on the domains of pure vampiredom, is the following, narrated by William of Newbridge, an English author who lived in the middle of the twelfth century, and quoted by Calmet. He states that, in his time was seen, in the county of Buckingham, a man who appeared bodily, as when alive, three successive nights to his wife, and after that to his nearest relatives. They could only defend themselves by watching, and making a great noise when they perceived him approaching. The creature even dared to show himself occasionally in the daytime; whereupon the Bishop of Lincoln assembled his council, who told him that similar things had often happened in England, and that the only known remedy against the evil was to catch the wandering body, and burn it.

The bishop could not at once fall-in with this; he thought the remedy cruel. He adopted another plan, and it was this: Having written a schedule of absolution, he placed it on the body of the corpse; and from that time no more of him was seen or heard. 'This sort of apparition would appear incredible,' wrote the author, 'if several instances had not occurred in his own lifetime, and if he did not know several persons who believed in them.'

The latter argument is, I humbly think, irresistible. The same author, Newbridge, states that a man who had been interred at Berwick came out of his grave every night, and made a great disturbance in the neighbourhood. He even boasted that he should not cease to disturb the living until they had reduced him to ashes. Thereupon the neighbours selected ten bold and vigorous young men, who took him up out of the ground, proceeded to cut his body to pieces, then burn it to ashes. But some one among the crowd having said that he could not burn until they had torn out his heart, his side was pierced with a stake. Through the opening thus made they extracted the heart, whereupon the body was consumed, and appeared no more.

It is a remarkable fact, and therefore worthy to be noted here, that amongst the pagan Romans the notion prevailed that dead bodies of certain persons were subject to be allured from their graves by sorcerers, unless incremation had been performed, or decomposition had actually taken place. On this point study the following allusion of Lucan—the words are represented by him to have been spoken by an enchantress to an evoked spirit:

> 'Tali tua membra sepulchro
> Talibus exuram Stygio cum carmine sylvis,
> Ut nullos cantata Magos exaudiat umbra.'

All this may have been, says Calmet; but that those who are really dead move their jaws, and amuse themselves by chewing whatever may be near them, is again, says he, a childish fancy—like what the ancient Romans said of their *manducus*, which was a grotesque figure of a man with an enormous mouth, full of big teeth, the jaws being moved by springs. The Romans frightened children with these manduci; hence the following allusion of Juvenal:

> 'Tandemque redit ad pulpita notum
> Exodium, cum personæ pallentis hiatum
> In gremio matris formidat rusticus infans.'

Some remains of the ancient custom may be seen in certain processions, wherein the figure of a serpent is carried, which ever and anon opens and shuts its jaws, between which cakes are thrown by lookers-on.

'Authors have reasoned a good deal on these events,' writes my authority. (1) Some have believed them to be miraculous. (2) Others have looked upon them as simply the effect of a heated imagination, or a sort of prepossession. (3) Others, again, have believed that there was nothing in them but what was very simple and natural, these persons not being dead, but acting naturally upon other bodies. (4) Others have asserted that it was the work of the devil himself. Amongst these, some have advanced the opinion that there were certain benign demons, differing from those who are malevolent and hostile to mankind. But what greater evils can one have to fear from veritable demons and the most malignant spirits, than those which the ghouls of Hungary inflict on persons whose blood they suck, and thus cause to die? (5) Others say it is not the dead who eat their own flesh or clothes, but serpents, rats, moles, ferrets, or other voracious animals, or even striges, birds that devour animals and men, and suck their blood. . . . It is added, that these vampires are known only to certain countries, as Hungary, Moravia, and Silesia, where plague, pestilence, hydrophobia, drunkenness, are most common; where the people, being badly fed, are subject to certain disorders, occasioned by climate and food. As to what some have asserted, that the dead have been heard to eat and chew like pigs in their graves, it is manifestly fabulous, writes my author. Such an idea can have its foundation only in ridiculous prepossessions.

From these remarks it would seem that Calmet is altogether sceptical about the narrations of dead-alive men and women. I do not know why he should be, since he does not venture to impugn the following still more extraordinary narration, communicated to him by a contemporary priest of his own church:

'A curé of the diocese of Constance,' he states, 'named Bayer, makes to me in writing the following relation. He states that, in 1728, he (Bayer) having been appointed to the cure of Rutheim, he was disturbed one morning by a spectre, who came in the form of a peasant, badly made, ill-dressed, and smelling abominably. He knocked at the door in an insolent manner, and, being admitted, entered the study. He then told the curé Bayer, that the prince-bishop of Constance had sent him (the hobgoblin) upon a certain business . . . but the statement was untrue. The hobgoblin then asked for something to eat; whereupon meat, bread, and wine were set before him. Taking up the meat with both hands, he devoured it, bones and all, saying, "Observe how I eat both flesh and bone: do the same!" Then taking up the wine-cup, he swallowed the contents of it at a draught; asked for another, which, when supplied, he served the same. Rising then, he withdrew, never so much as saying "Good-bye" to the curé. The servant who saw him to the door, having demanded his name, "I was born at Rutsingen, and my name is George Raulin," he replied; but he spoke falsely. Then turning to the curé, whilst going down-stairs, the hobgoblin said in German, "I'll show you who I am."

'He passed all day in the village,' Calmet's curé's letter of testimony goes on to state, 'showing himself to everybody. Towards midnight he returned to the curé's door, crying out three times in a terrible voice, "Monsieur Bayer, I will let you know who I am!" Day by day for three long years he returned towards four P.M., and every night remaining till day-dawn. He showed himself in different forms; sometimes like a water-spaniel, sometimes like a lion or other terrible animal, sometimes as a man, but sometimes (and this must have been the worst of all) in the guise of a pretty girl, sitting at the curé's bedside! Thus testifies Monsieur Bayer. Sometimes the hobgoblin made an uproar in the house, like a cooper hooping a cask. The curé, desiring to have witnesses, often sent for the beadle and other chief people of the village to bear testimony. At last the curé had recourse to exorcism, but with no effect.

'Despairing almost of being delivered from these vexations, he provided himself at the end of the third year with a holy branch, on Palm Sunday; also with a sword sprinkled with holy water. The hobgoblin was now soon to have the worst of it. Appearing again [whether in the form of a man or dog, a lion or a young lady, informant does not state], the curé first dashed the holy water in the goblin's face, then smote the being with the blessed sword. He did this once or twice, and from that time was no more molested. This is attested by a Capuchin monk, witness of the greater part of these things, August 29, 1749.'

Calmet declines to guarantee the truth of *all* these circumstances. The judicious reader may make what induction he pleases. If they *are* true, here, says he, is a real ghost who eats, drinks, and speaks,—giving tokens of his presence for three whole years, without any appearance of religion!

Sceptics may seek to throw discredit upon the narrations of vampiredom, by urging, what I conceive to be the fact, that although vampires have been seen by the thousand, have been known to leave their graves, and wander about biting and bloodsucking their once dearest friends; still, no authentic information is available relative to the manner in which they *leave* their graves, or the way in which they *go back* to the same.

No vampire, that I am aware of, has ever been caught in the very act of coming out of a grave, or going back again. The omission is not of a sort to shake the belief of any reasonable man in the general truth of vampiredom, knowing well, as all of us do know, that thousands of occurrences take place from time to time, under the very noses of people near, without their seeing what happens.

I once explored the battle-field of Waterloo, in companionship with a local guide, who, during that day of mortal strife, had been present in the amateur capacity of a suttler or canteen-bearer, ministering comforts to the wounded. Gazing from the summit of the huge mound whereon the Belgian lion stands—allegorical, in a certain sense, of Belgian bravery—I looked down on many a grave and many a trophied marble. Thick they were—thick those graves, those trophied marbles! —and I bethought me how far more thickly strewn on the evening of the day of strife must have been the writhing wounded, the shattered and gory dead! I pictured to myself the serried squares, belching their volleys at advancing French columns. I sought to reproduce the scene of men stricken by lead or steel, and suddenly laid low. 'They fell fast enough,' said I; 'it must have been an awful sight.'

'Parbleu!' interposed my guide; 'you may think it odd, but I did not see one man fall. They would come on. Then a volley, a bayonet or cavalry charge, a tremendous noise, fire, smoke, and all that; and when it was over, there they would lie, just like those sheep there, Monsieur; but, on my honour, not one fellow did I actually see go down.'

Very well; Calmet did not record, and assuredly would not wish it to be understood, that *revenans*, as he calls them —or, to be plain, disreputable corpses whom earth rejects—can be numbered by the million. He perhaps refers to some scores; and if nobody has ever caught one of these in the very act of coming out of a grave, what does this prove? Nothing, to my mind, after what the guide told me at Waterloo.

The act of munching in a grave, or even coming out of a grave, violates social proprieties truly, but nothing more. It is not every human mind, indeed, that is strong enough, or sufficiently well balanced, to look upon a horrible prodigy unmoved. If *revenans*, as Calmet denominates them, were more frequent than they are, then probably many spectators might be scared into fits or go mad outright; but if a disreputable corpse should get out of its coffin, and wander about murderously intent, wreaking vengeance all night, biting, bloodsucking, and going back to its grave before morning, it would be a very serious, a very *dangerous* matter. This is just what vampires do, nevertheless.

In like manner as sceptical people—the men of paralysed minds so beautifully described by Mr. Howitt, the paralysis having been induced by a too continuous study of what we falsely call the inductive sciences—find some absurd way of accounting for, or else denying altogether, the best-attested facts of pneumatology,—such as table-turning, table-dancing, spirit-rapping, spectral writing, luminous hands, mystical accordion playing, and other modern spiritual manifestations; so more than one writer has attempted to explain away the precise relations concerning dead-alive people of all varieties, from the masticatores of Ranfft to the vroucolakas of the Greeks.

Accordingly, it is argued, as already stated, that the milder, the less extraordinary of these recitals, are amply accounted for on the assumption of trance; and that the records of pure vampiredom, tales about dead-alive men arising from their tombs, stalking about, bloodsucking and murdering, are based on a pretension of the Greek church, to the effect that Mother Earth refuses to accept, and retain in her bosom, corpses of persons who have come under orthodox excommunication. It has even been accepted as a tenet of faith by the Eastern church, I believe, that no unorthodox corpse can possibly decay if buried in orthodox soil. There might be something in this view of the case, if records of dead-alive people were traceable only to authors of the pure Greek faith; but, in view of testimony from other quarters, considering that dead-alive people have been known to wander from their tombs in England, Germany, and elsewhere, it seems that the hypothesis cited falls to the ground wholly. It must be conceded, however, that vampiredom has received what we may call its highest development in countries the people of which acknowledge the orthodox Greek church. Eastern European vampires have always been more fierce, more murderously inclined, than corresponding beings of the west. Climate may have something to do with this; and perhaps temperament. Greek brigands are more terrible than others,—why not Greek vampires?

Even on matters most apparently transcendental, one can draw practical deductions. No harm can ever come of making security doubly sure. I am led to infer, then, that if a dead body, after a reasonable time of burial has elapsed, be still found soft and pliable; if it bleeds on puncture, and shows no sign of fulfilling the decree of *dust to dust*, there is room for the worst suspicions.

In such a case the unquiet and evil-disposed corpse can be laid by adopting one of two expedients. The first is, to cause the grave to be beaten with a hazel twig, the operator being a virgin of not less than twenty-five years old. The second expedient consists in digging the body up and burning it. My authorities leave me no room to doubt that the first and much simpler remedy is not equally effectual with the second; nevertheless, for some inexplicable reason, the remedy of incremation is always practised, in lands where vampires do most abound.

SALAMANDERS.

PERHAPS the basilisk, whose mystery I unveiled, is not so familiar in name to English people of to-day as the salamander. A certain wide-spread popular belief attributes to long-continued flame the power of generating a dragon-like monster—him of whom I write. Thus it was long a habit with glass-workers to extinguish their furnaces once in seven years, to avoid, as they believed, the generation of a salamander; and in the mining part of Cornwall, where 'fire-engines,' as they were once called, were used, a similar belief prevailed. The question to present itself is this: Was the belief a mere wayward prompting of the brain founded on nothing at all—not even a suggestion? or was it a distortion of some slight matter of fact? I shall soon resolve it to the latter.

As in the case of the basilisk, so here: the salamander has an ancient, a mediæval, and a modern history. The Greeks and Romans believed in a certain lizard, not only endowed with the modern salamandrine attribute of resisting fire, but also with properties of extraordinary venom. Not only was its bite considered fatal, its flesh if eaten deadly, but its evil influence was supposed to extend to living things it might have crawled over. Thus, if it crawled over a fruit-tree in bloom or bearing, all the fruit was believed to be poisoned; and woe betide the unlucky individual who should eat a herb on which a portion, be it ever so insignificant, of salamandrine saliva had fallen!

Aristotle had firm belief in the salamander. In his history of animals he cites the creature by name, adducing it in proof of what he believed the fact, that there was at least one animal over which flame had no power. As time advanced, the salamandrine attributes, in respect to flame, became still more extraordinary. Thus, according to Nicander, the salamander not only had the faculty of being absolutely impervious to flame, but no sooner came in the presence of fire, than the creature attacked it as an enemy. Dioscorides and Pliny attest the preceding facts; the latter swelling the list of attributes by yet another—according to him, salamanders are without sex.

This belief in salamanders having come down to mediæval times, got mingled with another, to no small degree inconsequential. It was affirmed they sucked cows and dried-up their udders. A similar belief prevails in respect to hedgehogs in some parts of England to this day. Comparing this allegation of salamandrine milk-theft with the attribute of mortally poisoning whatever living thing it might chance to crawl over, the impossibility of reconciling the one with the other is apparent.

The Romans considered the salamander to be equally fatal with aconite or hemlock. Two Roman proverbs attest the strength of the belief in the potency of salamandrine venom. 'He who is bitten by a salamander has need of as many antidotes as the creature has spots,' was one. 'If a salamander bites you, put on your shroud,' was another.

So deep-rooted had become this poisonous belief, that in later days we find Maupertuis considering it worth while to adduce some opposing testimony. He relates that a certain man, to whom his wife had administered portions of a salamander in hopes of becoming a widow, actually swallowed the flesh, yet continued to live. Maupertuis then records some experiments he had performed, and with the result of proving that salamanders were not so deadly as had been imagined. In one experiment he applied the teeth of a salamander to the thigh of a fowl, from which he had plucked the feathers, to the lips and tongue of a dog, and to the tongue of the fowl; in each case without any injurious result.

Galen thought it worth while to record that he knew the salamander *could* burn; a sufficient proof of the prevalence in his time of belief to the contrary. Equally fixed was the belief that any combustible matter became incombustible, if invested in the skin of a salamander. Accordingly, Marco Polo adverts to the belief, in speaking of a certain cloth sent by a certain Tartar king to the Pope. The garment was said to have been woven of salamander wool. A novel idea that a lizard should have been invested with wool—evidently the salamandrine attribute must have undergone some extension. This acute old traveller, however, divined the real truth, inasmuch as he quite correctly observes the so-called wool in question was none else than the mineral substance asbestos.

Amongst the ancient salamandrine beliefs must be noticed that it had a depilatory power. Thus, adverting to this belief, Martial wrote as follows:

> 'Desine jam, Lalage, tristes ornare capillos,
> Tangat et insanum nulla puella caput:
> Hoc salamandra notet, vel sæva novacula nudet,
> Ut digna speculo fiat imago tua.'

Salamanders' hearts worn as amulets were considered to be preventive against fire. Portions of the creature so reputedly poisonous were also used in medicine to cure leprosy. The alchemists also believed in salamandrine powers of transmutation. Hence these wretched reptiles, being placed in crucibles, and the latter heated on the coals, quicksilver was poured upon them until they died. To what extent the poisonous nature of the reptile was credited, may be inferred from the prevalence of the concurrent belief that the experiment was attended with danger to the operator.

Throughout these observations, I have written of the salamander as if under some certainty of its existence, which is more than I was enabled to do in respect of the basilisk. Indeed, the salamander is recognised by modern naturalists to have a present existence, in so far as the name is applied to a certain lacertine animal which may be occasionally purchased in London for the ornamentation of glass cases. It is a small creature, only a few inches long, wholly devoid of poisonous qualities, as indeed all lizards are, and its powers of resisting fire are of a moderate degree only, as will be gathered from the recitals to follow. We shall soon see from what small matters of fact large inferences may spring.

In the *Philosophical Transactions*, vol. i. p. 377, the following record appears: 'This came from that expert anatomist, M. Steno, to Dr. Croon Videl: that a knight called Corvini had assured him, that having cast a salamander, brought by him out of the Indies, into the fire, the animal thereupon swelled presently, and then vomited store of thick slimy matter, which did put out the neighbouring coals, to which the salamander retired immediately, putting them out again in the same manner as soon as they rekindled, and by this means saving himself from the force of the fire for the space of two hours. The gentleman above mentioned, being then unwilling to hazard the creature any farther: that afterwards it lived nine months: that he had kept it eleven months without any other food but what it took by licking the earth on which it moved, and on which it had been brought out of the Indies; which at first was covered with a thick moisture, but being dried afterwards again came. After the eleven months, the owner having a mind to try how the animal would do upon Italian earth, it died three days after it had changed the earth.'

In the preceding we find a record of a poor lizard, that must have been not a little tortured. When put upon the coals, it exuded a moisture, as *any* animal must necessarily have done; and lizards being low in the scale of creation can endure, without death, an amount of torture that would prove fatal to a creature of more highly-developed nervous system. Making allowance for some preconceived opinions, there is nothing very extraordinary in this record. An experimentalist, deeply impressed with the belief that his salamander must necessarily bear out the opinions entertained of it, would naturally tend to interpret phenomena to accord with his preconceptions.

The following salamandrine recital has reference to so late a date as the year 1789: A certain French consul at Rhodes—Pothonier by name—stated that, whilst sitting in his chamber there, he heard a loud cry in his kitchen. Running thither, he found his cook in a horrible fright, saying he had seen the devil in the fire. Thereupon M. Pothonier, looking into the fire, saw a little animal with open mouth and palpitating throat.

When first observed, the creature was perfectly quiet, and so remained until the consul tried to lay hold of it with the tongs. Thereupon it ran to the corner of the chimney; leaving the tip of its tail between the blades of the tongs. No sooner arrived at the corner, than it buried itself in a heap of hot ashes. Once more, the consul made an attack on the terrific monster that had so alarmed the cook.

Again did M. Pothonier seize his adversary with a pair of tongs, and this time successfully. He drew out of the fire some sort of small lizard, which he thrust into a bottle of spirits of wine, and sent it to the naturalist Buffon. The naturalist Sonnini happened to come soon after to Rhodes. He saw the bottled monster before its dispatch to Buffon, and divesting the recital of its supernaturalism, he reduced the prodigy to very small proportions. The consul—Sonnini testified—was a very amiable man, but completely ignorant of all that related to natural history. There was a lizard indeed—a somewhat mutilated lizard. The feet and some parts of the body were half roasted. The French consul's lizard salamander had been in the fire, and bore strong evidences of having come *from* the fire. Its feet, and some parts of its body, were half consumed.

Here then do we find a poor little lizard scaring a he-cook well-nigh out of his wits; and impressing a staid gentleman of consular dignity with superstitious feelings akin to awe. In this incident we see materials enough to account for the fire-defying part of the salamandrine myth. This was not the first time, doubtless, that a lizard had been cast amidst fire-wood into the fire, and that the creature's resistance to flame had been made manifest to observers. If a French consul's man-cook, in the eighteenth century, was struck with the portent — as it seemed to him and his master, made half credulous—what wonder that others had been the same when the world was younger, and that out of the belief came the fire-defying salamander?

In our own days, the cooling function of skin-transpiration is better understood than of yore. It is astonishing to what a high degree even the human body may be heated, provided the skin evolves moisture. It was once believed that the human body could not be, without injury, exposed even for a short time to a degree of heat much exceeding that of hot climates. The experience of Turkish baths teaches us better; but testimony had been adduced even before. The contrary opinion was strengthened by the result of some experiments made by Fahrenheit himself, and related by Boerhaave. He shut-up some animals in a sugar-baker's stove, where the mercury stood at 146° F., and with the following results: A sparrow died in less than seven minutes; a cat in rather more than a quarter of an hour; and a dog in about twenty-eight minutes. Probably the noxious atmosphere had even more to do with these results than the heat.

The truth upon this subject may be said to be the result of accident. It happened that in the years 1760-1761, MM. Duhamel and Tillet were appointed to devise some means of destroying a certain insect which consumed the grain in the French province of Angoumais. They found this could be done by a process of careful baking; the heat being graduated to a certain point not high enough to kill the grain, but sufficiently high to kill the insect. In order to learn the fiercest heat of the oven, they were in the habit of introducing a thermometer placed upon the end of a long shovel. The thermometer, on being withdrawn, indicated a degree of temperature considerably above that of boiling water; but M. Tillet was aware that the mercury must have partially cooled in the act of withdrawal; wherefore the temperature of the oven itself was not so well made out as he could have desired.

While he was debating with his colleague the best mechanical means of acquiring the needed information, a girl—one of the usual attendants—volunteered to go in and mark with a pencil the height at which the mercury stood. She did enter the oven, and remained there two or three minutes, marking the rise of the mercury. The point of its elevation was no less than 100 degrees Reaumur*—almost equivalent to 260 degrees of Fahrenheit. M. Tillet began to be alarmed for the safety of the girl; but she assured him that she felt no inconvenience, and remained in the oven ten minutes longer, during which the mercury reached the 288th degree of Fahrenheit scale: no less than 76 above the point of boiling water.

It seems, then, that all that portentous myth which refers to the ability of the salamander to live in flame, is referable to the fact that all lizards — but perhaps the salamandrine lizards in especial—evolve, when heated or otherwise irritated, a copious moisture from the skin.

Coming now to the poisonous allegation, to find a consistent theory is more difficult. Assuredly the salamandrine lizard is *not* poisonous; indeed, to generalise, no lizard *is* poisonous. Still, the idea that lizards *are* poisonous very widely prevails even in England, and at the present time. An English rustic will as soon touch a viper as a poor hedge-eft. He believes this small lizard to be poisonous equally with the common snake and the slow-worm (*anguis fragilis*). So obstinately do preconceptions linger where they have once been entertained.

* The thermometric graduation of Reaumur is now very little used. According to it the freezing-point of water is 0 or zero, the boiling-point 80. Fahrenheit's graduation makes the freezing-point 32, and the boiling-point 212. The Celsius or centigrade scale is now mostly used by scientific men. Its freezing-point is 0, and its boiling-point 100. To convert Reaumur degrees to Fahrenheit degrees, proceed according to the following formula:

$$\text{R.} \times \frac{9}{4} + 32 = \text{F.}$$

To convert centigrade degrees to Fahrenheit degrees adopt the formula subjoined:

$$\text{C.} \times \frac{9}{5} + 32 = \text{F.}$$

THE MORAL STATUS OF ALCOHOL.

I AM about to make some passing remarks upon a spirit which, together with its alliances and associates, occupies a very debatable place in the bead-roll of pneumatology; inasmuch as, despite an acquaintance with it, more or less intimate, from the time when Noah planted him a vineyard, grew grapes, made wine, and drinking thereof was gladdened, the public, sitting in committee of full house, hardly know whether to award it a place amongst good spirits or bad; whether it should stand adjudged a good thing or a thing of evil.

Seeing that, after a duration of time so long, a diversity of opinion should prevail relative to what may be appropriately called 'the moral status of alcohol,' would the conclusion not seem probable that truth lies in the mean?—that alcohol may be a bad thing if badly used—a good thing if employed at proper times, in proper quantities, and on proper occasions?

I am well aware that no sort of compromise like this will be admitted by total-abstinence people. I am cognisant that they look on alcohol in every guise it can assume; in each and every companionship, whether neat or water-diluted, whether associated with sugar and perfume, as in luscious curaçoa, maraschino, or noyeau; whether sparkling with carbonic acid, as in champagne, or laden with the delicate odour of peach-blossoms, as in kirschwasser; whether wedded in unison with a kindred spirit of exquisite delicacy—œnanthic ether, to wit—as we find preëminently in Rheinwein or Œdenberg—I am cognisant that under each and every circumstance of companionship, alliance, dress, association, alcohol is held to be a base spirit, an evil spirit, closely related to the father of lies, if not himself, by all thorough-going teetotallers.

It is hardly worth while to lodge a protest against drunkenness—to proclaim the utter repulsiveness, the bestiality of it; but no presentment of this degrading vice, however hideous, would be held sufficient, in any court of equity, to compass of itself the banishment of alcohol. Excess of whatever kind is reprehensible; and, speaking of alcoholic excess, it may almost be doubted whether the sobriety that can only come of alcohol banished do not belong to a lower category of virtue than is commonly assumed.

This is a point relative to which some manuscript lies before me, written by one—an intimate acquaintance—whose extreme violence, in the manner of putting his case, renders the document, taken in its entirety, unfitted for publication. Inasmuch, however, as it contains a certain underlying stratum of truth, severely enunciated, I shall not hesitate to quote from the document, parenthetically and reservedly. Expatiating upon the thought just adverted to, the doubt expressed whether the sobriety that can only come of alcohol banished be worth half the trouble total-abstaining advocates lavish in the seeking, the author of the rejected MSS. now lying before me uses the following words:

'Probably,' writes he, 'what may be called the eliminatory function of Nature in her ways with the human species has never been sufficiently heeded. If many influences were allowed to have full scope, in lieu of being thwarted and disturbed, might it not fare all the better with some of us? If, for example, the Home Secretary would turn a deaf ear to all petitions for commutations of capital punishment, allowing the sheriff to hang remorselessly, I have an idea that the good effects of that policy would be seen in an elimination of the unfortunate class who are unhappily characterised by the possession of the homicidal idiosyncrasy. If, too, every silly fellow who might deliberately choose, in defiance of the most elementary laws of gravitation and cohesion, to skate on thin ice and fall into ice-cold water, were simply allowed to remain there, instead of being fished out by royal humanitarians and petted into second life by brandy-grog and hot baths, then, as it seems to me, the metropolis would be thinned of some of its most silly individuals.

'I regret to write,' states my author in manuscript, 'that, so far as my personal experience has gone, I never yet saw an individual whose virtue of liquor-temperance was held on so frail a tenure that it must needs depart at the sight or smell of strong drinks, worth keeping. Viewing such people in relation with the whole human community, leaving reverently undebated the question of individual responsibility in a future state, then it seems to me it might have been well had delirium tremens, or some kindred malady, been allowed to make short work with them.

'Drunkenness is every way hateful and abominable: the conclusion, nevertheless, does not seem to follow in any sequence of logic or reason, that because drunkenness is a bad thing, alcohol, the cause of drunkenness, is to be banished. Take some parallel illustrations. The first case is this:—would it not be quite on a par, as to considerations of logic and reason, that fires should be abolished because certain results of great evil happen from the misuse of fire, as that alcohol should be abolished because there happen to be some drunkards? Might not a plea be urged for the abolition of razors, seeing that some few throats have been cut by razors?—of steam-boilers, seeing that grave accidents have resulted from the explosion of some? And thus forward ever, next door to infinity.'

These sentiments are altogether too harshly put; the laws they would lead to, if carried into practice, would be altogether too Draconian: nevertheless, it is impossible not to recognise an adumbration of pure and virtuous thought in the outpouring of those bitter words. Toned and tempered down a little, the sentiment differs not much from the one enunciated by Mr. Bright some time ago in the House of Commons.

Honour and praise to Mr. Bright! It is not always that I am able to agree with him; but, speaking in regard to an anti-alcoholic bill, he penetrated the shell of truth—that nut so very hard to crack and reach the kernel. Not having the reports before me, I am unable to quote the honourable member's words; hence he will acquire the right to complain of me. John Bright is always eloquent, even when most crotchety.

His sentiments, conveyed in the language of another, will be reft of much of the significance they bore when conveyed in his own. What the honourable member *did* say was much to this purport, viz. that he did not value at the worth of a straw any such alcoholic sobriety as might be the result of compulsion; he therefore would not support an anti-alcoholic bill. What he *did* value was the temperance as to strong liquors which came as the result of conviction, of hideousness revealed by the shining of that 'inner light' concerning which the early Quakers testified so much.

The honourable member would not force alcoholic abstinence on people; but he would desire that, by silent waiting, watching, and self-communion, individuals should be led to impose the necessary restraint on themselves. Sound philosophy this; words that might well be written in letters of gold; suggestive words. They prompt the mind to range over a wider field than that occupied by mere considerations of alcohol.

O, John Gough! there are other intoxications than alcohol; one, for instance, that infects the blood of man from the day of his making the discovery that ladies are prettier than lamp-posts. From heavenward, so high as the flesh-imprisoned soul can soar, down to the depths where Phlegethon rolls hissing, the influences of that intoxication may be traced!

Would you do away with holy love, for the reason that it may degenerate into evil? Would you make humanity loveless by abolishing the ladies? Let us feign an ideal state of things, such as would result from the abolition of alcohol, whether pure or mixed. By way of preparing a suitable arena of thought, it is necessary to propose and answer, each for himself, one plain straightforward question, 'Is man made for the world, or the world for man?' It seems the former; a point which if it were oftener borne in mind, much of God's seeming injustice in dealing with mankind would disappear.

From the very nature of man's condition and tenure of existence, individuals are naturally selfish. Should anything seem to go wrong with the career of any particular man, he is prone to repine, affecting to see some imperfection in the ways of God's dealings with humanity. Would it not seem that mere individuals are of small account in God's dealings with creation?—that they must be remorselessly sacrificed from time to time, to promote some grand behest?—a wise perfect behest doubtless, if the human mind were only competent to grasp the purport of it.

In early spring, almost before winter has ceased to deck the earth with silver gauze-work of morning frost, my apricot-tree blooms with a very galaxy of blossoms; of these, so soon as the days of trouble have gone by, hardly a tithe remain to set into apricots. Were apricot-blossoms sentient things, each fallen one might (human individual like) complain of its destiny, clamouring to have remained. Yet my gardener tells me it is needful that the sacrifice take place, for the welfare of the tree, to perfect the number that turn to fruit. He demonstrates the force of his belief in this sacrificial need, by plucking yet other blossoms which nature's blights have left. Friends, what of this? Is the case not suggestive? Can you not float away upon the flood of speculation, and drift to regions of thought, the nature of which a writer dares not indicate, for fear of seeming impiety?

If man be made for the world, then, in order to benefit the world, mankind must act, must be up and doing. By the implied tenure of our existence, we are bound, each of us, to gird-on our armour; to fortify the principle of vitality within us as best we may; and rush into the turmoil of the battle of life, impelled by the fixed resolve of doing something. Individually, it is all a chance whether any one of us comes out of that strife maimed or scathless; or whether, stricken down upon the field, any one of us may perish, to return no more.

It may have been needed and preordained, on behalf of the world for which we were created, that you and I, neighbour, should be amongst the strewn and blighted blossoms, destined to wither on behalf of the tree. It behoves us all to be up and doing; even though in the activity there be danger to our individual selves. Were it possible to lock the members of a family in whom we take a kindly interest up within four walls—feeding them, clothing them, altogether isolating them from the world without; thereby might we avert some issues on the battle-field of life. Held prisoners thus, the members of our chosen family would husband their vital forces by exercising the strictest economy: they would almost perforce die natural deaths.

If committed to the world, *this one* might have been hanged, *that one* drowned, the other one poisoned or blown-up by gunpowder. Better—despite such instances of violent death—that the family should have mingled in the world; worked on behalf of it; fought its battles. This way of viewing the mutual relations of mankind and the world; this train of reasoning, whereby action, activity, is shown to be a duty, suggests a most important question. Is it not a plain corollary of an appreciation of this duty for each individual person of us to eat and drink those things that are known by experience to bring out the energy of vital force, making it effective? I would advise nobody to commit himself lightly to an inconsiderate yea or nay, on this momentous question. Once acknowledge the principle, and it will lead to some startling extreme deductions. Thus, if a nervous bishop should make it out satisfactorily to his own conscience, that his visitation charge would be the better delivered when his mental organism had been brought to the certain state of exaltation popularly known as 'half-seas-over,' why, then it would be clearly the prelate's duty to conciliate his idiosyncrasy by a suitable ingestion of alcoholic fluid. Other issues not less extreme, and not less unexceptionable, might be imagined. Examples will occur to every thoughtful person.

From first to last there have been hundreds, ay thousands perhaps, of different modes and principles of classifying mankind. Somebody (was it not the great *maestro* Spohr, at the commencement of his book on violin instruction?) divided mankind into the two categories of those who play the fiddle, and those who do not: a division which, so far as it goes, is unimpeachable. That great African explorer, Captain Burton, establishes a grand primary division of mankind, under the two categories of those who *kiss*, and those who do not: a division which has the immense recommendation of being coördinate with marked ethnological qualities.

According to that great traveller and acute observer, negroes, when at home in their native Africa, never kiss. So little do they understand this delightful mode of salutation, that if by chance a traveller (*experto crede*, the captain would seem to wish one to infer)—if by chance a traveller essays to kiss a negro girl, she draws back in trepidation and affright; impressed with the belief that he is a cannibal about to eat her!

It would be difficult to over-estimate the ethnological importance of this truly grand discovery. Hereafter, when some future Cuvier or Buffon, Blumenbach or Owen, some Huxley, Vrolik, Henslow, or Darwin, shall speculate upon the negro's true *status* amongst the families or races of mankind, the peculiarity noted by Captain Burton will be made a more satisfactory basis of arrangement than the *pigmentum nigrum*, the high malar bones, the prominent *os calcis*, the *odor Æthiopicus*, the crisped wool, the elongated *os coccygis* (which, according to Professor Agassiz, gives such clear indications of a rudimentary tail), or any of the special qualities of race noted by ethnologists up to the time being.

There is much reason to regret, on philanthropic grounds, that the Burtonian deduction *de osculatione* should ever have been promulgated: that is to say, I very much fear lest the fact should be laid hold of by proprietors of negro slaves, to justify the possession of their chattels. Intelligent people need not be informed that some diversity of opinion has hitherto existed amongst ethnologists relative to the cardinal point—whether negroes *are* or *are not* on an equality with other races, but more especially the Caucasian race, physically and mentally: whether, to come to the point without unnecessary delay, the negro race is or is not one naturally inferior.

Well, I fear that such of us as may have had doubts on that point hitherto, will cease to have them; that conviction will take the place of uncertainty, and this in a sense most unfavourable to the social comfort of the negro. Alas! for my part I am forced to the conclusion that a race, the opposite sexes of which do *not* kiss, must needs stand low in humanity!

A third division of mankind has now to be indicated, as being more suitable to the ends we have in view than either of the preceding. For present purposes I shall establish a division of mankind under the two categories of the creative and the executive; and in reference to this classification the consequences shall presently be reasoned out that would have been evolved in times gone by, and would probably be evolved in times to come, had the spirit alcohol never been made the companion of man. Inasmuch as a position will be taken in discordance with the conscientious belief of total alcoholic abstainers, let the assurance be conveyed, at once and emphatically, that I am one who can always respect enthusiasm, even though I disapprove of the principles on which it may be manifested. Enthusiasm I regard as a blazoned testimony of living faith; under the banner of which he who testifies is prepared to incur any pain, trouble, discomfort—it may be worse—that can occur from the profession of a creed, and the practice of a code, dictated by conscience. Enthusiasm I reverence as a holy quickening fire, a living protest against that resource of lazy natures—a compromise.

> 'Des Menschen Thätigkeit kann allzu leicht erschlaffen;
> Er liebt sich bald die unbedingte Ruh.'

A necessary attribute of every enthusiasm is, that it shall aim at extremes. Few, if any, subjects of enthusiasm, if carried to the extremity aimed at, would be advantageous. In estimating their influence upon mankind and the world, it is necessary to contemplate the result, or, more correctly speaking, the *resultant*, eliminated or to be eliminated, through opposition brought to bear.

As a protest against the degrading vice of drunkenness, which had come to prevail in these islands, the enthusiasm of total alcoholic abstinence has doubtless been productive of good to British and Irish society; but if it were possible that the aspirations of total abstainers could ever be achieved, the result would, I think, be very unfavourable to the exercise of every sort of high intellectual energy. Bearing in mind the division of human beings that we have provisionally agreed upon, into the creatives and the executives, we shall now be in a position to evolve and place in evidence a fallacy which has seemed to underlie the philosophy of total alcoholic abstinence people: they would seem to lay down the proposition, that it is the bounden moral duty of each individual man and woman to feed the flame of life with aliment of the sort best calculated to preserve existence at one even burning rate of vitality. The furnace fires are to be ever banked (so to speak), but never raked and ventilated.

This seems to be their aspiration, their meaning—the culmination of their philosophy. 'Would the result be good or evil?' is a question we may each of us well demand; and for a satisfactory reply, we may profitably revert to the illustrative parallelism of a banked fire smouldering under a steam-engine boiler. Unquestionably, if such a fire be always banked, the boiler will incur little risk of bursting; but has a steam-engine boiler not an active as well as a passive function? Is it to be ever static, never dynamic? Is it not supposed to be endowed with a working as well as a waiting function? Are there not times and occasions when work has to be done, that the furnace-fires have to be fed with fierce fuel, raked and ventilated, caused to burn wildly? When these times and occasions come about, does it avail to plead the plea that such invigorated fires may generate steam so fast that the engine bearings may suffer from friction, may go out of gear more or less; that the engine's term of duration will be sensibly abbreviated; that the boiler may even blow up at once, the whole system collapsing, broken, ruined? Not one jot; the work having to be done, the risk must be incurred.

Total-abstinence people may be regarded as so many human engines, having fires perpetually banked under their boilers; smouldering, torpid, unenergetic fires, almost equally void of power for evil or for good.

The advocates of total alcoholic abstinence, as I know, are prompt with a rejoinder. They will affirm that the banked and smouldering fires are equal to the occasion. They will point to some thrifty mechanic, who, having taken the pledge, and forsworn alcohol many years ago, has never had a black

Monday since; who has done his work creditably in the workshop and at home; whose progeny (ample) reflect from their rosy chubby cheeks the warm glow of health so radiant upon the features of their total-abstaining sire.

Total abstainers, my friends! the case fails. It is wholly wide of the mark to seek illustrations in the executive or non-creative avocations of life. Know ye not that pearls never come in healthy oysters? Know ye not they are always the product of disease? It is quite possible to admit that total abstinence from alcohol may be most compatible with the maintenance of a body in the highest condition of physical health, without this concession involving, as a sequence, that the higher originative or creative efforts of the brain of man can be most effectively brought into operation without the stimulus of alcohol. A man might make very good shoes on toast-and-water; very good cradles, carriages, coats—coffins. He might be a very good short-hand writer, law copyist, a very good picture copyist, for aught I know; perhaps a copyist in any other sense. There have been such; there are such, genuine total abstainers; mediocrities all.

Useless wholly is it to point to such cases by way of attempting to show that total alcoholic abstinence would conduce to the benefit of all workers. Nobody is called upon—at least by me—to accede to the proposition that *no* originator of thoughts, as distinguished from the mere copyist of thoughts, can by any chance be a total alcoholic abstainer. Curiosities of existence will never cease. Nature is wayward in the richness of her treasure-casket; she often surprises with anomalies. You and I, friend, are looking at things in the concrete; we take heed of grand resultants; we eliminate the confusion of exceptions. We do not say that Shakespeare could *not* have been what he was, had he lived on toast-and-water; or (our case not needing so low a dietary as that) had he totally abstained from good Rhine wine and generous sack. What you and I want to know is, whether anybody, before whose eyes these lucubrations may come, can point to any author of even mediocre poetry, who adopted and held to total-abstinence principles.

If you tell me that poets are wildings of the earth—erratic, lawless; the very salamanders of brain-fires; pieces of mortal clockwork rattling on out of time and measure, even as clocks do that have lost their pendulums,—still the tenure of hold upon my victim fact is such, that poets shall be set aside. It suffices that I regard the creative, imaginative, or originative faculty in its most comprehensive sense—under any one of its multifarious aspects. Did you ever know of a new theory of science spring out of a dietary of toast-and-water? Did you ever in your experience meet with a painter who succeeded in conciliating his genius so as to get a really high flight of fancy out of diet on the similitude of a banked-up fire? And so on, for whole dreary pages, might I extend this questioning throughout the entire range of originative brainwork, were iteration needful. The answer, truthful to the best of my knowledge, would be, Never:—*Never!* emphatically.

Referring to the manuscript, still lying before me, and written by the same violent individual who would abolish the Royal Humane Society, because they fish out of the water certain silly young men who go skating on thin ice, I find that he—as might have been expected—takes a more extreme position than that adopted by me. According to him, the condition of total alcoholic abstinence is not even so favourable, as that by me assumed, to the executive or noncreative acts of human life. If this anonymous writer's propositions be established, then would it seem to follow that some of the best workmen in the mechanical arts are individuals addicted to strong drinks; men who make black Mondays, and are moreover intemperate as to liquor on certain other occasions.

'We hardly need go into the regions of high intellectual exercise,' writes he, 'for examples in proof of the position, that excellence of action, of doing, is almost incompatible with rigid abandonment of alcohol. Perhaps there have been no two qualities so much vaunted by total abstainers as belonging markedly to themselves, the results of an anti-alcoholic discipline, as a certain clearness of eye and steadiness of hand. "I could not do *that* in the times when I drank strong drinks," a certain celebrated lecturer on the advantage of total abstinence would boast, whilst lifting a brimming glass of water to his lips without spilling. To be candid, the feat was one that never appeared to me so difficult. So, when volunteers were established, and Wimbledon shooting-matches; and, best of all, when the gallant Havelocks, the real teetotal alcohol-hating forty-eighth Middlesex were incorporated, then did lookers-on begin, and naturally enough, to be on the alert for demonstrated proofs of teetotal excellence; sharp unclouded eyes and steady hands! My friends, what would you? Are these not the very qualities that make up good rifle-shooting? Have the gallant Havelocks done anything that way? If so, I never heard of it. Did you ever know or hear of any alcohol-hating total-abstinence man who excelled in rifle-shooting? *I* never did. To finish (and it is a matter of considerable delicacy), how came it about, if pump-water be endowed with such manifold excellences, that the gallant Havelock forty-eighth, once upon a time, got a wigging for its manœuvring inefficiency?

'Then as to skilled labourers in the peaceful arts of life: when it comes to the doing of regular, plodding, mechanical work, going the same circuit over and over again, like that of a mill-horse, your thorough abstainer is a good enough animal. If we speak of skilled labour and labourers, what then? Why, it unfortunately happens, that amongst employers of skilled labourers, the extreme opinion very generally prevails, that the hard-drinking fellows—men who make most black Mondays, and who sometimes are not quite ready for business on Tuesdays—are always the best. The belief is general. Would it have arisen without some strong foundation? and having arisen, is it not adverse to any strong faith in the temperance virtues imputed to cold water?

'Just at this moment a thought dawns; it makes me feel angry with teetotallers—makes me contemptuous. Wherefore do they not remember that sins come from the heart,—the soul of man,—which we know is desperately wicked? Beginning in inmost thoughts, sins expand outwards, and end in the very act, the doing. What mean these notices about "Temperance champagne" that I see so often? *Temperance* champagne, forsooth! Sinners, backsliders, pharisees, prevaricators! Emancipated from bondage, as you pretend, how shameful is this hankering after Egyptian flesh-pots, metaphorically to speak!

'How *dare* you even think about champagne? Will you audaciously tell me that those long-necked similitudes of Ay, Veuve Cliquot, or Epernay can be popped off under the very noses of teetotallers without the peril to virtue? Curiosity, I say, may be fatal (as it often has been fatal) to the virtue of man or woman. For shame's sake, let us hear no more about "Temperance champagne!" Of all vices, hypocrisy is the worst:—of all hypocrisies, that implied in just saving the mark—driving close up to a forbidden line, and taking credit to oneself for not transgressing the line—is about the meanest.'

Again I say, these are the opinions of a man who seems to hold *very* extreme views. Temperate he *may* be, in the matter of alcoholic liquors, but not in the matter of language. He goes at the teetotal people furiously, with a sort of moral sledge-hammer, as if they had committed some terrible sin.

Conviction is never won by violence like this. To my appreciation, it would have been extremely inconsistent had total abstainers gained fame on behalf of their target shooting and smart manœuvring. Confessedly, in time of peace, soldiering is heavy work; a vast deal of physical energy must be expended to achieve insignificant results. I can easily understand that the Havelocks are reserving their pluck and manhood for days of real strife. I can easily feign to myself a gallant forty-eighth soliloquising something after the following fashion: 'Prize-shooting—pooh! frivolity—*pooh!*—we reserve ourselves for war. Wait till our shores are invaded by beery Prussians, let loose from the German navy; *then*, O base revilers, shall the glory of cold water stand revealed. We stoop not to make-believes!'

Bearing testimony to the intrinsic worth of enthusiasm; giving total abstainers full credit, not for purity of motives alone, but likewise for much practical good by them accomplished; it may be permitted to offer some kindly-meant remonstrances to a certain weak point of their theory and discipline.

I would beg leave to note a certain weakness of abstainers' ratiocination, a certain flaw in anti-alcoholic logic, whereby the concession is made that total-abstinence people, in the event of their being ill, and the general needs of their illness prompting, may take alcoholic drinks in suitable proportion, without peril to virtue, or incurring the imputation of a fall. Alas, abstainers! With this concession down goes your barrier of reason utterly and for ever. What individual amongst us, I wonder, can say to himself, under all circumstances and at all times, 'I am wholly sound'? Rendered in other language, the teetotaller's concession to illness simply means this,—that it is permissible, good, and void of sin, for men and women to drink alcoholic drinks when they seem to require them. Neither more nor less than sensible people who are not teetotallers do now; and have done from times immemorial.

That under the excitation of alcohol the human organism can put forth an excess of power, bodily as well as mental, no unprejudiced and experienced person can deny. The circumstance is undoubted, though the explanation of it is open to some diversity of opinion. That alcohol does not conduce to the nutrient function of vitality, might have been inferred from a consideration of its components, being wholly devoid of nitrogen. Its stimulative power over the nervous system is undoubted; hence the only question open to debate relative to the immediate functions of alcohol is, whether it does or does not conduce to respiration. This is a matter still undetermined. Having conclusively admitted that alcohol does *not* conduce to nourishment, the question will arise, wherefore it happens that the practice of dram-drinking lessens the appetite, and in this way diminishes the consumption of nutritive food? This, as physiologists believe, is wholly attributable to a lowering of the rapidity of digestion. According to them, alcohol diminishes the pain of hunger without giving a nutritive equivalent; and in this manner alleviates many a pang. In denying to alcohol any quality of nutrition, it must be evident enough, that the remark only applies to those mixtures of alcohol and water, with a little colouring matter occasionally, of which our domestic drinking spirits are composed. As for pure or absolute alcohol, it does not belong to the drinking repertory. Rectified spirit of wine is a very near approach to it; but even rectified spirit of wine holds some portion of water. What we call 'proof spirit' is a mixture of pure alcohol with water in equal parts. Everybody knows that alcohol in certain states of combination, but more especially in the form of malt liquor, has a tendency not to fatten merely, but that it can also contribute to the formation of flesh. These results are not due to the alcohol, but to certain saccharine and nitrogenous principles with which it is associated.

Though the active principle of all intoxicating liquors be alcohol, yet the effects of the latter are modified by combination and alliance to an extraordinary degree. Medical men, before whom cases revealing the effects of drunkenness professionally come, are often able to pronounce, within the limits of small error, as to the class, if not the exact kind of alcoholic liquid, by which the constitutional disturbance has been effected. Dram-drinking gives rise to certain liver disturbances; imparts a wan shrivelled look to the face; causes a wasting, and, as it may be said, a burning-up, of the whole corporeal tissue. Beer, as already announced, tends to fatness; and is, moreover, not inconsistent with the formation of flesh. Frequently drinkers of beer in excess seem hale and hearty to the inexperienced eye. Often has it been one's lot to have heard that observation made in regard to the London brewers' draymen. Medical practitioners know better. Experience teaches them that about the very worst class of patients they meet with in practice are men of that community. Brought to the hospital for any trifling injury or illness, they sink alike under the effects of it and of the indicated treatment. Strong as they are to look at, brewers' draymen are less tolerant of bleeding almost than children. Their constitution is sapped—soddened. They die off like flies. Some of the modified physiological influences effected on alcohol by combination may be inferred from a consideration of the chemical nature of it, as learned by experiment. Thus, for example, if a little rectified spirit of wine—a liquid which, for all practical purposes, may be considered as alcohol—be mingled with the white of egg, the substance is immediately coagulated; but the result does not ensue, if for rectified spirit we substitute a mixture of it with water in considerable quantities; or any of the various mixtures of alcohol with water and colouring and odorous matter, which in the aggregate go to make up the various fermented intoxicating liquors. What happens to the white of egg also happens to the delicate lining or mucous membrane of the stomach.

The opinion commonly prevails, and it would seem to rest on good foundation, that the effects of alcohol taken in association with carbonic acid are more evanescent than otherwise. The passing quality of inebriation from champagne, sparkling

Moselle, and other wines highly charged with carbonic acid, is proverbial. Whatever be the true *rationale* of the action of alcohol upon the human organism, there can be no doubt as to the fact of varying tolerance of the same constitution for alcohol at different times and under different circumstances. It comes within my own experience to know a gentleman of stomach so delicate, that whilst he, normally living in his own sedentary way (being a literary man), can never drink even spirit-and-water without serious sufferings; yet when travelling, especially if the weather be cold, he sips raw spirit so continuously, that any one noting the habit would infallibly put him down as a sot. Nevertheless, the frequent drams have then not the slightest inebriating effect upon him.

In respect to the susceptibility of certain constitutions to feel the intoxication of alcohol, they are commonly spoken of as weak, and the proclivity is referred to weakness. Such explanation, however, is by no means correctly expressive. Physicians are well aware that certain of their patients, much reduced by sickness, and in the earlier stage of convalescence, cannot (to speak with a little licence) become inebriated; that so soon as the ability to get tipsy is manifested, there is, in this very circumstance, an indication of returning health. Sex would seem to regulate and determine the sort of liking for alcoholic liquors. It is very rare to meet with a woman who does not like champagne. Port-wine, too, is unquestionably an alcoholic drink congenial to the softer sex. Sherry is less generally appreciated by them; and as for claret or hock, one seldom meets with an Englishwoman who really likes these wines. Burgundy to the feminine taste is more tolerable; and it is at the same time stronger than claret. Given for scrutiny an equal number of confirmed drunkards of either sex, there will, in this country at least, be found more female than male dram-drinkers. A woman beer-sot is comparatively rare, even amongst the metropolitan lower orders. Born as I was in a cider-producing county, I have seen many a confirmed cider sot—men all, however. I cannot call to mind one example of a cider-sottish woman.

We come now to propose a question having great practical interest to all who take delight in habitual drunkenness under circumstances of difficulty, arising from alcoholic scarcity. Out of all the things in nature existing, or by the chemist producible, is there nothing that can take the place of alcohol?* I think we shall have to answer, 'Not one.' Though it may be possible to bring out the energies of a small modicum of alcohol by auxiliary treatment, yet for any genuine elevation to ensue—inebriation, that is to say, maliciously called *intoxication*—a modicum of alcohol ingested there needs must be. I have heard of a seafaring man who, to evolve the fullest power out of three-water grog, used to get himself triced-up by the heels, so that his head might hang downward. The device might, indeed, be effectual, but it is assuredly not graceful — moreover, in some cases, as will readily occur, the expedient would be socially objectionable. Whether we are to regard the mental exaltation produced by alcoholic liquors a condition of good or of evil, in either case the individual, be he who he may, who first imagined and brought into conventional usage the word 'intoxication' in its alcoholic sense, had no great notion of the benignity of inebriating spirit. The word 'intoxication' simply means 'poisoning:' literally, as by a poisoned arrow; but freely, and by metastasis, poisoning of any sort.

The late Sir Humphrey Davy, working in the interests of science, and whilst he was studying the characteristics of laughing gas, went through a painful course of getting tipsy on various alcoholic mixtures; chronicling the results he experienced. In this way was the fact not only made out, that hardly any two varieties of alcoholic mixture produce exactly similar effects; but that no agent could be substituted for

* Various alcohols are known to chemists. Ethyl alcohol is the one obtained by fermentation, and found in spirituous liquors.

alcohol, for developing the effect to which alcohol is competent. Many things, however—natural and artificial—can develop a sort of inebriation. Amongst these, chloroform and opium are self-suggested. As the rule, too, the essential oils —liquids of which turpentine may be accepted as typical—will, if swallowed, or if their vapour be breathed, originate a sort of inebriation. The liquid absinthe—so much consumed by the urban lower orders of France—belongs to this category; and when swallowed in conjunction with alcohol, it modifies considerably the character of mental exaltation naturally producible by the latter.

Quite recently the French military authorities instituted a medical commission of inquiry as to the physiological effects of absinthe. The resnlt was so incriminatory, that the consumption of absinthe by soldiers of the French army is now stringently interdicted.

In respect to the history of the master-spirit alcohol, need I state that in its pure, or even water-mixed, condition the people of civilised antiquity had no cognisance of it? The very name *alcohol* would imply an Arabic origin; nor is the implication at fault, seeing that it was first discovered, or rather eliminated from the wines and other fermented liquids in which it lurks, by one of those mighty Arabian chemists, or alchemists (call them which you please), who flourished during the golden age of the caliphate. That alcohol in its non-vinous form was not discovered by the Jews, or Greeks, or Romans, is immediately referable to the fact, that the process of distillation was not known to either of these peoples.

Alcohol, almost pure, *can* indeed be separated from wine and other liquids holding it without any distillatory aid.* Nevertheless, in practice, distillation is the scheme always

* By first decolorising the alcoholic liquid, if coloured, with subacetate of lead; throwing down excess of lead by hydrosulphuric acid, or still better, sulphurous acid; next adding dry sodium carbonate, which abstracts the water, and leaves a floating layer of alcohol almost pure. This was demonstrated by the late Professor Brande.

resorted to. The statement passes very generally current, that alcohol only admits of being produced as the result of fermenting sugar; the particular variety of sugar called 'glucose,' otherwise grape sugar. The statement is doubly incorrect. Evidently the fermentation of sugar of milk must be capable of yielding alcohol, otherwise how explain the production from mares' milk of the Tartar intoxicating drink known as *koumiss?* Moreover, in very small quantities, with great trouble, and as a mere chemical curiosity, alcohol *may* be evolved without the intervention of any sort of sugar; it may be produced, as a matter of curiosity, from coal gas.

This curious source of alcohol suggests to my mind the very remarkable way in which great discoveries are sometimes adumbrated by herald shadows which they cast before them. Just as some consummate musician mingles in the overture of an opera small indications of thought and sentiment, to burst upon the ear in the full glory of rhythm and counterpoint hereafter; so do we often find that half revelations of some great scientific truth are vouchsafed to mankind years —ay, whole centuries it may be—before their complete development.

The following is to the point. I claim to have extended to me for *my* tale the same amount of faith that has been so liberally dispensed to Doctor Newton. Twice since the beginning of the present century Plymouth has been honoured by the presence of the Russian fleet: once about 1810, I think—at any rate, while Plymouth streets were yet illuminated by oil-lamps; a second time, subsequent to the establishment there of gas-lighting. As is usual on the occasion of ships coming into port, the crews were granted absence on shore. An Englishman myself — one proud of his country and its institutions, especially the navy — I have been inexpressibly pained upon occasions to see the mad pranks committed by British man-of-war Jacks on shore. How intemperate of drink they are — sometimes of language! how ill-regulated their exuberant affections! I might have thought British Jack-tars had filled up the measure of every venial social iniquity, but for the Russian fleet at Plymouth. The Muscovites drank deep of spirits and beer — in that nothing remarkable; but they also drank, night after night, of train-oil from the street lamps: such was their barbarian propensity.

The lamps went out of course; again and again the streets were left in darkness. It would have been inhospitable to have made a fuss about it; and the Plymothians are kind. They simply refilled their lamps, making no remonstrance. The Russian fleet sailed away, and, after long years, returned. By this time street gas-lamps had taken the place of oil-lamps; but the dull Muscovites, ignorant of the substitution, climbed up the lamp-posts after the ancient, bold, bad way, and immediately began sucking. The result was calamitous, as somebody told *me*, who had the recital from another. A sort of intoxication came over the fellows; their mouths spell-bound, as we may say, each to a batswing burner, they grasped the metal tightly, and still continued sucking. One boatswain—a man shrivelled to look at, but whose skin was remarkably loose—blew out just like a balloon; then mounting aloft, flew away, and has never been heard of since! Others took a shorter flight; fell, and were picked up safely. Others yet—hard, tough-skinned, and *heavy* Russians—did not fairly ascend into the air at all, but kept bobbing up and down upon the pavement, just like so many of those light india-rubber bubbles now commonly seen in the hands of London children.

That the result is remarkable, I think no unprejudiced mind will doubt; but this also is remarkable, viz. that long before the possibility of evolving alcohol from coal gas was demonstrated, the adumbration, the foreshadowing of that strange chemical triumph, should have been vouchsafed to human eyes through the instinctive proclivity of some rough Muscovite sailors.

That class of temperance advocates, who only value the sobriety which results from conviction wrought upon the mind, have fair grounds for good augury as regards the future of strong-liquor temperance in this country. When the total change is reflected on that has come over the middle and upper ranks of Great Britain, as to strong-liquor intemperance, since the accession of our gracious Queen, then assuredly the hope and belief are not far strained, that the lower middle and lower ranks—wherein the habit of drunkenness unhappily now prevails—may work out a similar amelioration for themselves by a similar agency. And if the nature of that agency be demanded, I reply: The feeling of self-respect, awakened through an entire community; thus establishing a fashion.

In estimating the influence of social usage, of fashion, as to temperance or its opposite, the point should be ever borne in mind, that the tendency or inducement to hard drinking, purely on its own account, is very rare. Solitary drunkards can indeed be found, but they are not common: they *never have been* common. Hard drinking, in by far the largest number of instances, is altogether an indirect result of conviviality, of fashion, accepted in certain circles.

When the habit of solitary hard drinking has been acquired, the experience of all times and all societies is to the effect, that such habit is the most difficult variety to alter—such a drunkard the most unfavourable to work any good upon; and this naturally, seeing that there is no strong influence of social usage, of fashion, to bring into operation. It is quite easy, however, to effect a cure of solitary drunkenness, under the condition of having the drunkard caught and put in durance, to be dealt with according to the operator's will. The treatment is decidely homœopathic: it would furnish perhaps the strongest confirmation of homœopathy, if doctors of this persuasion did not deprive themselves of the value of its testimony by holding to a very peculiar dogma. They affirm, that alcohol is one of the few agents that are endowed with no homœopathic power whatever. Call the drunkard's cure what we may, it is as presently to be described: it is moreover infallible, as Prussian-army doctors, who use it when needful, could testify: you catch the drunkard, and lock him up—he being quite at your mercy as to what he shall eat and drink, or else avoid. He is a gin sot, we will assume; well, you give him gin—gin in abundance. What more kind? Indeed, he will not think so. Gin-and-water for breakfast, lunch, dinner, tea, supper; gin, nothing *but* gin!

Then fancy your eatables soddened with gin; your morning roll, your dinner—meat, cabbage, and potatoes; gin put into soup; gin with the salad vinegar; gin into coffee; gin everywhere, all day long; the evil, haunting, persecuting spirit! It may be all very pretty and pleasant to a gin sot at first; but the charm soon wears off, and he tells another tale. Horrible dyspepsia sets in! Headache; dreams disturbed. The patient implores for mercy—begs for cold water—promises amendment. The doctor perseveres, that the cure may be complete.

After the lapse of a variable time, according to circumstances, the patient is let loose: horribly ill, but, through the operation of disgust, a regenerated man. He seldom or never relapses to dram-drinking again. Hereupon, then, the question may well be propounded: Why so much trouble should be taken to make drunkards temperate by the operation of any such doubtful, lingering, not to say cumbrous, scheme as a prohibitive or permissive bill, when so ready a means as that just described is at hand? If some hon. member would bring in a bill providing that, on the certificate of two medical men, it should be competent for the police, the parish beadle, the Scripture reader, the parson, or other sufficient authority, to lay hold of the drunkard and imprison him, then submit him to the Prussian cure, he would command the praises of society.

To conclude. Alcohol is not so very bad a spirit as it has been painted. Of it we may say as of fire, that, though a good servant, it is a bad master. Nothing more conclusively proves the compatibility of alcoholic ingestion with the highest exercise of human thought than the social and convivial history of the British Association. How delightful the alternation of dining, debating, dancing, and flirting! How free the flow of learned language after abundant hock and champagne! Was ever an Association philosopher caught tripping in his section yet? It will be time enough to establish the British Association on teetotal principles when some chemist talks about the sweetness of vinegar; some astronomer about the seventh satellite of Mars; or some physical geographer, president of a section, introduces Dr. Livingstone—fresh from Africa—to the audience as—'That cel'bwated *Am-am-am-er' can* trav'-yer!'

HYDROPHOBIA.

ALTHOUGH there is no necessary connection between extreme heat and hydrophobia, yet popular belief, an influence stronger than truth itself, rules otherwise: hence my thermometer, marking eighty-three in the shade, suggests canine madness as a fitting subject of present discourse.

Since that fatal day when Pandora, unlocking her chest, rained down upon devoted humanity the manifold diseases that mostly make death terrible—whereas, but for them, dying would be little else than going to sleep—there has been none perhaps to compare with hydrophobia, all the elements regarded that go to make up terror.

It comes to us mostly through the bite of an animal that, generically at least, if not individually, is one of man's best friends—the poison may even be imparted by a caress. When a serpent bites mankind, the offspring of womankind, nobody marvels, nobody complains; it is a serpent's nature, and in some sense, I suppose, a serpent's duty so to do; but when a dog, the natural friend of man, as if incited by some demon, secretes a venom every way more dreadful than the serpent's; when, that venom communicated, the germ of future torments unspeakable is sown,—then are our thoughts prone to wander into a forbidden range, to suggest the unholy question: Whether all things here are ordained for the best.

It is no mere figure of speech to affirm that the poison of hydrophobia is more terrible than that of serpents. Divesting the case of all the sentiment which comes of looking upon dogs and serpents in contrast—*those* the natural friends of man, *these* his natural enemies—considering the matter intrinsically, the result is as I put it.

The poison-bite of a serpent is short and decisive in action and results. No lingering *here*, no room for suspense. The symptoms manifest themselves at once; the poisoning runs a rapid course; death or recovery is imminent, well-nigh immediate; and death, when occurring, is ushered in by no considerable pain.

All these conditions are reversed in hydrophobia. The specific results of a hydrophobous inoculation are never immediate. A period of incubation, more or less, there always is; wherefore an American pathologist was led to class hydrophobia among the contagious fevers. As touching this period of incubation, or rather the limits of it, the greatest uncertainty has prevailed, and still prevails.

Dioscorides states that hydrophobia, more frequently than otherwise, breaks out subsequent to the fortieth day after inoculation, but sometimes even after the lapse of a year,—'ut nos experientiâ comperimus.' This opinion of Dioscorides is, upon the whole, consonant with the preponderance of testimony which has been accumulating subsequent to the time when he wrote. This is the most a pathologist feels warranted in testifying about it.

Salus, Salmuth, and Albertus Magnus testified to the belief, that hydrophobia might break out after an incubation of even twelve, nay, even after so much as twenty years. Gaspar à Reies goes farther, in mentioning a special case that had actually occurred after an incubation of twenty years. Are we warranted in simply repudiating as fictions all these statements? Does testimony, does pathology, authorise us so to do? By no means; and, what is more to the purpose, no amount of evidence can ever directly negative that assumption, seeing that the question whether hydrophobia can arise spontaneously, or whether it be always the consequence of inoculation, is still undetermined. The balance of testimony distinctly favours the belief, however, that hydrophobia in human beings never arises without previous inoculation. I do not even find it ever alleged that hydrophobia has occurred in the human subject spontaneously; whereas in respect to dogs and wolves, several cases of spontaneously occurring hydrophobia have been recorded, though not definitively proved.

In the presence of all the marked and awful characteristics attributed to hydrophobia by general repute, and, as we shall find in the sequel, mainly justified, it may be a surprise to learn that certain physiologists have denied the existence of hydrophobia as the result of specific poison-inoculation altogether. Thus Monsieur Girard, of Lyons, was of opinion that the symptoms of hydrophobia were referable to the mere mechanical puncture without poison, just as lock-jaw is frequently referable to puncture of the hand or foot; an utterly untenable opinion, seeing that dogs have frequently communicated the disease by merely licking some abraded surface.

Others have referred hydrophobia to the operation of fear; an hypothesis which would neither apply to the cases of young children, nor still more emphatically to the instances wherein hydrophobic symptoms have been developed in animals of various kinds, amongst which cats, rabbits, guinea-pigs, and fowls may be enumerated.

Opinions of this sort must be looked upon as eccentric preoccupations, rather than as conclusions based upon any sufficient evidence. Similarly with all other animal poisons, that of hydrophobia is in its chemical nature very obscure. Vainly does the chemist test it by re-agents or the microscope: no agent, *no quality* stands thereby revealed.

In this respect the poisonons principle of hydrophobia is not more undefined, not less amenable to scientific scrutiny, than is the poison of small-pox or of plague, than the poison-liquid of serpents, scorpions, wasps, and bees. In respect to all these one remark is applicable, viz. that neither chemical, nor microscopical, nor any other scrutiny has been hitherto made to reveal any agent, material, or quality, with which the result can be rationally associated.

Passing in quick review such members of the long series of animal poisons as now occur to the mind, I can only think of one that chemistry is able to reveal; namely, cantharidine, or the blistering principle of Spanish fly; and even in respect of this, chemistry is so far at fault, that analysis merely reveals the poison without individualising it. Ultimate evidence of the presence of cantharidine is physiological. If dropped upon the skin, it raises a blister, in which the result, *blistering*, is the proof. As already remarked, very little doubt exists but that the only way of conveying hydrophobic poison to the human subject is by inoculation; and, the contingencies of accident regarded, the only inoculative fluid is saliva: nevertheless, the fact has been established by Hufeland and others, that the blood of a hydrophobic animal is quite competent to propagate the disease by artificial inoculation. All species of warm-blooded animals upon which hydrophobic inoculation has been performed have demonstrated, by the result, susceptibility to the disease, but not all individuals of each species.

That is to say, the hydrophobic poison, whether communicated by bite, lick, or artificial puncture, is very uncertain in its action. If an animal be bitten by an adder, if it be stung by a scorpion, wasp, or bee, the antecedent of puncture or poison-injection will be infallibly followed by consequent symptoms of poisoning. Not thus in respect to hydrophobia; for whilst some inoculations take effect, others do not, and these the majority. Dr. Hertwich, professor at the veterinary school at Berlin, inoculated fifty dogs with hydrophobic poison, but of these only fourteen were affected. Similarly to the poison of serpents, moreover, that of hydrophobia does not take effect when swallowed, as various experiments testify.

Though probably all warm-blooded creatures, at least, are susceptible of hydrophobic poisoning, yet it is still doubtful whether the number of warm-blooded species which can communicate it by salivary inoculation be or be not limited. The usual opinion as to this matter amongst physiologists is, that only the dog, cat, wolf, and fox can communicate hydrophobia through the saliva.

Although, as already stated, the blood of hydrophobic animals can be made to convey the disease by inoculation, yet saliva is the normal fluid of hydrophobic propagation. Here we find a certain adherence by nature to latent types; a fact well known to physiologists, the comparative anatomists, and botanists, but not generally heeded. Inasmuch as the typical idea is more easy of rudimentary illustration through botanical than anatomical or physiological examples, I will adopt a botanical exposition.

The natural tribe *Cucurbitaceæ*, the cucumber family, supplies the example needed. Passing the chief members of the cucumber tribe under mental review, a certain tendency will be recognised throughout the whole family to the secretion of a bitter, a more or less acrid and poisonous principle. In the colocynth, or bitter apple, the principle in question assumes its maximum of bitterness; in the elaterium its maximum of poisonous acridity. In the melon and cucumber the acrid and poisonous principles sink to their minimum; so that we enjoy the luscious melon and the cooling cucumber, heedless that both have suspicious belongings, that both appertain to the suspicious and, upon the whole, poisonous family *Cucurbitaceæ*. Nevertheless melons, and still more frequently cucumbers, degenerate sometimes; sometimes reveal the old Satan that has entered into their nature.

It has happened to most of us to meet with a bitter cucumber when we little expected to do so. It would seem that nature, having formed the entire cucurbitaceous family after one normal type, involving the presence of acridity or bitterness, either of these qualities, or both, may occasionally, through some little shock or twist of organisation beyond the scope of man's power to understand, reveal itself abnormally.

Having prefaced a botanical illustration, we shall be the better prepared to contemplate an analogy drawn from physiology and comparative anatomy. Saliva—the salivary liquid secreted from the blood by various special glands, and the normal function of which is to mingle with the food, lubricate it down along the œsophagus to the stomach, and there promote its digestion—is naturally, as everybody knows, an innocent fluid, a fluid wholly devoid of poisonous qualities. Nevertheless, the terrible poison-glands of venomous serpents are regarded by most comparative anatomists as actual salivary glands.

Considered as the embodiment of a major function, it is competent for us to regard the *normal* poison of serpents as typical of the *abnormal* function of the salivary glands of animals affected with hydrophobia. 'There is something curious about that salivary gland of animals,' observed a celebrated naturalist, now no more, to the writer one morning, whilst perusing the details of a case of hydrophobia; 'something *very* curious. The salivary gland of serpents, the poison-gland, always secretes poison; and observe,' continued the naturalist, 'if the secretive function of a dog's salivary glands be disturbed, this animal secretes poison too.'

Madness, canine madness, hydrophobia. Are these words to correctly designate and set forth the disease we are now considering? Scarcely: a valid objection can be adduced against all. Premising that hydrophobic symptoms vary, not only for each particular race of animals, but to some extent for different individuals of one race, the observation still holds good, that the words 'madness, insanity,' by no means express leading characteristics of the disease in respect to any species or individual; and as to hydrophobia, or the fear of water, the characteristic is only true in its application to *human beings* affected with the disease; not even to them invariably.

Human beings, when the disease is far advanced, and whilst suffering from a paroxysm, cannot swallow water or other liquids, because of the throat-convulsions that supervene; but they do not invariably, or even usually, manifest a *fear* of liquids. In dogs the throat-convulsions are less severe; hence these animals seem to have no difficulty in swallowing water. On the contrary, they lap it with avidity, as if suffering from an unquenchable thirst; and so far from showing any aversion to or fear of water, dogs affected with rabies, if previously accustomed to wade or swim, will betake themselves to water, and, plunging wildly about, will give the impression of their seeking to quench a consuming fire.

Madness, in the ordinary sense of persistent insanity, never characterises rabies in the human subject. Such mental wandering as occurs is more comparable to that of hysteria. It comes in paroxysms, then ceases, and leaves the faculties clear.

It has only happened to the writer of this to meet with a case of hydrophobia in the human subject once. It was during his student experience, and it made an impression that will never be obliterated. Speaking after the lapse of many years, I forget the antecedents of the case (nor would they be material here), the symptoms have only left their impress; but premising that the case here referred to was treated in Westminster Hospital in the spring of 1836, the particulars of it will doubtless come to the recollection of some individual readers who are old enough to remember. The patient was a man rather past middle age; and when it is considered that I saw the patient only the day before death, then will it follow that the disease must have been far advanced.

This patient had no dread of water; on the contrary, he even joked about his inability to drink it, said he would try, and *did* try again and again. Most of us have seen a juvenile attempt to achieve the rather difficult act of muscular mechanics, of simultaneously revolving the two hands in opposite circles. It is not an easy thing to do; many can never learn to do it; and the attitudes of boxing unconsciously assumed during the attempt, viewed in relation to the serious aspect of the executant, as he strives mentally as well as muscularly to overcome the difficulty of what, if reasoned upon, seems amongst the easiest of feats, gives an appearance of grotesque absurdity.

Comparable to this was the aspect of the poor fellow whose image is now reproduced to my memory. '*Not able to swallow a cup of water!*' (they did not trust him with a glass), he would seem to say. '*Why not* swallow a cup of water? Ridiculous! I *will* do it, so here goes!' Then he would slowly and stealthily raise the cup to his lips, as if to get it there unknown to some invisible enemy who sat mounting guard and denying.

He would open his lips; then what followed could best be compared to the effects of an invisible garrotting hand laid violently upon the throat, and clutching it with vice-like fingers. Soon the poor fellow's eyes seemed thrust from their sockets. Convulsions originating in the throat went racking along the muscles to each extremity. He uttered agonising sounds; foam issued from his mouth. It was a scene that might well have suggested demoniacal possession. Fanciful writers of olden time have described the sounds uttered by human patients suffering under an accession of hydrophobic convulsions as comparable to the barking of dogs. This is pure imagination; the sounds uttered are no more than such commonly uttered during convulsive pains, from whatever cause originating.

The case to which my memory reverts did not—at the time when I saw the patient, at least—reveal symptoms of that dreamy, contemplative, delirious wandering commonly referred to the disease when occurring to mankind, and which usually seems to characterise it when occurring to dogs. To expound the characteristics of this hydrophobic delirium I cannot do better than cite from Dr. Bardsley:

'I observed,' says this gentleman, speaking of one of his patients, 'that he frequently fixed his eyes with horror and affright on some ideal object, and then, with a sudden and violent emotion, buried his head beneath the bedclothes. The next time I saw him repeat this action I was induced to inquire into the cause of his terror. He asked whether I had not heard howlings and scratchings.

'On being answered in the negative, he suddenly threw himself on his knees, extending his arms in a defensive posture, and forcibly threw back his head and body. The muscles of the face were agitated by various spasmodic contractions; his eyeballs glazed, and seemed ready to start from their sockets; and at that moment, when crying out in an agonising tone, "Do you not see that black dog?" his countenance and attitude exhibited the most dreadful picture of complicated horror, distress, and rage that words can describe or imagination paint.'

The late lamented veterinary surgeon Mr. Youatt, in his wonderfully graphic accounts of hydrophobia in animals, more especially the dog, pays great heed to this wandering, this dreamy contemplation of imaginary objects by hydrophobic dogs. According to his high authority, there is no such certain sign of the presence of the disease as this. He never knew it fail; he could rely upon it implicitly. Endeavouring to sketch the progress of canine rabies from the beginning, I will, or rather Mr. Youatt shall, commence by giving an exposition of symptoms whilst the disease is yet incipient.

'The early symptoms of rabies in the dog,' says he, 'are occasionally very obscure. In the greater number of cases we find sullenness, fidgettiness, and continual shifting of posture. For several successive hours, perhaps, the dog returns to his basket or bed. He shows no disposition to bite, and he answers the call upon him haggardly. He is curled up, his face buried between his paws and his breast. At length he begins to be fidgety. He searches out new resting-places, but he very soon changes them for others. He takes again to his own bed, but he is continually shifting his posture. He begins to gaze strangely about him whilst lying on the bed. His countenance is clouded and suspicious. He comes to one and another of the family, and he fixes on them a steadfast gaze, as if he would read their very thoughts. "I feel strangely ill," he seems to say; "have you anything to do with it? or you, or you?" Has not a dog mind enough for this? If we have observed a rabid dog at the commencement of the disease, we have seen this to the very life.'

It is not invariably easy to detect nascent hydrophobia. In the year 1813 a child attempted to rob a dog of its morning food, and, the animal resisting the theft, the child was slightly bitten. No one imagined danger. Eight days afterwards rabies appeared in the dog: the malady ran its course, and the animal died. A few days afterwards the child sickened: undoubted characteristics of rabies were observed; they ran their course, and the child was lost.

Thus much as regards the incipient stage of rabies in dogs. As the disease advances, the peculiar characteristic of dreamy delirious contemplativeness evidences itself. The dog will sit by the hour, alternately watching small, or, it may be, wholly imaginary objects strewn on the ground, motes in the air, nails in the door of his kennel; then dozing, only to wake in terror, and stare and doze and dream again, often bending his eyes long at a stretch, following the gazed-at object, if it be movable, by turning his head.

The animal's breathing will quicken, his eyes will glare, and, impressed by some feeling of terror, he will spring at the object, and try to seize it between his teeth. Yet it is very rare that a dog, even when these hallucinations have begun to affect him, will be altogether bereft of reason and memory. To the voice of a friend he will usually respond; and gratefully too, as though glad to be roused out of some disturbing dream. He is now apt to manifest his gratitude, after a common manner of dogs, by caresses with his tongue. Let all who dread a death more horrible than disease or accident can match, or torturer devise, beware of the tongue of such a dog! If there be an abrasion on the skin, inoculation will no less surely follow than if the dog had bitten in rage instead of fondled affectionately. Many examples have occurred of death from hydrophobia caused by inoculation of this sort.

A dog is mostly silent until this dreamy contemplative stage of the disease is pretty far advanced; then, on being aroused from his reverie, he breaks forth into a prolonged agonising howl, which must be heard to be appreciated, but *once* heard will never be forgotten. It is the unfailing characteristic of hydrophobia.

On the 21st of October 1813, Mr. Youatt records that a dog was brought to him for examination, having vomited a considerable quantity of coagulated blood. Mr. Youatt, happening to be busy at the moment, and not observing anything peculiar in the countenance or manner of the dog, ordered some medicine, and promised to see the dog again in the afternoon. In the afternoon, accordingly, the dog was again brought; and then for the first time was it observed that the creature's mouth seemed to be swollen. On examination, some of the incisor teeth, both upper and lower, were found to be extracted.

'This somewhat alarmed me,' records Mr. Youatt, 'and, on inquiry of the servant, I was told that he expected they had had thieves about the house on the preceding night; for the dog had torn away the sides of his kennel in attempting to get at them.' Thereupon Mr. Youatt reprimanded the servant for not having mentioned this before; and, talking of various things to fill up time, he carefully watched the dog. 'I saw, or thought I saw,' the narrative goes on to state, 'but in a very slight degree, that the animal was tracing the fancied path of some imaginary object. I was then truly alarmed, and more especially since I had discovered that in the giving of the physic in the morning the man's hand had been scratched. A youth had suffered the dog to lick his sore finger; and the animal had also been observed to lick the abraded arm of an infant. He was a very affectionate dog, and was accustomed to this abominable and inexcusable nonsense.'

The veterinary surgeon had seen enough to awaken the gravest apprehensions for the safety of these two persons. That the dog was *actually* rabid, he did not much doubt. Detaining the animal, Mr. Youatt tied him up, and sent a note to a surgeon by the man who had brought the dog, communicating his fears, and suggesting instant cauterisation; which accordingly was freely practised. Meantime the surgeon and the veterinary surgeon kept their eyes on the dog in quarantine.

'I watched the dog day after day,' writes Mr. Youatt. 'He would not eat, but he drank a great deal more water than I liked. The surgeon was evidently beginning to doubt whether or not I was wrong; but he could not dispute the occasional wandering of the eye, and the frequent spume upon the water. On the 26th of October, however—the sixth day after his arrival—we both of us heard the rabid howl burst from him. He did not, however, die until the 30th.'

In this case, no ill results followed to either the man whom the dog had bitten, or the boy whom he had licked. Whether this immunity be due to the precautions taken, or to some natural non-susceptibility, is of course non-apparent; and from the very nature of the case could not be made apparent. As we have already seen, Hufeland determined by actual experiment that the number of individuals attacked by hydrophobia after specific and competent inoculation was, according to all the testimony he had collected, a minority. But many, perhaps the majority, of tooth-punctures and lacerations inflicted by rabid animals do not supply the conditions of infection.

Even the bite of a poisonous snake is usually less dangerous when delivered through an article of dress than when inflicted on an uncovered part of the body; and if so in such a case, wherein teeth specially adapted by perforation to inject poison into the flesh, to how much greater an extent may we occasionally assume articles of clothing to be effective against the poison-inoculation of non-perforated teeth?

It would seem farther, that surgical treatment—excision, cauterisation—is almost invariably effective in obviating hydrophobia, though a subject have been inoculated by a creature undeniably rabid, and in a manner wholly unexceptionable, speaking physiologically with reference to embracing all known conditions favourable to infection. To be precise, there is hardly a case on record testifying to the accession of hydrophobia subsequent to prompt excision or cauterisation, one or both, immediately following a bite, suspicious at the time, but subsequently confirmed as to its hydrophobic character, by waiting and watching the issue of symptoms upon the animal.

This is a deduction that cannot be otherwise than favourable to a belief in the efficacy of surgical treatment in a very high degree, though, of course, stopping short of actual proof, inasmuch as the questions may be raised, whether, firstly, inoculation was complete; secondly, whether, if complete, it would have taken effect in the particular case or cases adverted to. Certain questions may ever be raised, and never rigorously disproved. A certain large residue of moral faith, if not moral conviction, remains as to the efficacy of surgical treatment in warding-off hydrophobia. Unfortunately no such assurance can be given in respect to medical treatment in this disease, whether as preventive, or palliative, or curative, after the disease has once become fully manifested. To various nostrums the faculty of warding-off an accession of hydrophobia has been attributed; but the merits of them do not rest on evidence satisfactory to physiologists and medical men. It is easy to understand, however, that the malady is of such sort, that an advocate vaunting the powers of a prophylactic might occupy a position of great seeming strength, owing to the circumstance already noted, viz. that, of the number of subjects exposed to hydrophobic contingencies, the number actually infected is always a minority.

As to the cause of hydrophobia, nothing whatever is known. A certain vague popular opinion refers it to extreme heat, and associates it in some manner with the dog-days. This is wholly an error: first, the months in which, in Europe, hydrophobia is most prevalent are not July and August, but April, November, and December; secondly, in all hot climates the malady is rare,—in some, Cyprus and Egypt, for example, wholly unknown. Jamaica was a stranger to it until recently, when the disease was conveyed there by importation; and Africa and South America have furnished very few cases.

Wherever hydrophobia *does* occur it presents the same symptoms for similar animals; establishing a comparison between hydrophobia in human beings and hydrophobia in dogs. We have already seen that the chief characteristic difference is, that whereas in man the difficulty of swallowing liquids is usually extreme, dogs experience little or none. Although dogs have been the chief subjects for the study of hydrophobia, the characteristics of the disease, when affecting them, have been greatly misrepresented.'

Amongst other erroneous statements concerning rabid dogs, it has come to be matter of general credence that a dog thus affected commonly runs about seeking out human beings and animals, snapping at them as if urged by malice prepense. This is erroneous; the truth being that a rabid dog rarely goes out of his way to attack animals, and still more rarely to attack mankind. The characteristics of rabies in dogs, as popularly imputed, are very closely applicable to rabid wolves.

Of all rabid animals wolves are most to be dreaded. They mingle a cunning, a deliberate wickedness with their rabies, to which dogs are wholly strangers. A rabid wolf, losing the natural cowardliness of disposition which keeps him from the haunts of man, save when hungry or in a pack with fellow-wolves, will lurk at the entrance of some village, and bite and rend every living thing that chances to come in his way. A rabid badger too is, as might have been inferred from his nature, a very terrible creature. Hufeland records the particulars of one that bit two boys; that was killed whilst fastened on to the thigh by his teeth and sucking the blood of the second. This boy became hydrophobic and died; but the other boy escaped.

Mr. Youatt, to whose acute power of observation pathologists are so much indebted for records of hydrophobia in domestic animals, has left a most vivid history of his experience, limited to two cases, of hydrophobia in cats. If the two feline cases noted by that gentleman are not of exceptionable gravity, a mad cat is an animal far more to be dreaded than a mad dog. The first stage of rabies in cats, according to Mr. Youatt, seems to be one of sullenness; a state that would probably last to death, were the creature not interfered with. A dreamily contemplative rabid dog may be generally awakened to consciousness by the voice of one he knows, as already stated; and he rather likes to be thus awakened. Not so a rabid cat. With *her* dreamy musings it is perilous to interfere. 'Probably,' says Mr. Youatt, 'a rabid cat would not, except in the paroxysm of rage, attack any one; but during that paroxysm it knows no fear, nor has its ferocity any bounds.' Mr. Youatt had good reason to remember *one* rabid cat: not only was the memory of her madness impressed upon his mind, but her teeth were impressed into his lips. Mr. Youatt shall tell his own tale:

'A cat that had been the inhabitant of a nursery, and the playmate of the children, had all at once become sullen and ill-tempered. It had taken refuge in an upper room, and could not be coaxed from the corner in which it had crouched.

'It was nearly dark when I went. I saw the horrible glare of her eyes, but I could not see so much of her as I wished, and I said that I would call again in the morning.

'I found the patient on the following day in precisely the same situation and the same attitude, crouched up in a corner, and ready to spring. I was very much interested in the case, and, as I wanted to study the face of this demon—for she looked like one—I was foolishly, inexcusably imprudent. I went on my hands and knees, and brought my face nearly on a level with hers, and gazed on those glaring eyes and that horrible countenance until I seemed to feel the deathly influence of a spell stealing over me. I was not afraid, but every mental and bodily power was in a manner suspended. My countenance perhaps alarmed her; for she sprang on me, fastened herself on my face, and bit through both my lips. She then darted downstairs, and, I believe, was never seen again. I always have nitrate of silver in my pocket; even now I am never without it. I washed myself and applied the caustic with some severity to the wound, and my medical adviser and valued friend, Mr. Millington, punished me still more after I got home. My object was attained, although at somewhat too much cost; for the expression of that brute's countenance will never be forgotten.'

Inasmuch as this cat's latter end was mysterious—nobody knowing what became of her or how she died—perhaps it cannot be said, according to strictest logic, that the fact of her rabies was determined. Mr. Youatt, however, had no doubt of the case; whence, taking her madness for granted, we may severally form our own opinions as to the value of cauterisation.

Inasmuch as the two cases of human hydrophobia already chronicled in this narrative are English cases, it may be as well, before concluding, to present two French cases by way of set-off, if only to prove that the disease comes introduced to us under the same guise, whether the statement of it have reference to France or England; whether narrated by Frenchman or Englishman.

'A lady,' writes Monsieur Perquin, in his treatise on Hydrophobia, 'owned a greyhound, that she petted by allowing to sleep on her bed. One morning, she remarked that he had torn the bed-covering; and although he ate little, he drank often, and in much larger quantity than was usual with him. A veterinary surgeon, on seeing the dog, pronounced that nothing ailed him; but the greyhound having bit his mistress's forefinger near the nail, she became anxious, and led the dog to the veterinary surgeon a second time. Again he reassured her. On the following day, however, the dog died, having never ceased to drink abundantly up to the very last. This happened on December 27th. On the 4th of February subsequently, as the lady was dining with her husband, she found some difficulty in swallowing. She wished to take some wine, but could not. The day following she consulted a surgeon, who wished her to swallow some soup in his presence, but she could not. She then fell into a state of violent agitation, with spasm and constriction of the throat, and on the 7th — four days after the first manifestation of disease—she died.'

Far more terrible the progress of disease to its issue in the following case, also narrated by Monsieur Perquin:

'Joseph Delmaire, of Looberghe, was, on the 6th of October 1836, bitten by a dog that had attacked him in the forest. Suspecting the dog to have been mad, Delmaire went on the following day to a medical man, who washed and scarified the wound. He returned home far from satisfied. The dog's image was ever before him, and he was troubled with the most frightful dreams. Four-and-twenty days passed with no farther development of symptoms, when Delmaire, rising from his bed one night, felt the most dreadful trepidation. He panted violently. An enormous weight seemed pressing upon his chest. From time to time he sobbed and sighed profoundly. He complained that he was being smothered. His mouth was dry, his throat burning, his thirst excessive. All that he attempted to swallow was rejected with horror. He was bled largely, with some relief to breathing, but the dread of every fluid remained. After an hour's repose, all the symptoms returning, the bleeding was repeated. His face looked dreadful; eyes starting from their sockets, muscles convulsed.

'He would continually start from his seat and howl fearfully, foam starting from his mouth. In his violent fits six men could barely hold him. Often would he disengage himself from them all, and dash himself about on the floor. There, freed from all control, he would roll about, beating himself, tearing everything within reach. There were intervals, however, during which he had his full remorse. He would then beg his old father to pardon him; he would talk to all around him with intense affection; and when feeling a new accession, he would implore his friends to leave him.

'At length the violence of these mental symptoms subsided. From time to time the dreadful convulsions returned. The impossibility of swallowing remained, but there was no fear of liquids. Asking for something to drink, they handed him some white wine. He tried to swallow, but it was returned through the nostrils. The patient then went to sleep, and woke no more. His death was easy.'

As I did not take up the pen to write a medical treatise on hydrophobia for medical perusal, I will not shock and horrify susceptibilities by any farther record of cases, by any farther lingering upon symptoms no less terrible than they are hopeless. There is a certain fascination about horrors, of whatever kind, to some minds. One sort of human temperament will best minister to its horror-loving element of existence by gazing on public hangings. Physical horrors some people like best. Roman ladies, I doubt not, watched the quick movements of the retiarius, as, netting his adversary, he plunged his trident deep between his ribs, with all the interest with which I have seen Spanish ladies gaze upon a horse turned inside out by *toro's* horns, and trampling upon his own inside! Every variety of human temperament needs a pabulum of some sort of terror now and then, by way of mental condiment or spicery. There may be persons who could satisfy their cravings with recitals of hydrophobic symptoms.

Let all such read the pages of Hufeland, Dr. Bardsley, Monsieur Perquin, &c. and they will see enough. My object was not to furnish horrors to satiety, but just enough to illustrate a disease that is well worthy to be studied by all human beings who live, or may live, in any country not devoid of dogs. The practical conclusions to which we arrive are:

That the pathology of hydrophobia is not known; that the spontaneity or non-spontaneity of it is still undetermined; that the opinion referring it to the operation of extreme heat, and associating it with the dog-days, is a myth; that the surgical prophylaxis of the disease is no less hopeful than the medical prophylaxis and treatment of it when established is hopeless; that the evidences of the disease in dogs are clear; the chances of injury through unprovoked attacks of dogs slight; finally, that the poison cannot be communicated by mere contact with the unbroken skin—abrasion there must be; but this conceded, the salivary contact of licking is not less dangerous than the puncture of an actual bite.

CURE BY Yᴱ TOUCH.

Assume that, in the present year of grace 1870, her most gracious Majesty Victoria should cause the following announcement to go forth:

'Whereas, *agreeable** to representations duly made by her Majesty's officers of health by law ordained and appointed, there be divers persons of both sexes in these her Majesty's realms afflicted with the malady known as scrofula, or king's evil, and to whom physic and chirurgery give no relief:

'Whereas, furthermore, it hath been testified by divines, physicians, chirurgeons, and divers other learned men, that the power of curing the aforesaid disease, by stroking with the royal hand, hath been given to sovereigns of this realm from Edward the Confessor downwards:

'Therefore, by the advice of her Majesty's lords spiritual and temporal in council assembled, it is ordained, that henceforth and until farther notice, such of her Majesty's subjects as be stricken of the disease, and long for cure through the imposition of royal hands, shall repair to Buckingham Palace at 10 of the clock on the first Monday of every month, and be holpen accordingly.

'Given under our hand and seal this blank day of blank month,' &c.

Assume, I say, a proclamation of the sort to have gone forth; then contemplate the probable reception of it. First, in respect of the candidates themselves, individuals stricken of scrofula or king's evil; I have no doubt they would be

* 'Agreeabl*e*,' not 'agreeabl*y*,' let the reader be assured, is civil-service Queen's English, as by authority decreed and by precedent consecrated.

numerous. If Dr. Newton could find patients, then *à fortiori* the sovereign. I have as little doubt that many, honestly believing themselves better for the royal imposition of hands, would pronounce themselves cured.

Then a considerable number, feeling no better for the touching, would nevertheless testify to the cure, prompted by a certain spirit of subserviency (toadyism I think they call it), to the influence of which some individuals have ever been prone, and ever will be. If, in reviving the pretension, the practice were also revived of hanging a gold medal round the neck of each candidate, then doubtless witnesses to the truth, as by royal proclamation set forth, would be still more numerous.

As for lookers-on, individuals not stricken with disease, yet called upon to offer some sort of opinion, it *may* be testimony; probably the result might be as it was of old. A considerable portion of the educated classes, starting with testimony of cures performed, would supply what they might conceive to be the *ratio medendi.* Amongst dissentients, the majority would veil their dissent, actuated by the desire of peace and quiet, leaving the minority to be snubbed into sneering acquiescence by combined force of state and church, fashion and interest; aided by certain professors of law and physic, perhaps—for certain, by a legion of sycophants.

Even so *was* the result, and so it would be again. Assuredly, if the belief in spirit-rapping and table-turning can find acceptance, credence in the efficacy of the royal touch should not be a matter of surprise. Mesmerism, indeed, has prepared the way for a revival of the belief, inasmuch as (taking the evidence furnished by mesmerists as reliable) cures of diseases by gentle passes of the hand, similar to the act of caressing a cat,* are by no means uncommon.

* Hence the expression *stroking for the evil,* formerly universal. During the reign of Charles II. several private gentlemen acquired high repute as strokers. An Irish gentleman, named Valentine Greatracks, was the most

The real difficulty would consist, not in reëstablishing a faith in the efficacy of the royal imposition of hands, but in discriminating between the properties and characteristics of what might seem to uneducated people analogous or closely-allied operations. A few words in explanation will make all apparent. To begin with the frictional treatment of various diseases, rheumatism and paralysis for example, this method is of high antiquity and considerable present repute. Now, if the practice of curing by royal touch were reëstablished, one may rest assured that certain disaffected subjects and evil-disposed critics would be found endeavouring to prove the identity of *medendi ratio* between the royal 'smoothing down' and any ordinary friction.

This, though a matter of high treason, would hardly, I fear, in the present depraved state of public opinion, induce the proper consequences of that crime—hanging, drawing, and quartering. Again, it was usual with British sovereigns in times gone by to supplement the health-bestowing sliding touch with the dotation of a coin or medal, usually of gold, to be suspended from the neck by a ribbon. Now this circumstance would assuredly be cited by disaffected and heretical people, having faith in relics and amulets, as evidence to prove that the virtue of gold was all in all—the sovereign nothing. Such an opinion would of course (argue my authorities) be both wicked and absurd.

'To dispute the matter of fact,' says Collier, in his *Ecclesiastical History*, 'is to go to the extreme of scepticism, to deny our senses, and to be incredulous even to ridiculousness.' 'King Edward the Confessor was the first,' says Collier, in another place, 'who cured this distemper [king's evil], and from him it has descended as an hereditary gift upon all his

celebrated of these. Many notabilities of the day were treated by Greatracks, among them Boyle and Cudworth. Considerable jealousy was manifested against these private strokers. It was maintained by high-church-and-king people, that 'stroking' was a special prerogative of his Majesty, *i.e.* Charles II.

successors.' And as though this testimony were not enough, the same author, in another place, writes, 'That Edward the Confessor cured the king's evil is beyond dispute. The first person cured by the king was a young woman; the manner was by stroking the affected place with his hand.'

I desire to be impartial as touching the ability of British kings and queens to cure by imposition of royal hands and gentle smoothing down (not to be confounded with friction). That allegation rests, I say, on the testimony of so many bishops, clergymen, physicians, surgeons, nay, even people averse to kingly authority either in the abstract or otherwise, *e.g.* Roman Catholics, Quakers, and other Nonconformists, that to doubt its reality would not be easy.

How, for example, shall we dispose of the testimony of John Brown, chirurgeon in ordinary to his Majesty Charles II., surgeon to St. Thomas's Hospital, and author of many learned works on surgery and anatomy? An inkling of that testimony one gets in the title-page of his book, 'Charisma Basilicon, or the Royal Gift of Healing Strumaes, or King's Evil, by contact or imposition of the sacred hands of our Kings of England and of France, given them on their inauguration. The whole concluded with above 60 admirable cures, performed with and without gold, by his Majesty's benediction, by his late Majesty's precious blood, and the like.'

The 'Charisma Basilicon' is dedicated to the Right Honourable and Right Reverend Father in God, Nathaniel Lord Bishop of Durham, and Clerk of the Closet to his Majesty. Chirurgeon Brown, addressing the bishop in a dedication, commits himself to an opinion of speculative physiology:

'Whosoever considers,' writes he, 'the daily blessings our three kingdoms do receive from his sacred Majesty [*i.e.* Charles II.], must necessarily be convinced that, as the animal faculties lodge in his royal head, which gives that sense to every affair we prosecute, so his sacred hands are sweetened with that sacred salutiferous gift of healing, which both supports the body politic, and keeps up the denizens and subjects thereof in vigour and courage.

'My lord [*i.e.* the bishop], the eminent and well-deserved place your honour enjoys in the king's presence, as well as in his princely and royal palace, being clerk to the closet of his sacred majesty, does not only place you near your sovereign, but puts you at his right hand, by whose clean hands the royal gold, which is used at our daily healings, is presented to our sacred majesty. And this makes you as great a judge as observer of these his wonderful and miraculous cures, so frequently made good by his sacred hands; the which, as they have been infinite in numbers, so ought they to be accounted miraculous in their nature.'

Thus inferentially, you see, my lord bishop testifies to the fact; and were time and space more propitious, dozens of bishops might be cited who testified directly. Are we to believe this mass of evidence? Do *I* believe it?—not, that is to say, in any reserved non-natural sense, but plainly, literally, chapter by chapter, phrase by phrase, line by line, word by word?

Ay, to be sure I believe (using the words of a bishop to Dr. Colenso), that, 'if viewed in relation to the subject it really refers to—the state, mentally and morally, of those to whom it was addressed, and the effect it was intended to convey—it will bear the pressure of any test applied to it.' Should some disparager of the divinity of kings affirm the contrary, then my reply is (again quoting the same bishop's words), 'I must attend to other duties than a controversy with one who has been so ably encountered.'

To doubt the efficiency of royal touch is, let us admit, for peace and quietness' sake, impossible; but having studied candidly every aspect of the case, and weighed impartially a vast array of evidence, I am unable to indorse the extreme opinion, that the gold, silver, or other token given by the sovereign was absolutely without influence on the malady.

In support of this opinion, very deferentially advanced, I may be permitted to cite a case recorded by Mr. Dicken, sergeant-surgeon to Queen Anne. By reason of his position as sergeant-surgeon, it was a part of this gentleman's duty to select and pass suitable candidates for the Queen's touch.

Once upon a time, he relates, a certain woman applied to him as a candidate for royal-hand imposition; but not liking her appearance, he was reluctant to make the presentation. He judged from the individual's look that she only wanted the gold, which, when obtained, she would be base enough to hypothecate to Jew or Lombard—perhaps sell outright.* Pleading hard, however, this woman's request was granted. The queenly touch being vouchsafed, and the gold presented, behold, the cripple was healed!

Years passed, and the stricken one came again. The sergeant-surgeon, thoroughly up to his duty, recognised an old face, and addressing the woman, said, 'I've seen thee before;' whereupon she fell upon her knees, owned the crime of selling the coin, pleaded for another, and vowed she would keep it till the day of doom. As her symptoms were very bad, the doctor, straining a point, introduced her a second time; whereupon another stroking, another medal, and another cure. This case proves that in the instance cited the medal had something at least to do with the cure.

As a set-off, take one of different purport, Charles the martyr being operator. The result distinctly proves that his dread majesty's power of healing was so great as to be wholly independent of the aid of an amulet:

There was a certain Robert Cole, an innkeeper at Winton, that was highly diseased with the king's evil. His majesty, being about this time removed from the Isle of Wight, passed through Winton, when this object of charity, pressing to come near the sacred person, was prevented, and ill-treated by the

* This feminine characteristic, I would remark, only applies to those times.

soldiers. Upon which he making several exclamations of 'God save the King!' it reached his Majesty's sacred ears; when our dread sovereign gave the weak and despairing man his blessing, in the like words to these:

'I see thou art not permitted to come near me, and I cannot tell what thou wouldst have; but God bless thee, and grant thy desire.' 'After which, and without the king's stroking, the diseased man returned to the liquor he had formerly washed his sores with; upon which the water wasted until it was quite dried up. Still more wonderful to relate, scales began to cover the bottle on its outside, and as they did increase on the bottle, so did they diminish on the body of the aforesaid Robert Cole. One day a lady, moved by curiosity, to which the sex is prone, did essay to remove these scales from the bottle. Robert Cole was distant at the time; nevertheless, as every scale was plucked from the bottle, so was he filled with agonies even unto y^e marrow. Now I challenge all y^e sceptics upon y^e earth to produce an instance more astonishing than this,' exclaims my authority. Well he might!

The result will, I think, demonstrate beyond cavil that his dread Majesty, the royal martyr, could cure not only without aid of gold, but even without imposition of hands, so lively was the divine power of healing in that royal person.

Divers ill-disposed subjects, revilers of the divine power, sought to make it appear that the sole efficacy of the process was referable to the sign of the cross wherewith it was accompanied. Herein, however, the same do egregiously err, as the following testimony shall prove: the virgin Queen, of blessed memory, never used the sign of the cross, nor was that popish emblem again used until the reign of James II. Nevertheless, the divine power of cure never streamed so prodigally from the fingers' ends of British sovereigns, as when the sign of the cross was no longer used; notably from the hands of his Majesty Charles II.

By this time the benevolent reader, confused by recitals which I shall not wonder if he call a farrago of nonsense, may feel inclined to exclaim with Faust, when confused with the mad chattering of the Blocksberg witches,

'Mir widersteht das tolle Zauberwesen.'

The wildness of narrative, the 'Tollheit,' is, however, in no degree attributable to the scribe who condenses, out of solemnly attested records many, this bare recital of a pretension urged by and on behalf of British sovereigns; attested by divines, physicians, surgeons, by the score; defended by the terrors of impending high treason; only relinquished by George III., seemingly for family and domestic reasons, to which farther allusion may have to be made by and by; and, for aught I can learn to the contrary, still a constructive article of belief with orthodox members of the established church, inasmuch as belief in the divine gift of healing vouchsafed to kings, as it was formerly called, once so strenuously upheld by high dignitaries of the established church, has at no time been unequivocally revoked.

The pretension, or function—call it which pleases you best—of royal cure by the touch, illustrates by its records, as seen in English history, and by apologue, of course, a certain old proverb about what will happen to—well, not a king, if rope enough be given. I do not think any author has ever written so fully as the case merits on the troubles which may afflict individuals through being permitted to have their own way—the embarrassments, the humiliations. It is a topic that many of us might reflect upon with great gain to personal happiness. Youth of both sexes are invited to think on this matter, especially young ladies. It was through unlucky heedlessness of the results that may come of having one's own way that the English king of olden time, whatever his name (and on this point history is confused), proclaimed to his loving subjects that, by virtue of a certain divine grace within him, he possessed an unlimited power of healing.

What could be more delightful than such a right royal announcement at any time, the more especially at a time when medicine and surgery were both so barbarous? *Benevole lector*, if you should tell me that you could change my own gray hair to raven black by stroking it with your hand, why need we waste words about it? I might, without imputation of high treason, say nay. Why *should* I say nay? Lifting my hat, I would bid you come and do it. When kings and queens began to heal by imposition of hands and stroking, they had formed no consistent theory of the *ratio medendi.* It is natural for the human mind to invest persons in authority with exalted attributes. Probably no ruler of men was ever spoken of during life by subjects as not being stamped with some sort of excellence beyond that of the governed. What happens in the empire of bees seems to have prompted the notion.

A queen-bee is obviously different from a common bee—handsomer, bigger, every way more majestic. She bears imprinted on her front and figure the stamp of heroism unmistakable. Notwithstanding this profound physical difference between her majesty the queen-bee and her subjects the common bees, her majesty, as good old blind man Huber satisfactorily made out, was a common bee once, only having risen to the physical majesty of queendom through sheer force of refined diet.* It might be worth while to try whether something similar to the physical exaltation wrought by attention to diet on bees might not be effected upon young people in legitimate succession to thrones. Had rulers of men been endowed with a distinct heroic cast of form and

* If by any accident a queen-bee dies, a successor, equal to her in every respect, of heroic stature and bearing, is manufactured out of a common bee, which, being walled into a special apartment, and fed on a particular sort of food, is thereby metamorphosed into a queen-bee.

feature, there might have been less of that baneful scepticism concerning the divinity of kings. Such outward sign of physical superiority *not* having been always vouchsafed to kings and queens, it behoved them to illustrate the divinity of their appointment by the display of moral and spiritual qualities, amongst which the assumed power of curing diseases by the touch must be numbered. Some pretension of this sort has been pretty common amongst rulers, temporal as well as spiritual, in most countries and at most times; but it is wholly in respect of the healings performed by kings and queens of England that we have now to concern ourselves.

Nothing like a consistent account of curing by the touch, as possessed by British sovereigns, can be found prior to the reign of Henry VII.; nor is this wonderful, when we remember that printing had only then just come to be substituted for the tedious process of hand-copying. It was remarked by Lord Bacon, that Henry always showed great partiality for the observance of forms and ceremonies. This monarch's title to the English crown was none of the best: to speak plainly, he may be called a usurper. Desirous (so runs the argument of such as revile the divinity of kings) of some token whereby he might assure his subjects that the divine blessing was upon him, Henry laid his royal hand, with doubt and trembling, upon a scrofula-stricken patient, whereupon the latter was cured. This discovery made, Richmond began to hold up his kingly head right royally, like any other legitimate heaven-appointed king. Grateful at the manifestation of such healing power through strokings by the royal hand, Henry (thus do evil-disposed traducers allege) began to scan the chronicles of his predecessors for examples of previous cures effected. He studied the ceremonials that had been adopted on these occasions, retaining several, and adding others. All that had hitherto in the matter of royal healing been conducted arbitrarily, was now codified into a system. This monarch was the first amongst English sovereigns who accompanied the stroking with the substantial token of a fair rose-noble, the coin being suspended from the neck by a piece of white ribbon. Evil-disposed people are never at a loss for pretexts for venting their malevolence; accordingly, the like have urged that this royal dotation of a piece of gold was nothing else than a bribe for testimony, an inducement for a patient to swear he was cured, whereas without the gold he might not have seemed to see it. As if an English cripple, chastened by disease, temp. Henry VII., would have given false testimony for a paltry bit of gold! or, for the matter of that, any other cripple!

The curative strokings of Henry VII. are worthy a philosopher's deepest consideration, both as regards the royal person and the outward ceremonies he vouchsafed to use in performing his cures. The point is thoroughly well made out that God, in recognising kings, does what mankind are now wont to do—*i.e.* recognises them *de facto*. Richmond could advance no claim to what certain weak-minded people call legitimacy. Pooh! pooh! Richard being out of the way, Richmond put the crown on his own head, and thenceforth before the eyes of man he stood a king. Of man, did I write? ay, and of Heaven too; how else could he have cured the evil as well as any other king?

Treating the subject-matter in hand historically, we next come to our British Bluebeard of divine succession; divine inasmuch as Henry VII. had been permitted to display, through the gift of healing, his acceptance by Heaven. As a medical and chirurgical stroker, Henry VIII. was even more renowned than his royal father; and to some the cures effected by this king will appear the more extraordinary that they were performed in despite of the anathemas and fulminations of Rome. Not only was Henry VIII. most powerful in the cure of scrofula, or king's evil, by imposition of hands with stroking, but he also acquired much celebrity for the cure of cramps. The latter operation he did not accomplish by stroking, but either through the influence of certain rings, known as cramp rings, or through some occult emanation of the kingly power, of which cramp rings were a token.

For some reason, the explanation of which, so far as I am aware, has never been vouchsafed, the kingly office of stroking for the evil was not exercised by Edward VI. Mary certainly practised it, though scant notices of her majesty's successes in this line have been handed down to us, most probably for the reason that all chroniclers of the royal gift whose testimony is now available were Protestants, incapable of doing justice to a queen, even in a matter of fact, whose faith differed from their own.

The reign of Elizabeth, considered in relation to the divine gift of cure by the touch, is remarkable in several particulars. It is remarkable for the lack of faith on the part of the virgin queen herself, in respect of a virtue which, according to my testimony, she possessed in the highest exaltation of its excellence, and of which examples shall be set forth by and by.

Elizabeth's reign is remarkable for the appearance of several books, all in defence and vindication of the royal prerogative: books written not by ignorant men, but by authors of high repute, such as divines and surgeons practised in the cure of the very diseases operated upon by majesty.

Thus, Dr. William Tooker, a divine* who wrote in this reign, testifies, in language the most unequivocal, to the virgin queen's salutary power.† This author, not content with referring the first example of cure by imposition of royal hands with stroking to Edward the Confessor, carries the gift as far back as Lucius, by some supposed to be the first of our Christian kings.

Perhaps the testimony to the Queen's power of cure by

* Some time chaplain to Queen Elizabeth; afterwards canon of Exeter (place of his nativity); and later dean of Lichfield.

† Vide his book, *Charisma, seu Donum Sanitatis.*

the touch rendered by chirurgeon Clowes will be more satisfactory to some minds. This gentleman, a native of Warwickshire, served as surgeon both in naval and military expeditions of this reign. In consideration of surgical services rendered, he received a grant of arms in 1576. Clowes wrote many professional books; amongst others, one entitled 'A right fruitful and approved Treatise of the Struma,' &c., the very disease, be it remembered, most amenable to cure by royal manipulation. Surely this is a question in which the testimony of one like Clowes—a contemporary, a professional expert—must be overpowering. What, then, *is* the testimony? Hear it, ye sceptics, and slink away abashed! He gives the whole particulars of a cure upon a scrofulous person, by the virgin Queen's stroking, which he judged to be 'more divine than human;' and he expressed the confident belief, 'that upon failure of other methods of cure, people may expect relief from her Majesty.'

I have stated that the Queen herself underrated the divine power so miraculously vouchsafed. Thus, it is recorded by Dr. Tooker, that when the Queen was in Gloucestershire, many poor people afflicted with the disease, pressing upon her in an unruly manner, she let fall these words: 'Alas, poor people! I cannot cure you; it is God alone who can do so.'

Now, with Dean Tooker, I cannot but agree that the expression above cited has been wrested from its proper and legitimate meaning. Probably, what the Queen really *did* mean was, that she held herself to be, in this matter, no more than God's agent.* This capacity of healing—independent of will and belief of the royal person—thus demonstrated, is important. Being proven, the delicate question arises, whether any English sovereign has a constitutional right to abandon a practice so fraught with blessing? Of this perhaps more anon.

* Nevertheless, the practice of touching for the evil was discontinued by Queen Elizabeth at a certain period of her reign.

Wonderful though the examples of royal cure already cited, it was reserved for the line of Stuart sovereigns to display the divine gift in all its full-blown excellence. I have already discussed the question whether the coin or medal bequeathed had any efficacy. I think we must admit that it counted for something. The British Solomon, as he has been not unaptly called, devoted the whole energy of his great mind to solve some long-outstanding doubts relative to this metallic question. As I understand the case, his majesty came to the conclusion that a metallic gift was useful 'as an adjuvant,' to express oneself homœopathically;* but to this monarch's investigations we owe the discovery of the truth that *siller's as gude as gowd* (how very Scotch!). Accordingly, silver *was* often used in the ensuing reign. Charles the martyr, poor king! had not always gold; so the discovery to him was of great practical importance: greater, however, the discovery already noted of this monarch's ability to cure by simple benediction. Charles II. reverted to the gold; but when Doctor Johnson presented himself to be operated upon by Queen Anne, he only received a shabby bit of silver.†

In pursuing our sketch, we now come to the troubled reign of Charles I., when all that had hitherto been seen in the cure of diseases by royal influence was fairly eclipsed. The very successes of the royal martyr are, however, by some adverse critics deemed unfavourable to the general pretensions of royal cure by manipulation. It is advanced that the evidence proves too much; that the cases belong to the general category of saintly miracles. In the beginning of this narrative I had occasion to quote the particulars of a cure, effected by the martyred king, that can only be called miraculous. Others, by the hundred, if not by the thousand,

* Homœopathic practitioners frequently promote the action of a ten-billionth part of a grain of powdered flint by half an ounce of castor-oil, administered as an adjuvant.

† Now held as a relic by the Duke of Devonshire.

could easily be cited, did space, need, and occasion offer. They will be found recorded in several good books, published mostly during the succeeding reign.

The divine gift attained, if not its highest excellence, its broadest expansion, in the reign of Charles II. True, this king could not cure by mere prayer and benediction, as his royal parent was wont to do; true, the smoothing manipulation was needed in his case; yet, when we remember that the king stroked for the evil no fewer than ninety-two thousand one hundred and seven in twenty years, being on the average twelve per diem, all of whom, according to my authorities, he cured, we must admit the virtue of cure by stroking, as distinguished from cure by mere benediction, to have attained its highest development.

The history of cure by touch, in the middle and latter part of the seventeenth century, would not be complete without reference to cures performed, or said to have been performed, by private individuals. In preceding reigns, the impression had been very general that, in such cases as demonstrated the power of cure by manipulation, the result was attributable in some measure to witchcraft. Thus the preamble of a statute of Henry VIII., in 1511, sets forth, 'that smiths, weavers, and women boldly and unaccustomally take upon them great cures, in which they partly use sorcery and witchcraft.' In the next century, however, and mostly in the reign of Charles II., several private individuals, against whose character no evil could be justly alleged, became conspicuous under the name of 'strokers.'

Of these the most renowned were Valentine Greatrakes an Irish gentleman, Dr. Streper, and a gardener called Leverett. Of Greatrakes the lord bishop of Derry declared that he had seen dimness cleared and deafness cured, pain drawn out at some extreme part, grievous sores in a few days healed, obstructions and stoppages removed, and cancerous knots in breasts dissolved. It is easy to gather from perusal of contemporary records, that these private manipulators were considered by some to trench upon the kingly prerogative. Thus Dr. Thomas Allen* dissuades persons from applying themselves to seventh sons of those strokers; but these seem to have found much favour nevertheless. Some quality in their times seemed to favour the transmission of influence through manipulation. Nor was this manipulation peculiar to the Old World, according to Dr. Cotton Mather, who, in his *Magnalia Christi Americana*, states it was no rare thing for the old set of Quakers to proselyte people merely by 'stroking them, or breathing upon them.'

Properly investigated, a complete distinction is established between these cures by private individuals and the cures effected by sovereigns. In the former case the cure was exhausting—always needing effort, expenditure of vital force; in the latter case otherwise. On this point accept the testimony of Leverett the gardener: 'I am more exhausted by stroking thirty or forty people, than by digging eight roods of ground,' said he; whereas the circumstance has already been noted, that Charles II. stroked, on an average, twelve per diem for twenty years, thus making up a sum-total of ninety-two thousand one hundred and seven—a sufficient proof that the kingly operation of stroking could not have been exhausting.

As lamps burn brightest just before their lights expire, so was it thought by divers learned men, witnesses of the exceeding power of the divine gift as manifested by Charles II., that with him that power would end. Guided by the doctrine of type and antitype, Dr. John Bird† was led to this conclusion through Scripture analogy. 'Now, according to Scripture and reason,' writes he, 'as the precious oil ceased

* 'The Excellency; or, the Handywork of the Royal Hand: dedicated to the Duke of York.' By Dr. Thomas Allen, sometime of Caius College, Camb., afterwards physician to Charles II.

† *Ostenta Carolina.*

to be when Christ had suffered, and as the substance being come so the shadow goes away, and there is no reason to expect a sign when y^e thing signified thereby is now come; I conclude that our royal sovereign will be the last of the kings of this nation to whom God will give the gift of healing the king's evil.' I need not point out the fallacy of this surmise; cure by royal touch having been publicly used down to the reign of George III.

Having now treated as fully as space permits this blessed gift, 'vouchsafed solely to the kings, by grace of God, of Great Britain and France, and denied to other Christian kings,'* it may not be amiss to reproduce a few of the disparaging and venomous cavillings that certain evil-disposed persons have used, to cast doubt and ridicule on the royal gift.

The circumstance cannot fail to be noticed, they argue, that just in proportion as the title to the crown was weak or uncertain, or that a belief in the divinity of kingcraft had need of extraneous support; then, ostentatiously, and, as it might seem, perversely, the sovereign power to cure by touch and stroking was vaunted to the highest. Then, they say, the legitimacy of Henry VII. was none of the best, yet he dispensed the healing aura from his fingers' ends with the freedom of a spendthrift and the efficacy of a saint. Then consider the reign of Henry VIII., they say. In his time, doubts having arisen as to the power of that monarch to cure after the fashion of his predecessors, because of the Pope's anathema; the doubt was set at rest by the monarch's not only stroking for the evil with effect, but curing cramp as well. Then these evil-disposed critics urge, that so long as British kings and queens remained on good terms with Rome, the pretence or reality of curing by manipulation met with no sort of opposition by the clergy, nor were the grounds upon which the claim was based scrutinised over-rigidly.

* Clowes.—N.B. Our author means kings and queens. He was Elizabeth's own surgeon, and frequently testifies to her Majesty's healing virtues.

After the schism between church and state, however (so they say), it would be a tendency of the ancient church to prove that the royal gift of cure by stroking was imparted through priestly benediction, not inherited; that, moreover, it was not imparted in perpetuity to a sovereign, but *quamdiu se bene gesserit.* The case does not admit of doubt (so they allege), that so long as it was convenient for church and king to remain in good accord, the spiritual theory of imparted virtue would be adopted as most consistent. All other theories are so manifestly inconsistent, they say, that, being adopted, the fallacy must at once be detected.

To have admitted the healing faculty of kings and queens as being of the same sort with the healing faculty of seventh sons and other common strokers, would be, say they, an obvious abrogation of regal prerogative. To have attributed a cure wrought to the power of a medal given, would, again, not have been politic. In the interests of kingcraft, it was always necessary to show that the virtue was neither personal nor symbolical; neither the result of ordinary stroking nor of influence conveyed through a mere piece of metal: wherefore (they go on to say) when ties between Rome and the British throne were severed, the pretence of cure by stroking began to sit uneasily on British kings. It is easy to perceive (so allege the scoffers) that the pretension of this virtue was made a ground of violent religious contest even so early as the reigns of Henry VIII. and Elizabeth,* and only restrained within bounds by the fear of indictment for high treason.†

* And yet, if we are to believe Clowes, instances occurred of cures wrought by the virgin Queen upon Catholics—said Catholics being driven to afford testimony thereto. A letter from a gentleman at Rome, published in London anno 1721, confirms the above. 'A Roman Catholic in Elizabeth's reign,' writes he, 'grew terribly afflicted with the king's evil. Having applied to doctors without success, he was at last touched by the Queen, and perfectly cured. Being asked how the matter stood with him, his answer was, "He was now satisfied, by experimental proof, that the Pope's excommunication of her Majesty signified nothing."'

† Much later, *i.e.* in 1684, Thomas Russell was tried for high treason,

We pass on now to the Restoration; accepting for our guidance in the matter of cure by the royal touch contemporary records—especially the *Ostenta Carolina* of John Bird, already adverted to. Some scoffing traducer of the divinity of kings has committed himself, I observe, in writing thus:

'Let us take a glance at the political relations of this epoch, inasmuch as the contemplation will help us to a fair understanding of the position and prospects of cure by the touch and stroking of kingly hands at the time. The church-and-state party having caught their king, it was an object of first importance with them to set him off to the best advantage. The erroneous and strange doctrine that kings were even as common men—not heaven-appointed and heaven-inspired—had to be opposed. The public had to be brought to a due state of reverence for sovereignty restored; and, inasmuch as the memory of Cromwell could not be swept away, policy of church and state dictated that it should be made to seem hateful if not contemptible. To this end superstition was invoked; and divers were the manifestations of it. High church-and-state pamphleteers testified to the appearance of supernatural beings coming before mortals with political intent. These supernatural visitors, though diverse in their aspects, were referable to one of two categories: bad spirits, coming in grotesque shapes, such as of black dogs, bears, hyenas, &c., all smelling abominably of brimstone; and good spirits, decently robed in white garments, George Cruikshank notwithstanding.* As for the bad lot, they—according to pamphleteers of the time—so soon as conjured, were wont to change into their proper shapes, *videlicet*, Cromwell, Ireton, Bradshaw, *id genus omne*—then disappear howling.

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for having spoken contemptuously of the king's touch (Wadd's *Maxims and Memoirs*).

* George Cruikshank's argument against ghosts is, that they always appear decently clad: can there be ghosts of coats, cloaks, petticoats, and breeches, he would like to know? He has evidently neither read Lucretius nor studied palingenesy.

'In short, the revelations of spirit-land proved that king-killing was looked upon as no small matter up yonder. On one point of testimony black spirits and white were unanimous, and it was this: Britons would never prosper again until they had atoned for beheading the father by long years of worship to the son. The tendency of the age was to establish the restored king as demigod. If Charles II. had happened to be cast in a religious mould, whereby the pretensions of his adulators could have been seconded, then, like to Japan, we might have had a Mikado. The spirit moved our restored sovereign otherwise: he worshipped fervently indeed, but at another shrine.'

In this strain does an evil-disposed writer proceed to lengths whither I scorn to follow him. The tendency of his reasonings is only too plain: let every good subject beware!

With Charles II. the majestic days of regal cure by stroking of hands departed; not that any abatement of the divine gift had followed, so far as I can learn, but for the reason that a certain perverse hardness of heart had afflicted the multitude. The good gifts of Heaven cannot with impunity be spurned. That his gracious Majesty George III. abandoned the practice of stroking for the evil, is already recorded. Had he wisely kept to the ways of his forefathers, need for tall neckcloths in the succeeding reign there perhaps might not have been; George IV. might then perhaps have inaugurated the epoch of neck-ribbons and paper turn-downs; Beau Brummel might have left the study of starch to washerwomen, devoting himself to higher aims and nobler occupations.

VIVISECTION.

FROM time to time the necessity or non-necessity for vivisection is a question that comes up to harrow the public mind. It has so come up of late, the presumed cruelties of French veterinary practitioners having been the starting-point. I say presumed, knowing nothing personally for or against. The question, moreover, can be discussed impersonally, without vilifying the French.

There are some things in respect of which ideas intuitively arise so strongly tinctured with preconceptions that an investigator's first care should be to admonish his own judgment to be guided by evidence *only;* as juries are admonished by the presiding judge.

Of such things assuredly vivisection is one. The all-wise decree of God, whereby death is made a mystery, implies a corresponding reverence for animal life; reverence for all the elaborate machinery with which life is associated, with which animal vitality is alone compatible. The well-ordered mind naturally shrinks from inflicting unnecessary pain; it recoils with shuddering and abhorrence from the idea of dissecting a live animal.

To bring laboured proofs in support of the proposition, that the sentiment of repugnance to pain-infliction is natural to every well-ordered human mind, is hardly needful. The universality of that sentiment must be conceded; concurrently with maintenance of the proposition, that no mere repugnance of a mind to the idea of vivisection would furnish rational and valid ground for barring its practice, if testimony should prove vivisection needful, the interests of humanity regarded.

Let us accept the postulate, that, however repugnant the idea of vivisection, however repulsive, still no argument founded upon that sentiment *wholly* can be admitted to have reference to the case. Let us eliminate, therefore, all inbred prejudices against vivisection, discussing the matter on the strength of intrinsic evidence.

First, proposing the question whether vivisection be necessary or justifiable, whether needful to impart dexterity to the operator, I say emphatically, *No!* coupling that denial with expression of surprise that the affirmative should ever have gained credence.

Needful to give dexterity of hand in operating! Operating upon *whom* or *what?* Is it operations upon the human subject that are contemplated, or operations upon brutes? If human surgeons never avail themselves of this means of acquiring dexterity, then assuredly no sufficient plea can be urged for veterinary surgeons.

Here it is proper that a certain condition limitary to the performance of vivisection in aid of operative dexterity should be apprehended. In such a case the operation, if performed at all, must be *identical*, not *analogical*.

The cutting-open *one* animal of *one* species could afford, as will soon be proved, no guidance to a surgeon designing to operate upon *another* animal of *another* species; whereas if furtherance of science be the plea for vivisection, then investigations conducted on a lower animal may lead to deductions applicable to the case of a higher animal. Whether the conception be rational or irrational, well or ill-grounded, I shall endeavour to determine farther on.

The incompetence of analogical vivisection to give dexterity of hand in operating is self-evident to every anatomist. Inasmuch, however, as this is written for those who are mostly *not* anatomists, I will endeavour to demonstrate the proposition by some easily comprehensible evidence.

Success in the performance of a surgical operation, other things being equal, will depend on the practical conversance the operator has acquired with the arrangement of parts, and the distribution of organs he has to operate upon. Just as rationally might an engineer seek to make himself acquainted with the scheme of ramification of the gas- and water-pipes of London by studying the gas- and water-pipes of Manchester, as an operator to acquire dexterity of hand upon *one* animal through experience gained by operations conducted upon *another*.

Even if it so had happened that animals were devoid of pain—an hypothesis under which all objections to vivisection on the score of cruelty would be disposed of—still, analogical vivisection would never be performed by any intelligent surgeon to impart dexterity of surgical manipulation.

I am under no concern that this denial of the need of vivisection as an aid to surgical dexterity should seem to be laboured. Better supererogation than that there should remain on the mind of any one the smallest trace of a lingering belief in the advantages of analogical vivisection—none else is possible—to the end and with the object here contemplated.

The reason for emphasising the words *analogical vivisection* will be presently apparent. It will soon be demonstrated by a process of exclusion that vivisection is unnecessary to veterinary operators; arguing that, inasmuch as it is never had recourse to by operators on human beings (the major case), hence there can arise no good plea for adopting it as an aid to dexterity in operations performed upon brutes (the minor). In what, let me now ask, consists the knowledge requisite for the performance of surgical operations?—whence comes the power of operating? It comes from the conviction, the *self-assurance* in the mind of an operator, that he has mastered the topography, the relation of parts, the arrangement of nerves, veins, arteries, and muscles of the organism he operates upon.

The acquaintance he needs is a mechanical, *not* a functional acquaintance; and being this, he requires to pursue his investigations on an animal mechanism of exactly similar pattern to the one to be operated upon hereafter. The knowledge he seeks is topographical. The topography is not to say amply revealed by mortuary dissection, but revealed with a completeness, a clearness, that never could result from vivisection, however remorselessly conducted.

The chief difficulties attendant upon surgical operations have reference to arteries and nerves in their relation to adjacent organisms. In respect to nerves, death effects no visual change upon them; in respect to arteries, a dead body offers manifest advantages of demonstration over a living body, inasmuch as arteries *may* be—and for purposes of mortuary dissection commonly *are*—injected with some liquid composition which, ultimately setting hard, brings out into full relief before the anatomical student each arterial branch and ramification far more completely than the organism of any living body could be made to reveal; and lest the very completeness of topographical illustration thus demonstrated should seem to prove too much—should seem to imply the need of vivisection, to furnish difficulties that are removed by the condition of arterial plethora resulting from injection—then the obvious rejoinder is, 'the anatomist, if so minded, need not inject his subject at all.' In this matter he has his choice. He may vary his conditions. Having begun with applying himself to the easiest conditions within the scope of the problem, he may end by encountering the most difficult.

Another obvious advantage of mortuary dissection over vivisection is the following, namely, the superior facility it gives of coming to just conclusions relative to variations of normal standards in animal organisms, relative to peculiarities of distribution and arrangement.

Here, before discussing the proposition, it will be needful to beg a postulate; one that will be readily granted even by the most strenuous advocates of the necessity of vivisection in aid of operative dexterity. Whereas no sentiment is opposed to mortuary dissection being practical, up to the extreme limit determined by facility of supply, yet nobody, not even the most strenuous vivisectional advocate, would claim a field of operation so wide for the practice of vivisection.

Neither would the vivisector be able to acquire a field of action comparable for extent with the one occupied by the mortuary dissector, even were he to press the claim. Even though it were possible to make out a case distinctly favourable to the practice of vivisection in aid of surgical dexterity —ay, of vivisection on *whatever* behalf followed—still, the natural repugnance to this practice is so strong, the balance of human sentiment is so much against it, that the sentiment, through the operation and effects of which mankind are influenced and their actions determined, would limit the practice to a comparatively narrow field.

If we calmly and thoughtfully reflect on the spring and causation of human impulses; if we seriously propose, each individual to himself, the cause and reason of our likes and dislikes, the result of that inquiry may astonish some who may not have yet entered upon it. Though human beings, having regard to the glorious attributes of thought, investigation, reflection, and judgment, which appertain to human nature, should be able ultimately, and after the exercise of sufficient thought, with the concomitants of thought, to adduce a reason for individual likings and antipathies, yet this process of ratiocination is slow. It is so slow, that God has seemingly impressed us with instincts to stand in aid before judgment, founded on ratiocination, can take effect. In this way we tend to like or dislike persons or things, acts or policies, on the instant. Did space permit entering upon a theme only collateral here, I believe the proposition could be borne out, that in by far the majority of instances the unreasoned intuitive likings and dislikings, which impress us whether we will or no, are in the end confirmed by reasoning.

Assuming as granted that vivisection could never be prosecuted over so large a field as mortuary dissection, then one great disadvantage of it by comparison with mortuary dissecton, regarded as a means of giving operative facility, will now be made apparent. It fails, and must fail, in evolving the law of averages as affecting abnormal conditions of organism. An anatomist will at once perceive the scope and purport of the last objection; but to aid the general comprehension of it, I will give an illustrative example with strictly practical bearing.

One of the surgeon's greatest solicitudes, if not the very greatest, in the conducting of operations, is that of heeding the arteries. It happens that Nature is somewhat irregular in her scheme of arterial distribution. Looking at the general aspect of arterial supply, the impression likely to be created is, that Nature has considered it a matter of secondary moment how any part or parts of any organism or organisms be supplied with blood, so that supply there be. Nevertheless there exists in all animals provided with a blood-circulation such a preponderance towards one general arrangement, that the anatomist is under no difficulty to establish a type; speaking of all deviations from that type as irregularities.

In respect to arterial irregularities, it is a matter of the highest as well as most commonly recognised value amongst surgical operators, that the comparative importance of each leading deviation from the normal type of distribution should be appreciated, and impressed upon the mind statistically; in other words, from the consideration of average probabilities. Assuredly no argument is needed to make good the proposition, that directly proportionate to the field upon which the observations are conducted, so will be the approximation to truth conveyed by the resulting average. Of course it hardly need be observed, that the illustrations here cited, and the arguments founded upon them, are restricted, by the very nature of the case, to the limits of veterinary practice; inasmuch as *identical*, not *analogical*, vivisection is that alone contemplated for the present. Nobody, at this time, need be at the trouble of controverting the proposition, that it is needful and desirable to vivisect one living *human* being in order to acquire facility of operating upon another.

It being now shown that vivisection in aid of securing dexterity is *not* used, that it *cannot* be used, and, I may add, *is not desired to be used*, by surgeons operating upon human individuals, it may seem conclusive to the minds of most, as it does to me, reasoning analogically and *à fortiori*, that the necessity of such aid to operation upon brutes is barred by exclusion. If vivisection be *not* adopted in the case of major importance, then what plea for its adoption in the minor?

The question—Whether it be necessary or desirable, for the purpose of giving dexterity to the operator, that vivisection should be practised?—has hitherto been discussed on terms of manifest advantage to those who maintain the affirmative. Premising, though the premiss may be hardly necessary, that the discussion is limited to brute vivisection and veterinary operations, an important concession hitherto made must be noted, hypothetically merely, and for argument-sake. It has been hitherto assumed, tacitly and inferentially, that human surgical operations and veterinary surgical operations stand on an equality, whether the gravity of them be regarded or the interests involved.

As to the interests involved, no argument is needed; seeing that between the value and destinies of human life on the one hand, and of brute life on the other, the difference is infinite. Wherefore it only remains that we apply ourselves to the question—Whether the number and the gravity of veterinary surgical operations are equal to the number and gravity of operations performed, or liable to be performed, upon the human subject?

Concerning the answer there can be no doubt. The reply will be emphatic and negative; this too for obvious reasons, founded upon a consideration of the difference between brute and human life. Under no circumstance or possible contingency is the surgeon permitted to take the life of his patient, whatever the gravity of an accident; whereas the contrary rule legitimately applies to veterinary surgeons. Consideration of this fundamental difference reduces the veterinary surgeon's responsibilities to very small dimensions. Regarding him only as a mechanician—one whose duty may call upon him to move amidst and to handle parts of machinery more or less delicate belonging to the mechanism he has to deal with; measuring his duties and responsibilities as an engineer with those of the surgeon—then will the call for dexterity on the veterinary surgeon's part fall to a low comparative standard. When one of the animated machines which claims his solicitude gets disordered beyond a certain mark, then he without compunction, and in the interests of his patient, destroys the machine by taking away the force—*the life*—that alone can actuate it.

Contemplated under the light thus disclosed, the veterinary surgeon's operative responsibilities will be seen to be small as to extent and insignificant as to gravity, when placed in comparison side by side with the ever-varying, often tremendous operations it may be the surgeon's duty to perform.

Perhaps when the whole field over which veterinary operations are possible is examined, it will appear that the removal of tumours represents the veterinary surgeon's art in its highest advancement and greatest delicacy. And assuredly of tumours it may be averred, that if the plea of vivisection, considered as a means of giving facility of hand, be weaker in any one case than another, the very limit of weakness is here reached. No two tumours are ever alike, whether as to exact size, or as to exact relationship with other parts: furthermore, a tumour does not admit of being made to order in aid of vivisection.

The conclusion to which we arrive is, *the utter needlessness of vivisection, considered as an aid to promote dexterity of hand in operating.*

I have endeavoured to show, that conclusive evidence against the practice of vivisection for operative purposes can be adduced without invoking the aid of human sentiment, of pity and compassion. I not only deny the need of vivisection for operative purposes, but I deny the existence of conditions under which that need could possibly arise. I support the denial by reference to the opinions and practice of every surgeon of high position and repute that it has ever been my lot to meet with; I might even aver, by the opinions and practice of surgeons of all grades.

At this point the argument might be considered exhausted, so far as any plausible reasoning to the contrary has been adduced. Inasmuch, however, as what may seem puerile to one mind may seem plausible to another, let me not conclude without adverting to a plea sometimes urged in defence of vivisection for operative purposes—urged, however, by persons who demonstrate, by the very reasoning on which their arguments are based, the worthlessness of any opinions they might advance on this matter. It is urged by them, that vivisection is desirable as a means of deadening sentiment, accustoming the operator to look unmoved upon the shedding of blood and animal suffering; whereby (as they submit) he may the better prosecute a surgical operation without the trembling of hand or disturbance of mind that might wait on inexperience.

So low a ground of advocacy never *has* been taken, and never *will* be taken, by any disputant whose knowledge of the springs of human impulse is deep enough and refined enough to warrant him in forming an estimate of the qualities which go to constitute a successful operator. Any amount of confidence in operating that might accrue from aught save knowledge would be no other than recklessness at the best—a quality obviously undesirable. Assume a surgeon to be well versed in anatomy—to be moved to the performance of some operation by the sense of duty, yet to fail in the particular sort of courage (as we will designate it) that, according to the assumption, can only be imparted by the sight of blood and suffering,—assume this, and a case is made out, *not* for vivisection indeed, but for the abandonment of a profession by one whose temperament is so peculiar.

Were it possible to grant the case of only one surgeon ready and willing to operate, accessible; him to possess the requisite knowledge, him to favour the operation, but refusing to operate save under the proviso that he might be allowed to fortify his courage by a preliminary course of vivisectional torture—*then* there might be grounds for taking into consideration the following question—Whether the bad confidence of recklessness would not be better than the absence of *all* confidence? This is a mere hypothesis obviously; it is one beyond all probable, even all *possible*, limits.

No greater fallacy exists than the one that assumes a connection between cruelty of disposition (whether natural or acquired) and the ability to conduct with dexterity and success a surgical operation. According to my experience—and it is not small—the best, the most philosophic, the most resolute surgeons have each possessed a nervous system delicately attuned to all impressions; and in respect to this I would here parenthetically remark, that I never yet *did* see, and I never *expect* to see, the delicacy of touch so indispensable to a good operator associated with a hard, stolid, unimpressionable nervous organisation.

Those who would strive to make us believe that a cold and stolid, if not an absolutely cruel disposition of mind and temperament is a quality to be aimed at by operative surgeons, found their postulate on an assumption wholly untenable:

the assumption, namely, that the performance of operations is and should be regarded as constituting the highest aim of surgery, the ideal perfective goal to which surgical education should tend. The legitimate aims of surgery are not in this direction, but in one diametrically opposed. Looking back on a somewhat long experience with surgeons of many grades and social ranks—on surgeons of many nationalities—I cannot call to mind a single one of mark or position who failed to own that a surgical operation, so far from being a triumph of surgical skill, implied a defect; in the sense of being a tacit acknowledgment of the mastery of disease or accident over the surgeon's curative power. This reasoning is in the highest degree applicable to amputations and excisions; but there are few, if any, surgical operations to which the remark is not applicable in some measure.

So far as my experience enables me to judge, surgeons high and eminent in their calling look upon all the class of excisions and amputations very much as philanthropists and statesmen look upon war—as a necessary evil, that is to say inseparable from the conditions of humanity indeed, but still an evil, and hence, when possible, to be avoided. Not only, so far as my experience extends, have surgeons of highest mark and fame been men of tender mental organisation, but, what is more, the most highly endowed in this respect have proved themselves the best operators.

As affording a pertinent illustration, an incident comes to mind that may here with propriety be stated. It was a question of removing the scapula or bladebone of a man, together with the corresponding arm, on account of disease underneath, which had extended some way amongst the important vessels of the armpit, or axilla. Operation was finally decreed, the intending operator being one who then was, as he still is, a surgeon attached to one of the largest metropolitan hospitals. This being an unusual as well as a terrible operation, the prospective operator set about qualifying himself for the task. By what means—what training? That of vivisection? Assuredly not; though, if the practice of vivisection in aid of surgical dexterity could admit of palliation in *any* case, this might have been the one, inasmuch as between the bladebone and accessories of a dog and the bladebone and accessories of a man there is a very close structural analogy. Yet no sense of duty, no consciousness of what would be a fitting exercise, prompted the surgeon whom I have now in my mind to operate upon the bladebone of a living animal. He repaired to the dissecting-room, where upon the tranquil and unconscious dead he operated again and again. It might have done good to certain men, who profess the belief that cruelty, either natural or acquired, is a profitable quality in operative surgeons, to have visited the dissecting-room that day, and studied the operator. It was but a corpse his bright scalpel lacerated—the unconscious, painless dead. Yet to see the pale look of resolute anguish the operator's countenance wore—to note the large sweat-drops falling from his brow, as, glancing alternately from the stop-watch beside the corpse to some new revelation of artery, nerve, or vein each movement of his delicate hand calmly yet rapidly and resolutely laid bare, he still worked on; to have seen all this as I saw it, would have left an impression never to have been eradicated. On the hypothesis of cruelty being needful to the operator, the surgeon whom I have so vaguely sketched would have given small promise of acquitting himself well. He was then, as now, recognised as one of our chief operative surgeons. When the excision had to be done, it was well done; rapidly, as behoves an operator, who shrinks from needless prolongation of suffering, but not recklessly.

We come now to the second point of discussion—Whether vivisection is necessary or justifiable for the general purposes of science?

Irrefragable as is the chain of reasoning to my mind, whereby I am led to the conclusion, that the practice of vivisection, considered as a means of imparting surgical dexterity, is wholly unnecessary, hence unjustifiable; I am not less firmly convinced that the interests of science justify vivisections in certain cases and under certain limitations. I have no difficulty in coming to *that* conclusion: whatever difficulty I feel has reference to the defining of cases and the imposing limitations.

Lest the general admission here made to the justifiableness of vivisection in aid of science should beget a repugnance in certain minds, unfavourable to tranquil investigation of the proposition on its merits alone,—I will cite an illustrative example, concerning which it will surprise me much if the very strongest dissentients to the practice of vivisection do not accede to the justifiableness—even the *duty*—of performing it.

Here, perhaps, it may be desirable to enlarge the field of debate, so as to take in certain cases of pain-infliction; not vivisectional truly, but so far appertaining to a kindred category, that they concern the revelation of vital action through the pain-inflicting scrutiny of living animal organism. The cases here referred to belong to the toxic or poison-scrutinising department of physiology; they involve the administration of poisons with a view of noticing their effects. It may be that the administration of certain poisons is attended with a degree of pain more excruciating than has ever resulted from vivisection.

The field of debate being thus enlarged, two questions present themselves. The first is an abstract, the second a practical question. Is it justifiable, on moral grounds, to inflict pain in order that science may be advanced? or, what comes to the same thing, that truth may be revealed? Then, if justifiable, what are the justifying limits?

In regard to the first or abstract question, I must hold it to be universally conceded; wherefore the second question, involving the idea of pain-infliction, only remains to be debated.

The first limit is one imposed by an obvious and ever-present moral conviction. I assume the tacit acquiescence of every rational and sane human being to the general proposition, that pain should not be inflicted—not to say gratuitously, but not without presumptive need. Animal life is very precious; pain is hateful. Vivisection should obviously be restricted to occasions when there seem no possible means of revealing the truth sought by any other class of experiment. He who recklessly and cruelly adopts so terrible a means of truth-revelation as vivisection, unmoved by pity for the creature under the torture of his hands, thereby proclaims himself unfitted for the task he has undertaken. Philosophy has nothing to expect from the labours of such a man; let him, then, abandon her shrine, ceasing to desecrate her temple.

Instances there have been of foreign physiologists violating the conditions of restraint here laid down; cutting live animals to pieces recklessly and remorselessly; operating as a sculptor might operate upon a block of marble, or a carpenter on a log of wood. Has science been advanced by these men? have the fields of science been enlarged through their cruelties? Scarcely. I am disposed to think, in *no* degree; but assuredly the physiological truths revealed by these men are no way comparable for extent or importance with others that owe their origin to men who shrank from the infliction of pain, even when they deemed such infliction needful.

Perhaps the whole range of physiological inquiry does not present an example of a truth appertaining to the mystery of life so clearly revealed, so fully placed beyond the limits of doubt or cavil, as that of the dual construction and dual function of the spinal nerves.

To apprehend the scope and purport of this subject, let it be understood that the spinal nerves of a vertebrate animal present to the eye a certain regularity of form and arrangement strongly prompting to the belief that they are typical; and that observations conducted in regard to them might be reasonably expected to make known, not the functions of spinal nerves merely, but, through analogy, the functions of cerebral nerves also. Each spinal nerve of a vertebrate animal joins the spinal marrow by two roots. Each of these is made up of nervous filaments, which, after travelling a short distance, unite together, pass into one envelope, and henceforward are regarded—anatomically, though not physiologically—as one nerve.

It remained for Sir Charles Bell to discover the reason of this double origin; and, starting from this discovery, to impart the elements of order, method, and regularity, to a branch of physiological inquiry that had up to his time been marked by disorder and lack of method in the highest degree—namely, to the study of the nervous system, 'neurology' as it is called. Inasmuch as I regard (with what amount of truth or justice others must determine) the investigations of Sir Charles Bell on the nervous system to have ended in bringing about the grandest revelation to man of coördination between structural form and vital function ever vouchsafed, I may, it is assumed, be pardoned for dwelling upon this case somewhat at length; and in order that my observations may be fully intelligible to all, whether conversant with anatomy or otherwise, some preliminary statements must be made. Referring to the double origin of each spinal nerve, attention is now directed to the anatomical circumstance, that whereas the anterior nervous root has the appearance of a simple plain nervous chord, the posterior root has more the appearance of a chord that has had a knot tied in it. The posterior root is furnished with what, in anatomical language, is called a 'ganglion.' Out of the knowledge of this come important deductions.

Physiologists had speculated upon the use of nervous ganglions prior to Sir Charles Bell; had even attributed a specific use to them. When he began his neurine inquiries, the prevalent belief in the use of ganglions was, that they were endowed with the function of cutting off the power or faculty of sensation from any nerve upon which they might exist, leaving such nerve endowed with the faculty of motion only.

Slightly to anticipate the development to which a systematic inquiry into the experiments and conclusions of Sir Charles Bell on the nervous system would lead, it will be convenient to announce, in this place, that the great British physiologist's experiments led him to a deduction the very converse of that assigned by prevalent belief concerning the use and endowment of nervous ganglions. He proved the posterior or ganglionated root of a spinal nerve to be made up of sensitive fibres exclusively; whereas the anterior or non-ganglionated root he proved to be made up of motor fibres exclusively. Next, having extended his inquiries to the cerebral nerves, he eventually came to the conclusion that, functionally regarded, they were symmetrical with the spinal nerves; differing from the latter in mechanical arrangement of parts truly, but conforming to the typical ordinance that sensitive nervous fibre should ever be associated with ganglionic nervous matter.

Here, then, was effected not only a very grand but a very clear physiological discovery. It has nothing veiled, misty, or indeterminate about it. The truth stands revealed in sharp-cut prominent outlines. It is comparable, in this respect, to any geometrical truth, such as the equality between the three angles of a triangle and a pair of right angles, or the equality between a large square on the hypothenuse and the sum of the two small squares on the two sides of a right-angled triangle. The demonstration accomplished by Sir Charles Bell, moreover, so far from having been prompted or led up to by discoveries that had preceded him, and opinions founded thereon, was diametrically opposed to the latter, and assuredly not prompted by the former. All who have had at any time to concern themselves with the unravelling of truth by experiment leading to evidence, will be at no loss to appreciate at its full worth a demonstration arrived at under such a combination of circumstances.

It may be reasonably apprehended, that a full and just appreciation of the value of the knowledge conveyed by the discovery that the anterior root-filaments of a spinal nerve are wholly motor, whereas the posterior root-filaments are wholly sensitive, will be impossible to one except he has undergone medical training. I must therefore beg, by postulate, the concession of that value.

The concession made, then will the conclusion be obvious, that the discovery effected by Sir Charles Bell could only have been arrived at by vivisection. No apparatus, save that of living animal organism, *could* have been made to reveal a function appertaining to animal life. No experiment, short of operating upon a living spinal chord, *could* have made known the separate and respective functions of the anterior and posterior spinal roots.

So soon as the idea of duality of function corresponding with duality of form, in the origin of these spinal nerves, had suggested itself to Bell, the promptings of curiosity, the love of truth—all the complexity of impulses and motives, by which an experimentalist is urged along in his experimental course, he hardly knows how or wherefore—must have tempted him to solve by vivisection the suggested mystery. The temptation must have been one of a force and energy and wildness beyond general ability to conceive. *Did* Sir Charles Bell readily yield to the temptation—legitimate although I submit it to have been? *Did* he lay hold of the first brute creature that fell in his way, and vivisect that creature? By no means. He distinctly gives his readers to understand that he long deferred the performance of an experiment which would have solved the question that had presented itself to his mind, in consideration of the disagreeable nature of the experiment, *because of the cruelty of it.* When at length the physiologist's mind had adopted the resolve to operate, a vertebrate animal was chosen—a rabbit—an animal with a nervous system less delicately amenable to pain than is that of many vertebrate animals which have sometimes been made the subject of vivisectional experiments—dogs, cats, horses, and asses, for example. Then, whilst farther prosecuting his investigations, Sir Charles Bell found that it was quite possible to make the organism of a rabbit reveal the crucial truths he needed, under circumstances of vivisection which reduced suffering to a minimum. The amount of suffering was below that commonly experienced, indeed, by animals whilst being slaughtered by man for the purposes of food. He soon came to operate upon rabbits made insensible —or rather stunned—by a blow delivered on the back of the head. Subsequently Bell, as well as the majority of other experimenters upon the nervous system by vivisection, used frogs for subjects. Rabbits being vertebrate animals, having vertebral nerves of the ordinary bifid type, present the needful conditions of research; whilst frogs, being endowed with a low nervous organisation, their susceptibility to pain is low in a corresponding degree.

Is it incumbent in this place and on this occasion to disclaim the tenet of belief, or rather of poetic expression, whereby it is affirmed that all animated beings are susceptible to pain in an equal degree? 'The poor beetle that we tread upon' does *not* feel 'in corporal sufferance a pang as great as when a giant dies.' No unbiassed person, coming to the present inquiry with an amount of anatomical and physiological knowledge competent to the occasion, can entertain a doubt as to *that* point. Speaking approximately, and for general purposes, it may be affirmed that the capacity of an animal for physical pain is in a direct ratio to the intellectual intelligence of such animal. A leech may have its tail cut off when sucking, and not desist from sucking. A spider may have a leg amputated without seemingly interfering with its immediate appetite for a fly; and, to take a rather extreme case, a bull-dog (which is assuredly not the most intelligent among the race of dogs) may be beaten and kicked, without seemingly heeding that usage, if at the time his fangs be closed upon an antagonist or a victim.

At this point the investigator does not fail to apprehend that what I have called 'analogical vivisection' can, in the examples at least of physiological inquiry already contemplated, be used with effect. In proof of this, accept the illustration of a frog being made to reveal the conditions of nervous arrangement and nervous energy in a human being. Various palliative and suggestive thoughts, moreover, arise, predisposing the human mind to tolerate vivisection for scientific uses. In the first place, palliative thoughts based on the obvious infrequency of the need for having recourse to these physiological vivisections. If it could have been shown that vivisection is needed to give aid in operating, then a case would have been made out for the frequent performance of vivisection. Every successive student would be called upon to acquire the faculty of dextrously operating, by performing the necessary vivisectional tortures each one on his own behalf. There is clearly no parallel need to this in the acquisition of physiological knowledge.

A fundamental truth once proved, remains proved for ever. What chemist now ever thinks it needful to burn diamonds in oxygen gas to satisfy himself that the result of such combustion is carbonic acid? What physiological student need give himself the trouble (to take no other ground) of operating upon a living animal in order to prove (what no one doubts, or for a long time past *has* doubted) that the anterior root of a spinal nerve is a motor root, whereas the posterior one is made up of sensitive filaments? This observation, however, must not be construed as signifying that an experimenter may not, if there be reasonable cause of doubt in his mind, repeat any experiment by the teaching of which other people had come to their conclusions. There must be no dogmas of infallibility in the teaching of experimental science; no affectation of high-priesthood. Testimony based on experiment is all in all in such a case. This I fully admit, whilst affirming (what must be obvious) that so soon as testimony is held to be conclusive to the mind of any philosopher, he will not desire to re-perform an experiment. This is a deduction almost self-evident. It is one that teachers of physiology should impress upon the minds and understandings of all physiological students.

The pride of knowledge is sometimes represented as being very strong. I do not concede the truth of that doctrine, though fully acquiescing, if for the expression 'knowledge,' 'assumption of knowledge' be substituted. It is often a tendency of young men to think themselves competent to the investigation of recondite problems in science before they have mastered preliminaries that alone could give presumptive hope of success. In this way, and actuated by this motive, I have seen young men, not naturally cruel, urged to the practice of vivisection under the belief that they were acquitting themselves of a needful though disagreeable duty. I have seen this, but rarely.

Having recognised as justifiable the aid of vivisection pursued in the interests of scientific advancement; being fully impressed with the desirability, not to say duty, of restricting that mode of inquiry within the narrowest profitable limits; recognising too the force of the general proposition, that it is inexpedient for individuals scientifically inclined to be impeded in their experiments;—impressed with all this, I am conscious how difficult it is to suggest practical means whereby the sentiments here expressed in regard to vivisection may find practical application. I am of opinion that this means of acquiring knowledge ought to be regarded as an exceptional means, and one to be dealt with exceptionally.

I would be found amongst the foremost to contemplate with horror the contingency of an individual who, impressed by the belief that he had a special call to the department of physiological science, yet unprepared through previous education to profit by any evidence the organisation of a living animal might be made to reveal, should tamper unchecked with animal life, and inflict pain recklessly, by vivisection or otherwise.

I think that no detriment would accrue to science if an act of parliament were passed restricting vivisection to medical schools, registered as such, and amenable to the supervision of the inspector of anatomy. I can imagine exceptional cases, to the circumstances of which it were well that the provisions of such an act of parliament did not apply. I am, moreover, aware that such an act could not be easily worded so as to avoid legislative miscarriage through ridicule. Literally, the gardener who cuts an earth-worm in twain is a vivisector; so is an angler who lacerates an earth-worm on his hook. A really efficient act should be loosely worded; it should avoid all recondite definitions. The interpretation of it in every separate case should be made under the light of common-sense.

I apprehend that neither here nor abroad is the practice of vivisection *in aid of scientific inquiry* so commonly performed, or so cruel in its results, as to call for strong reprehension. I apprehend that it is to vivisection performed in furtherance of operative dexterity by veterinary surgeons upon which the opprobrium of civilised humanity should be concentrated. I hold that vivisection, to this end employed, is a stupid misapplication of a cruel mode of experiment; that it is a practice useless, not merely to the operator, but injurious, for reasons already set forth. I hold it to be one in whose defence no argument can be adduced that does not admit of being easily disproved and set aside; a practice, consequently, that ought to be put down, if needful, by the strenuous force of law.

The Royal Humane Society some years ago offered a prize for a thesis on vivisection. That prize was awarded to some writer who denied the utility of vivisection in any case. I am not able to concede so much, and am farther of opinion, that such extreme rulings injure a good cause.

As a nation we are strangely inconsistent in our ideas of compassion to animals. Reprobating Spaniards for their bull-fights, we tolerate the cruelty of *bleeding* a stag preparatory to the Epping Hunt to check the power of his running, and in this way accommodate him to the Cockney sportsman, whom, left to his native vigour, he would outrace. Again, is the Royal Stag-Hunt establishment not a barbarism unfitting the reign of a Christian sovereign—*à fortiori*, a female Christian sovereign? To hunt a wild deer is one thing; to hunt a tame deer, reared in a paddock, and carted to the starting place, another.

I would rather perform Calcraft's duties than be master of her Majesty's stag-hounds. The first office I would accept at a price; the latter at no price. Rather let me eat workhouse gruel with a wooden spoon.

WHAT IS THE SUN MADE OF?

If that question had been proposed to any chemist, naturalist, or astronomer, twenty years ago, the reply might have been, 'Who knows?' If the chemist, naturalist, or astronomer, had been farther questioned as to his belief whether science of any kind might not probably some day inform us of the sun's composition, he would have assuredly answered, 'No!'

To have replied otherwise, indeed, would have seemed unsound and ignorant. With what reason could it have been expected that any portion of the sun's materials would reveal their composition to mortal sense? The moon's composition would have seemed a far more promising subject of inquiry. Occasionally, aërolites or metallic masses fall to us from above. Whence they come is still uncertain. According to one theory, they are assumed to have originally belonged to the moon, and to have been thence projected by volcanic eruptions, so far as to come within reach of the earth's attraction.

Many of this class of bodies have been collected and analysed. Their constituents have been made known through the direct evidence of chemical analysis; therefore—only granting their lunar origin—a portion of the moon's constituents will have been revealed. I am aware that most of these aërolites are now supposed to belong to fragmentary asteroids, coursing in planet-like orbits through our solar system; but the very fact of their having been taken for lunar productions, shows that the materials of the moon's structure were not deemed wholly beyond our observation or comprehension. These fragments only were thought to confirm our conclusions as to the moon's physical structure as observed by the telescope.

But as for the sun—ninety-four millions of miles away—there seemed no hope that we should ever succeed in making a closer chemical acquaintanceship with him. This has still been effected; and, without giving a detailed narrative of *how* it has been effected, I shall do well to contemplate the bonds of union and acquaintanceship, so to speak, that subsist between the sun and ourselves.

Firstly, we maintain a bond of acquaintanceship with the sun through the intervention of the light that emanates from him; and this we may denominate the bond of popular acquaintanceship. Between our great luminary and the philosopher, there is another bond of acquaintanceship—the force of gravitation.

Whereas, however, any considerable knowledge of the laws of gravitation requires close study, a considerable knowledge of the properties of light is forced upon us, willingly enough, by the very construction of our eyes, and the necessities of our existence.

Astronomers, long ago, reasoning upon facts to which their experiments led them, came to the conclusion, that the sun, regarded as a whole, is lighter, size for size, than the earth; only about a fourth of the earth's weight, indeed.

To put the case in another way: assuming that the whole materials of the sun could be intimately mingled, so as to yield an average, and then a piece cut out of the sun exactly as big as our earth, such piece would only weigh about one-fourth of that our own planet weighs. To explain in what manner the weighing of the sun has been effected, would be altogether impossible here.

The weighing *has* been accomplished, and accomplished through gravitation; and this, until very recently, was all we knew in regard to the composition of the sun. Whether it were made up of materials wholly different from those of our planet, or whether of materials identical in nature with some of those of which the earth is composed, was beyond the scope of human ken, and seemed likely to remain so. The lighter weight of the sun conveyed no information as to the nature of the materials. The proportional weight of the same thing varies according to the amount of heat it has. For example, metals—the very heaviest class of bodies—can by the aid of sufficient heat be driven into vapour; and vapours, as we all know, are characterised by their lightness. So, it might be that the sun was composed of materials naturally heavy, but expanded to lightness by heat; or it again might be that the sun was composed of materials naturally light—light, that is to say, at ordinary temperatures.

Long ago, the opinion began to prevail that the sun was a molten mass of fire; and a very rational opinion to most people this will seem to be, considering the heat and light ever evolved from the great centre of our system. Then afterwards came a period when that opinion fell pretty much into the back-ground amongst philosophers. It was argued that both heat and light might be produced by an orb neither inordinately hot nor luminous; an opinion that could never have gained much acquiescence by the unlearned—much philosophical refinement of thought being needed to reconcile the mind to the notion of heat and light being produced by a body of itself neither hot nor luminous.

Such continued long to be the sum-total of our knowledge in regard to the sun's composition. Doubting, speculating, we lived, but never hoping. Philosophers little knew what a glorious discovery was in store for them.

Everybody knows what is meant by the term 'prismatic spectrum,' the wondrous coloured image thrown upon a screen when a jet or thread of white light is analysed, or unravelled, so to speak, by means of a transparent triangular prism. Whatever the source of light may be, provided it evolve white light, a coloured spectrum may be produced by the agency of a triangular prism. Take heed, then, of the following fact; for upon a full comprehension of it a good deal hinges. A very unimportant fact it may seem, but the philosopher looks upon every fact, every revelation of truth, as having importance. The application of it may not come to-day, to-morrow—not in our time perhaps, or it may be not for centuries *after* our time, but come assuredly it will; for facts are laws, and the laws of nature are impressed by God, and He does nothing in vain.

The fact to which I would direct attention, is the existence of certain black transverse lines across the solar spectrum, and only across it. If some sufficiently powerful light be substituted for that of the solar rays, then the particular black bands now under consideration are no longer developed.

It is important, moreover, to note that the black solar spectral bands never vary—are never altered as to their relative position. This fact was noted and recorded in the annals of science; for, whenever the philosopher notes a constant occurrence, he treasures it. Not unfrequently such treasured stores of truth are pregnant with marvellous revelations; though at the time their full meaning and bearings may be unknown. So much, then, for the aforesaid black spectral bands. Premising that they were first remarked by Frauenhofer, and from that circumstance they have always been called *Frauenhofer's bands*, I will leave them for a time—their consideration to be resumed hereafter.

I must now record the evidence of certain experiments that will seem to be a long way removed from anything connected with the solar spectrum. Nevertheless, their evidence—joined by and by to the evidence furnished by Frauenhofer's bands—will hereafter reveal to us the great secret of the sun's composition, in part at least.

Did you ever see a display of artificial fireworks, wondering in what manner the beautiful flame-tints were produced?

Did you ever see an old woman throw a pinch of salt upon the fire 'to clear the fire,' as she said, before setting on the gridiron? Did you ever push, by design or inadvertently, a bit of copper amongst burning coals or into a candle-flame? The evidence of the fireworks, the salt, and the copper wire, all goes to prove one and the same thing—namely, that each and every metal, as a rule, burns, evolving its own peculiar tint. What metals, or what composition of metals, enter into ornamental fireworks, we will not here stop to investigate; but let it be understoood that each metal communicates to flame its special hue.

The second and third illustrations (both very simple) are quite sufficient for my purpose. The old woman's pinch of salt—should you witness that experiment again, if not, you can perform it—will be observed to tinge the fire yellow; and so, if you dip a bit of string into some salt-and-water, then dry it, and when dry plunge it into the flame of a candle, the flame will acquire the same peculiar tint of yellow. And so, if, cross-questioning nature still, you take some of that beautiful and very curious metal which enters into the composition of sea-salt, and which is 'sodium,'—if you take some of that metal sodium, and set fire to it in a small platinum spoon, it also—the metal sodium—will be seen to burn with a flame having the same tint of yellow.

Similarly, the experimenter would find—were he to take the trouble of performing the experiment—that copper, and every preparation of copper, burns with a green flame. In order to perceive the distinctive tints evolved by respective metals undergoing combustion, no apparatus is necessary; but it is only by the aid of an electric lamp and a triangular prism that the full beauty of the tint can be made manifest. Then will it be seen that sodium, when burned in a little charcoal crucible within the electric lamp, develops, on the yellow portion of the spectrum, a still yellower band; that copper, similarly burned, produces on the green part of the spectrum a still greener band; and so on—a particular band or bands for each particular metal.

And this is curious too, viz. that, if two or more metals be consumed in mixture, such as brass—a mixture of copper and zinc—for example, the prism picks out (so to speak) the rays peculiar to each metal, depositing them in the spectrum duly arranged—each of its own peculiar tint, each in its own proper locality.

So we now, by a course of experiments, have succeeded in obtaining a banded spectrum. The bands of *our* spectrum, however, are coloured, whereas those of the solar spectrum—the bands of Frauenhofer—are black. 'There can hardly be any connection between the two phenomena,' say you. Wait a while.

Turn back now to our sodium. It is burning in a platinum spoon, we will suppose, evolving a vapour; that vapour is burning with the yellow light peculiar to sodium. We will now hold that sodium flame in the very track of the yellow rays that have been separated by the triangular prism from white light of the electric lamp. Watch now the result from the spectrum—a band of yellow seems to be clean cut out. There is, in place of it, *a black band*. Now, is this an arbitrary black band, or is it one to be found in the solar spectrum? Is it one of the Frauenhofer black bands? Yes, it so happens to be; and now, so far as the presence of sodium in the sun is concerned, we have our revelation.

Assume the following case. Assume that the sun *is*, as quite anciently it *was* assumed to be, a glowing ball of fire 1,384,492 times larger than our earth—a seething mass of burning materials. Assume a blazing flame of vapour to surround him—one constituent being the vapour of sodium. These conditions granted, we at once account for the one particular black sodium line or band of the Frauenhofer scale corresponding with sodium; and we can account for its presence on no other assumption.

Repeating the experiment with other metals, we produce other black bands on our artificial spectrum, conformable in every respect to other Frauenhofer bands. And thus, by following out this beautiful train of reasoning, philosophers have arrived at two conclusions: First, that the sun, as was anciently supposed, is a mass of molten fire; second, that he is surrounded with a blazing atmosphere, in which at least exist the metals iron, magnesium, sodium, chromium, and nickel.

Nor have the experiments of Professors Bunsen and Kirschoff, of Heidelberg (to whom these discoveries are due), only revealed a new mode of analysis for substances already known, but they have actually succeeded in discovering two new alkaline metals, to which the names *cæsium* and *rubidium* have been given. Subsequently our own countryman Mr. Crookes, using spectrum analysis, discovered the new metal *thallium*. Indications of both these metals having been recognised in the waters of Baden and Durckheim, the professors, after a tedious course of manipulation, succeeded in obtaining them. It now remains to be seen whether this beautiful spectral analysis may not be hereafter applied to the discovery of mineral poisons.

EUTHANASIA.

The change from this scene of existence to the next is usually heralded by suffering and pain, insomuch that dying has come to be regarded as the extreme of calamities.

Usually the animated machine clogs, and in mid-career is disarranged, then struggles before coming to the pause which is death, long before the component parts of it are so far worn or altered as to be unfitted to the functions of vitality.

Few of mankind can be said to die of old age pure and simple; fewer still of non-human animals. Disease or violence or accident precipitate commonly the issue. For man, disease is the normal rule of death, violence and accident the exception. For non-human animals, conditions are reversed; comparatively few die naturally. In fish the chances in favour of natural death sink to the lowest level. Fish eat each other without compunction, heedless of consanguinity or species similarity.

Violent death may well be called the *natural* death of fishes; and perhaps this way of going out of the world in their case has important consequences in nature's economy. If terrestrial animals were to die naturally and to remain unburied, the atmosphere would soon become so contaminated, that no living creature could long breathe it and live. It is known that putrefactive decomposition takes place in fresh water at least as readily as it does in air; and although the saline materials of sea-water *do* check putrefaction to some extent, yet they are not in quantity sufficient to prevent it wholly; wherefore the cannibal propensities of fish may be a wise provision of nature for keeping the waters pure.

Though life-duration, regarded as to the individual, is most uncertain, nobody being able to form the vaguest notion of the hour of his decease, yet considered as to the species, the period of life-duration can be estimated with much certainty. Were it otherwise, the practice of remunerative life-assurance could not obtain. In a general way the rule has been established, that the normal life-duration of an animal is directly proportionate to the time occupied by it in coming to the extreme of growth. To this, however, there are so many exceptions, that they almost invalidate the rule. Thus ravens die extremely old; so do parrots; both having been known to attain ages beyond a hundred years; yet neither parrots nor ravens are slow of growth.

From very ancient times there has been a traditionary belief in the long life of deer—even hundreds of years. The Egyptians in their hieroglyphic code chose the deer for their symbol of longevity. From the Egyptians the belief passed down to the Romans, and thence to our own times.

In no part of the world is belief in the longevity of deer more firmly fixed than in the Highlands. It is not asserted by Scottish Highlanders that the lives of deer *in general* are immoderately long, something like twenty-five years being assigned for the usual term of existence of a red deer. The Highland belief is, that certain old stags are endowed with a magic vitality; that they are a sort of wizard stags. Of these weird creatures numerous tales are told. Take, for example, the following:

In the year 1826, the late Glengarry, when hunting in the garth of Glengarry, shot a fine stag, which was seen to have a certain mark on the left ear. A gillie coming up said it was the mark of Ewen-Mac-Ian Og. Five other gillies coincided, and they all agreed that Ewen-Mac-Ian Og had been dead one hundred and fifty years. The tradition had been handed down, that this old chieftain for thirty years before his death had marked with this particular brand all the calf-deer he could lay hands upon. Assuming the mark on this particular deer to have been authentic, then the animal's age could not have been less than a hundred and fifty, and it *might* have been a hundred and eighty years.

The anecdote is narrated by Mr. Scrope, who, however, suggests that the old forester's mark was known to the hill-men, and had been by them imitated. Hundreds of Highland traditions might be cited in regard to the alleged longevity of deer. The belief has always prevailed in the Highlands, and hence a certain Gaelic proverb, which stands thus translated into English:

'Thrice the age of a dog is that of a horse,
Thrice the age of a horse is that of a man,
Thrice the age of a man is that of a deer,
Thrice the age of a deer is that of an eagle,
Thrice the age of an eagle is that of an oak-tree.'

What may be considered the normal age of man, the age to which the human mechanism might be expected to endure but for disease, accident, or other collateral interference? Threescore years and ten is the scriptural answer; but without irreverence we may easily assume that the scriptural statement contemplated the probability of disease, of accident, of one or another amongst the extraneous causes which in by far the majority of cases terminates human life; not allowing *euthanasia*, or death from actual wearing out of the animal mechanism, to supervene.

The physiologist Blumenbach came to the conclusion that there is no period which can be said to be entitled by its frequency and marked regularity to be considered the natural term of advanced old age. Trying to determine this point, he consulted all the bills of mortality he could gain access to, and the conclusion he was able to arrive at was, that in Europe no inconsiderable number of individuals reach their eighty-fifth year, but few get beyond it; that farther, from one or other cause, only one in every seventy-eight human beings in a thousand can be said to die in the condition of euthanasia. Blumenbach, it is worthy of remark, died in the beginning of 1840, aged eighty-eight, having retained his faculties to the last. He continued to lecture up to a few days before his death, and with the spirit and humour that had always been his wont. Hufeland was of opinion that, were it not for disease or accident, or other extraneous cause, the natural term of man's existence, ending in euthanasia, might be fixed at about two hundred years. He considered the assertion strengthened by its agreement with the proportion between the time of growth and the duration of life. An animal, according to Hufeland, lives eight times as long as it grows; and the growth of man can be hardly looked upon as complete until twenty-five. According to this calculation, the term of human euthanasia would of course be two hundred years.

Hufeland occupied by no means a solitary position among physiologists in respect to this conclusion. Blumenbach was of the same opinion; so was Buffon. Those who uphold this belief have much to advance in support of it. Take almost any extreme case of old age of which records are extant, and it will be found that death came through the operation of some extraneous cause. Take the case of Old Parr, for instance, who died at one hundred and fifty-two. We shall find he did not actually *wear* out; he was killed by kindness.

Who of us, having arrived at the age of one hundred and fifty-two, would mind dying under the perpetration of such kindness as I find recorded in a certain ancient book entitled *The Old, Old, very Old Man*, being a chronicle of Mr. Parr's last days? From the account in this book, it seems that the Earl of Arundel and Surrey, being in Shropshire, heard of the venerable Mr. Parr; 'when,' states my record, 'his lordship was pleased to see him, and in his innate noble and Christian piety, he took him into his charitable tuition and protection, commanding that a litter and two horses be provided for him; also that a daughter-in-law of his (named Lucy) should likewise attend him, and have a horse for her own riding with him. And to cheer up the old man and make him merry, there was an antique-faced fellow called Jack, or John the Fool, that had also a horse for his carriage. These all were to be brought out of the country to London by easy journeys; the charges being allowed by his lordship, and likewise one of his honour's own servants, named Brian Kelley, to ride on horseback with them, and to attend and defray all manner of reckonings and expenses; all of which was done as followeth.'

Then comes the itinerary. How Master Parr was received in this town and that is minutely recorded; how Master Kelley 'had much to do to keep the people off that pressed upon him in all places where he came; yet at Coventry he was most opprest; for they came in such multitudes to see the old man, that those that defended him were almost quite tired and spent, and the aged man in danger to have been stifled.'

Arrived at London, Master Parr was sumptuously lodged, profusely and delicately fed. He became a court lion, dividing the regards of sight-seers of Charles I.'s court with a giant and a dwarf, also under royal patronage; all three, as I gather from the curious old book from which these particulars are taken, court pensioners. There seems to have been a court poet in those days, whose name has passed into oblivion. He printed an effusion to celebrate the three court prodigies; the opening lines of this effort of genius are as follow:

'Of subjects, my dread liege, 'tis manifest
You have the old'st, the greatest, and the least;
That for an old, a great, and a little man,
No kingdom, sure, compare with Britain can.'

They lodged Master Parr sumptuously, they fed him delicately. It killed him. Abundant meat and generous wines failed to agree with one who throughout life had eaten very little animal food, and who, though indulging in ale occasionally, had seldom tasted wine. He died at the mature age of one hundred and fifty-two, but not of pure old age, the condition of euthanasia. Harvey, the celebrated anatomist, who dissected Master Parr's body, found in it no signs of natural decay. And here it may not be inopportunely stated, that when Master Parr had outlived a century by some years, a certain youthful indiscretion brought on him the penalty of doing church-penance in a white sheet!

Speculating on the average age of mankind, and animals in general, some have expressed surprise that the organism should wear out at all, seeing that the materials of it are so constantly replenished; others, on the contrary, have wondered that the mechanism should last so long as it ordinarily does.

In reference to the former, it has been said that every part of a living animal's body undergoes renewal once in about three months; but this is not strictly correct. Every *soft* part of the body may, indeed probably *does*, come under that process of regeneration in the time specified, gelatine or the soft portion of the bones inclusive. The composition of our bodies alters with age, notwithstanding. During life something goes on comparable to the furring of a tea-kettle or the fouling of a steam-boiler. Hard earthy concretions deposit in the heart, impeding its movements; in the arteries, impairing the elasticity needful to their vital functions. Vainly are the soft portions of our bodies renovated, whilst those earthy depositions continue to be formed. The longer we live the more brittle do we grow. Young children can fall about, rarely breaking their bones; whereas old people often fracture their limbs by the mere exertion of turning in bed.

Bearing in mind the fact, that as we grow older we become more brittle, this is explained; and being explained, shall we not marvel that life's fire burns so long? Consider what the animal machine has to do to keep itself alive and going, the heart above all. Taking an average of different ages, the human heart may be considered to beat one hundred thousand times in the twenty-four hours. A human adult may be considered to hold from fifty to sixty pounds of blood; and this has to be kept in continuous motion by the pulsating heart to the very end of life. The mechanical labour is enormous. Were a mechanician to devise a machine of ordinary materials for overcoming the weight of fifty or sixty pounds, as happens to the blood, repairs would be incessant, the machine would soon wear out.

I do not know how it happens that, when an illustration of extreme old age is in question, we all recur to Master Parr. He was an old man certainly, a *very* old man; but by no means the oldest of whom authentic records exist. Old Jenkins beats him. Of Jenkins more anon. The very oldest man I can find account of is Thomas Carn, who, according to the parish-register of St. Leonard, Shoreditch, died 28th January 1588, æt. two hundred and seven. He was born in the reign of Richard II. in 1381. He lived in the reigns of ten sovereigns, viz. Richard II., Henries IV. V. and VI., Richard III., Henries VII. and VIII., Edward VI., Mary, and Elizabeth.

Some years ago, when Parliament had closed and London was deserted—when the silly season, as newspaper-people call it, had fairly set in—the leading journal admitted to its columns a series of letters, the general purport of which was to cast a doubt on records of extreme longevity. Could it be demonstrated that, since the existence of scriptural patriarchs, any man or any woman had completed a hundred years?

Such was the general question; and much argument was expended to prove the negative. Amongst other reasons for disbelieving the statements of persons of extreme age, their failure of memory was insisted on; also a certain pride of age, that dawns and dominates, just like the pride of youth at earlier epochs of life. Deferring to these arguments in their general application, it is still impossible to set aside the precise testimony of certain cases. However easy it would be for a supra-centenarian to tell an untruth, or to make a mistake, as to the bare statement of age, it would not be easy —rather would it be impossible—for him to make the bare statement consist with cross-questioning founded upon consideration of events and historical periods. The extreme age of Jenkins — he died at one hundred and sixty-nine — is attested by the following line of, as it would seem, unimpeachable evidence.

Henry Jenkins is said to have been born at Bolton-upon-Swale, Yorkshire, in 1500, and to have followed the active employment of fisherman for about a hundred and forty years. Being produced as a witness on a trial at the Yorkshire assizes, to prove a contested right of way, he swore to near one hundred and fifty years' memory, during all which time he said he remembered the right of way. 'Beware what you are swearing,' said the judge; 'there are two men in the court each above eighty—they have both sworn they have known *no such* right of way.'

'Those men,' replied Jenkins, 'are boys to me.' Upon which the judge inquired of those men how old they took Jenkins to be. Their answer was, they knew Jenkins very well, but not his age; for that he was a *very* old man when they were boys.

Here, then, we have evidence of the great age of this patriarch,—evidence, so far as it goes, of the most satisfactory kind; educed, as it was, from the testimony of those who, being in a certain sense antagonists, can hardly be assumed to have gone out of their way to enhance his antiquity. Evidence equally satisfactory and more precise, as it goes to fix his age *exactly*, was elicited by judicial cross-questioning founded on comparison of historical dates. Being brought before a court of law to give evidence, he testified to one hundred and twenty years: having been born before parish-registers were kept, these only having been established by the 30th of Henry VIII.

This seemed so extraordinary, that Jenkins was cross-questioned with reference to historical occurrences. What remarkable battle or event had happened in his memory? 'Flodden Field,' said Jenkins; 'I being then turned twelve years of age.' How did he live? 'By thatching and salmon-fishing. I was thatching when served with your subpœna, and can dub a hook with any man in Yorkshire.'

Reference to Flodden Field brought more cross-questioning. His reply was consistent, and still more confirmatory. When eleven or twelve years old, he said, he was sent to Northallerton in the North Riding, with a horse-load of arrows to be used in the battle of Flodden Field. From Northallerton the arrows were sent on to the field of battle by a bigger boy; all the men being employed getting-in the harvest. The battle of Flodden Field was fought September 9th, 1513.

Being farther questioned, Jenkins said that he had been butler to Lord Conyers of Hornby Castle, when Marmaduke Brodelay, lord abbot of Fountains, did frequently visit his lord, and drink a hearty glass with him; that his lord often sent him to inquire how the abbot did, who always sent for him to his lodgings, and, after ceremonies, besides wassal (a liquor made from apples, sugar, and ale), ordered him a quarter of a yard of roast beef for his dinner (for that monasteries did deliver their guests' meat by measure) and a great black-jack of strong drink.

Being next questioned whether he remembered the dissolution of religious houses, he said, 'Very well;' that he was between thirty and forty years old when the order came to dissolve those in Yorkshire; that great lamentation was made, and the county all in a tumult when the monks were turned out. After this sort of evidence, it will be impossible, I think, to refuse credence to this *very* old man's tale.

Is growing old an art to be acquired? is it a matter of eating, drinking, and avoiding? These are amongst the questions that people, desirous of growing *very* old, will not fail to propose to themselves. And thus may we reply: Viability, or the capacity of living long, wrote somebody, is an inheritance. Like talent, it may be cultivated; like talent, it may be perverted; but it exists independent of all cultivation. Some men have a talent for long life. Longevity tends to be hereditary. M. Charles Lejoncourt, in his *Galerie des Centenaires*, publishes some curious examples. He cites a day-labourer, who died at one hundred and eight; his father having lived to one hundred and four, and his grandfather to one hundred and eight. His daughter, then living, had arrived at eighty. In another page of M. Lejoncourt's treatise, we find a saddler whose grandfather died at one hundred and twelve, his father at one hundred and thirteen, and he himself at one hundred and fifteen. This man, two years before his death, being asked by Louis XIV. how he had managed to live so long, 'Sire,' said he, 'by acting on two principles since I was fifty; the principles of keeping my wine-cellar open and my heart shut.'

A more surprising illustration of hereditary longevity is furnished by John Golembiewski, a Pole. In 1846 this man was living, aged one hundred and two. His father died at one hundred and twenty-one, his grandfather at one hundred and thirty. This Pole had been eighty years a common soldier. He had served in thirty-five campaigns under Napoleon; had even survived the terrible Russian campaign in spite of five wounds.

We perceive, then, that capacity for living to very old age tends to be hereditary. It is a talent, so to speak, and, like other talents, it may be developed or abused. If the question be proposed, By what regimen longevity may be most subserved,—the answer would be, A temperate regimen. The reply is indefinite; not one whit more precise than are the circumstances that make a *bonâ-fide* traveller.

I cannot discover in the annals of extreme old age any sort of testimony favourable to the views of total abstainers. As little does the faculty of long life comport with excess, either in food or drink. Gluttony and drunkenness are both unfavourable to longevity; but gluttony, as it would seem, in a higher degree than alcoholic drinking. Buffon places the mountainous districts of Scotland in the very first rank for longevity, and we all know that John Highlandman is *not* a teetotaler. Whether total-abstinence people would like to argue, that though John Highlandman lives long, yet but for 'whusky' he would live longer still, I know not. To support that argument they might adduce St. Mungo, otherwise called Kentigern, founder of the bishopric of Glasgow. This worthy is said to have lived to one hundred and eighty-five, eleven years older than Jenkins, thirty-three years the senior of Old Parr.

In respect to sex, I do not find that women figure as supra-centenarians in any way comparable to men. Old women of eighty-five or ninety are plentiful enough, but not antique women—female old Parrs and Jenkinses. This rather unsettles the somewhat common belief—or is it a petulant outburst only?—that old women never die.

Married life or celibacy—what shall we say? Unfortunately I can come to no conclusion at all; worse, a conclusion I come *near* to is opposed to the belief of wiser men than I. Nowadays insurance actuaries tell us that the married state is favourable in the highest degree to longevity; but how is this to be reconciled with the case of St. Mungo, who died at the astounding age of one hundred and eighty-five? Being a saint, *of course* he was a celibat; a standing proof of old bachelordom vitality.

One swallow makes not a summer: I fancy most of the antique people whose records I have scanned were, in some sense, married. Mr. Parr was so little of a celibat, that, arrived at the age of one hundred and five, they made him undergo penance at church, as we already know, to atone for a youthful indiscretion; setting him up as an example to be avoided by other young men.

Thus it seems that, fearfully and wonderfully made, the chances of dying from the effects of mere old age—the condition of euthanasia—are so much against us as well-nigh to bar the hope. On the most favourable computation, it only happens to one in a thousand; and out of that thousand, the one can only belong to some seventy-seven or seventy-eight.

Is euthanasia—death without disease—coming when life has been prolonged to the uttermost, a result to be desired? Perhaps not. The optimist, believing all things to be for the best, must fain believe not.

When hearing fails, and taste flags, and sight grows dim; when memory of things past mingles, wavering, with visioned thoughts of the change to come; when the lifelong-palpitating heart pauses in its beat as if worn and weary,—is it not better then that the silver string should be cut in twain, and the pitcher broken at the well?

THE SUFFOLK WITCHES.

EUPHONY, or prettiness of sound, regarded, there is not much amiss with 'Amy Duny.'

If taken for the name of the heroine of a love-tale, it might have served; if of some gentle consolation-ministrant or tender nurse—some young lady of uncertain age, powerful in religious exhortation, addicted to tea-muffin-toast convivialities, Dorcas charities, tracts, stray puppy-dog reclamation, curate-coddling, female-physicking, and all the other things single ladies take up with,—still there is so little amiss with the name of Amy Duny, that any estimable woman might have borne it, even had she been a saint.

Not to be prolix, I hereby give leave and license to imagine any model paragon of female excellence, of whatsoever variety, to call that female paragon Amy Duny, and then consider if the name be not pretty, at least not much amiss. The patronymic Cullender has a homely, plebeian sound, suggestive of cabbage set draining. There's nothing suggestive of wickedness or of diabolism in it. The Christian name Rose needs no apology; how redolent of youth, of beauty, and goodness!

Yet there *was* an Amy Duny, and there *was* a Rose Cullender, and in the year 1662, at Bury St. Edmunds, they were hanged. An intelligent British jury returned the verdict 'guilty of witchcraft' against them. The indictment had thirteen counts; the presiding judge was Sir Matthew Hale, lord chief-baron of the Exchequer; a man against whom no imputation of cruelty has ever lain, who was conspicuous for the purity of his life at a period (temp. Charles II.) when license ran riot; one the force and complexion of whose intellect are attested on better evidence than traditionary repute. Sir Matthew Hale published much; his *Contemplations Moral and Divine*, *History of Pleas of the Crown*, and *The Original Institution, Power, and Jurisdiction of Parliament*, proclaim at once the broad range of his perceptive faculties, and the general soundness of his judgment.

Many curious accounts of witch trials and condemnations exist, and are accessible; but the fault too commonly prevails, that their matters-of-fact are so thickly overlaid with a crust of religious polemics, with exhortation, pious imprecation, &c., that any one coming to investigate the circumstances without favour or repugnance, absolved from influences that biassed minds in a past age, incurs no small amount of trouble in clearing away rubbish to attain the ore.

From all objection of this kind the printed record of the witch-trial in question is free. It is drawn-up in a terse and unimpassioned style; being a plain record of evidence given, without any straining after sensational effect. On the title-page no author's name appears; but from contemporary records the fact comes out, that the particulars were written down by the marshal of Sir M. Hale's own court, and committed to print, after some delay, by an appreciative friend.

Let us imagine that the chariot of time has been made to retrograde over near two centuries. We are at Bury St. Edmunds, county of Suffolk, on the 10th day of March, in the sixteenth year of the reign of our sovereign lord King Charles II.

Matthew Hale, knight, lord chief-baron of his majesty's Court of Exchequer, is criminal judge of assize. Amy Duny and Rose Cullender, both widows, and both of Leystoff, are at the bar, severally indicted that they had bewitched Eliz. and Ann Durent, Jane Bocking, Susan Chandler, William Durent, and Elizabeth and Deborah Pacy. It is the solemn moment when the judge sums-up to the jury.

Silence! The court is stilled. Not a voice, not a sound, save deep low moans from a child—a victim of witchcraft, as they think, who had been brought to the court in testimony, and reclined on a mattress.

'Gentlemen of the jury,' said the judge, 'I will not repeat the evidence unto ye, lest by so doing I should wrong one side or the other. Only this do I acquaint ye. Two things are to be inquired. First, whether or no these children be bewitched. Secondly, whether the prisoners at the bar be guilty of it. That there be such creatures as witches I make no doubt. First, the Scriptures have affirmed so much. Second, the wisdom of all nations hath provided laws against such persons, which is an argument of their confidence of such a crime. And such hath been the judgment of this kingdom, as appeareth by that act of parliament which hath provided punishment proportionate to the quality of the offence. I bid ye strictly observe the evidence; and may the great God of heaven direct your hearts in this weighty thing. For to condemn the innocent, and let the guilty go free, be both an abomination unto the Lord.'

With this short direction the jury depart from the bar to deliberate. In the space of half an hour they return, bringing in a verdict of guilty upon the several indictments—thirteen in number. Then the black cap—the sentence. Amy Duny and Rose Cullender must die!

This was upon Thursday afternoon, March 13, 1662. Mark now a prodigy.

'Next morning the three children with their parents called on Lord chief-baron Hale at his lodgings. They spake perfectly, and were in as good health as ever they were; only Susan Chandler, by reason of her very much affliction, did look very thin and wan. Their friends being asked at what time they were restored thus to their speech and health, Mrs. Pacy did affirm, that within less than half an hour after the witches were convicted they were all of them restored—sleeping well that night, feeling no pain, save Susan, who did feel a pain like pricking of pins in her stomach.'

'That same morning,' the author of the report from which these particulars are taken—Sir Matthew Hale's own marshal, as collateral documents teach—goes on to state:

'We,' *i.e.* Sir Matthew, the marshal, and retinue, 'went on to Cambridge.' Whilst there, and on Sunday preceding March 17th (Monday), when Amy Duny and Rose Cullender were executed, Sir Matthew penned a sort of confession of faith in respect to his belief in witches. 'That he was well satisfied with the conviction,' writes a chronicler of the time, 'may be perceived by his writing this meditation so immediately upon it.' 'Therefore,' the chronicler goes on to explain, 'I think it very proper for this place, not only for the use which well-disposed people may make of it, but also as an evidence of the judgment of so great, so learned, so profound and sagacious, so cautious, circumspect, and tender a man in matters of justice, and especially in matters of life and death, to check and correct the impiety, the vanity, the self-conceitedness or baseness of such witch-advocates as either maintain that there be no witches, or, contrary to their duty and their oaths, make light of the examination and trial of them. Such persons may have cause to be ashamed of themselves after notice of such a judgment, and others may hereby be admonished what to think of them.' So much for the preface; the discourse opens thus:

'That there are such evil angels (witches) is without question. The Old Testament assures us of it, as easily appears upon consideration of the temptation of our first parents; the history of Abimelech and the men of Sechem; the history of Saul and the witch of Endor; the history of Micaiah and the false prophets; the history of Job; the prophecy of the desolation of Babylon, wherein Jim and Ziim and the satyrs were prophesied to inhabit. The New Testament more explicitly and abundantly clears it by the history of the temptation of our Lord; the demoniacs of several symptoms cured by our Lord and his apostles; the procession of the evil spirit, and his return with seven other spirits; the vision of the fall of Satan from heaven like lightning, by our Saviour; the several assertings of it by the gospel and apostolical epistles; the prince of the power of the air, the spirit ruling in the children of disobedience; the kingdom of Satan; principalities and powers in high places; and more frequently yet in the Apocalypse. It is also confirmed to us by daily experience of the power and energy of these evil spirits in witches and by them.'

The lord chief-baron is no waverer; his mind is pretty well made up. That he should have come to believe in the general existence of witches, has been cited by some modern writers as a proof of intellectual weakness. But for that matter, I have myself heard an English judge, belonging to one of the superior courts, affirm in society that the published evidence brought against witches is, when taken intrinsically, equal to the best evidence he ever knew deposed in a court of law.

The matters of fact constantly sworn to in those old witch-trials—often by many witnesses seemingly independent of one another—are most extraordinary. Having exorcised the belief in witchcraft, one of two general explanations must be taken—falsehood or collusion. If the former, the concession that such a depth and power of lying should have been possible is calculated to throw a doubt on all judicial evidence. If the latter, then the organising power needful to such elaborate collusion would be extraordinary in people of high mental qualities and large attainments. Exercised by commonplace illiterate people, it seems miraculous.

What can be more precise and circumstantial than the following evidence, sworn to by Dorothy Durent?—who deposed, that about the 10th of March, nono Caroli Secundi, she having a special occasion to go from home, and having none in the house to take care of her infant child William, requested Amy Duny to see to him, for which said Amy was promised a penny. Great stress was laid that Amy should not do something to the infant that, as will appear, she *did* do (for particulars consult original).

When Mrs. Durent goes to reclaim her young William, and learns that Amy has done by the sweet child exactly what she was admonished *not* to do, then came words and some exchange of eloquence. Deponent waxed angry with said Amy, whereupon said Amy was disconcerted. She did use evil speech, telling mamma, amongst other things, 'that she had as good to have done otherwise than to have found fault with her; and so departed out of her house.'

That very night baby fell into strange swoundings, and so continued for divers weeks. Deponent then in her anguish did go to a certain person named Dr. Jacob, who did live at Yarmouth—one having great reputation in the country for helping children that were bewitched. The doctor's advice to mamma will seem peculiar—something that had been more appropriately told to the marines than to a baron of his majesty's Exchequer. Peculiar or not, it either took effect, or there was perjury, or else hallucination.

'Hang up,' said Dr. Jacob to Mrs. Durent, 'hang up young William's blanket in the chimney-corner all day. At night, before wrapping the blanket about him, look well to see if anything be there. Whatever you find, fear not,' quoth Dr. Jacob. 'Dead or alive, cast it into the fire.' All this did deponent. Going to take down the blanket at night, with intent to put William therein, out fell a prodigious toad! It did run up and down the hearth.

Now there did live with deponent a certain youth, to whom she spoke, 'Catch that toad and throw it into the fire,' she said. And the youth *did* catch the toad with a pair of tongs, and did hold the toad in the fire. Then did the toad make a great and a horrible noise; then after a space, was there a flashing in the fire like to gunpowder, and a noise like to that of a pistol. Thereupon was the toad no more seen nor heard.

Being asked by the court, if that after the noise and flashing there was not the substance of the toad to be seen to consume in the fire, it was answered by deponent, that after the flashing and noise there was no more to be seen than if there had been no toad there.

The next day there did come a young woman, a kinswoman of said Amy, and a neighbour of deponent. She did tell deponent, that her aunt (said Amy) was in a most lamentable plight—her face all scorched with fire—though sitting alone in her house, in her smock, without any fire. Deponent Dorothy would not have been woman if, on hearing this strange recital, she had not gone forthwith on a visit of curiosity to Amy, to see generally how matters stood, and to inquire after her health in particular.

She found Amy in the same condition as narrated—her face, legs, and thighs (which last deponent did see) all scorched and burnt with fire; at which deponent did seem to wonder.

Asked of said Amy how she did come to be in that sad condition. 'May thank thee for it; thou the cause thereof. Thou shalt live to see some of thy children dead, and thyself on crutches!'

After burning of the said toad, child recovered—was well again; was living at time of assizes; but about March 6th, x. Caroli Secundi, her daughter Elizabeth, being about the age of ten years, was taken ill like to manner of first child, and in her fits complained much of Amy Duny, saying that she did appear to her and afflict her. One day, having gone out of the house, when she did return, she found said Amy Duny there, and asked her what she did do there. Her answer was, that she came to see her child, and to give it some water. Deponent was very angry with her, and thrust her forth of the doors; and when out of doors Amy said, 'You need not be so angry, for your child will not live long.'

This being on a Saturday, the child died on Monday following. Not long after death of this child deponent became lame of both legs, being fain to go on crutches. The thing remarkable was this: after Mrs. Durent had gone on crutches for upwards of three years, appearing on them at the trial, no sooner had the verdict of guilty been brought in, than, to the great admiration of all persons, deponent was restored to the use of her limbs.

As regards Elizabeth and Deborah Pacy, also supposed to have been under Amy's spells, there was a prodigy too. The elder (eleven) could speak no word, but seemed as one in deep sleep. Lying upon cushions in the open court upon her back, her stomach and belly, by the drawing of her breath, would arise to a great height. The said Elizabeth having lain a long time on the table in the court, she came a little to herself, and sat up, neither seeing nor speaking, but sensible of what was said to her. By direction of the judge, Amy Duny was privately brought to Elizabeth Pacy; whereupon the child, without so much as seeing her, for her eyes were closed, suddenly leaped up and catched Amy by the hand, afterwards by the face, scratching with her nails until blood came.

Mrs. Pacy's evidence being taken, next followed her husband Samuel Pacy, a merchant, a man who carried himself with much soberness during the trial, from whom proceeded no words either of passion or malice, though his children were so greatly afflicted.

Sworn, examined, and deponed that his younger daughter Deborah, upon Thursday the 10th of October last, was suddenly taken with a lameness in her legs, and so continued until the seventeenth day of the same month; which day being fair and sunshiny, the child deemed to be carried on the east part of the house, there to be set upon the bank which looketh upon the sea.

While she was sitting there, Amy Duny came to deponent's house to buy herrings. They were refused, and she went away mumbling—came and denied twice—came and denied thrice. Mumbled something—what, not evident; but at same instant said child was taken with most violent fits, feeling most extreme pain in stomach, like pricking of pins, shrieking in most dreadful manner like unto a whelp.

Continued in this state until thirtieth of same month. Doctor came; could not conjecture what might be amiss. Another child taken ill. Sometimes both children would be lame; sometimes not lame, but deaf. Then would they swound; then recovering, cough and bring-up pins; said pins amounting to forty or more: once a twopenny-nail with a very broad head (nail produced).

Deponent often caused said children to read New Testament. Would read until they came to the name of Lord, or Jesus, or Christ; then before they could pronounce these words they would suddenly fall into fits.

When they came to the name of Satan or devil, then would they be in ecstasies. At such time as they be recovered out of their fits (occasioned, as this deponent conceives, upon their naming of Lord, or Jesus, or Christ), deponent hath demanded of them, what is the cause they cannot pronounce those words. They reply, and say that Amy Duny saith I must not use that name.

The children are next sent for change of air to an aunt (father's sister), one Margaret Arnold. Sworn and examined, saith: Deponent gave no credit to the witch-tales, conceiving that the children might have used deceit in putting pins into their mouths themselves. Wherefore deponent unpinned all their clothes, leaving not so much as one pin upon them. All unavailing. The children raised at several times at least thirty pins in deponent's presence. At some times the children (only) would see things run up and down the house in the appearance of mice; one of them suddenly snapt at one of aforesaid little things, and threw it into the fire, where it did screech.

Once the younger child, being out of her fits, went out of the door to take fresh air, and did open her mouth, when a little thing like to a bee did fly in her face and would have gone into her mouth. Then did the child run in all haste to the door to get into the house, 'skreeking' in a most terrible manner. Then followed swoundings; and then came up the inevitable twopenny-nail.

'How did she come by the aforesaid nail?'

'The bee brought it, and forced it into her mouth. Often bees did come bearing pins, nails, and such-like things between their *teeth!*'

Thus goes on the evidence to farther lengths than space permits me to record, or than circumstances make necessary. Sir Matthew Hale has been stigmatised for the part he took in the trial and condemnation of these Suffolk witches; stigmatised—would it not seem unjustly? A judge has not to make laws, but to administer laws as he finds them. If in Sir Matthew Hale's time there existed an act of parliament against witches, as there did so exist, then, as presiding judge on the occasion referred to, he would really have had no option.

Considering this great judge's private opinion in respect to witches, the confession, I think, must be made that witchcraft, in respect to the amount of credulity which belief in it imposes, does not draw so deeply on the fountains of faith as do certain beliefs in spirits and the doings of spirits which even now prevail. Authority, powerful authority, favoured the belief in wizards and witches; ay, for that matter, the authority exists to this very time, never having been revoked.

'I would have no compassion on these witches,' Luther could say; 'I would burn them all.' Then does Luther expatiate with fervour on the burning of witches, informing us that 7000 witches and wizards were said to have been burnt at Treves; 600 by a single bishop of Bamberg; 800 in a single year in the bishopric of Wurtzburg; 1000 in the province of Como; 400 at Toulouse at a single execution; 500 at Geneva in three months; 48 at Constance; 80 at the town of Valery, in Savoy; and 70 in Sweden. A judge named Remy boasted, that he himself had been the means of putting to death in 16 years 800 witches. Well on to our own time, powerful authority could be cited favouring the existence of witches. 'To give up witchcraft,' said John Wesley, 'is to give up the Bible.' 'From which,' said Dr. Colenso, in a lecture delivered by him at the Marylebone Literary Institution, May 23d, 1865, 'from which also follow a number of similar conclusions, viz. that to give up the date of the creation, the account of the rib turned into a woman, the stories of the Fall and of the Deluge, of the speaking ass, of the sun and moon standing still; to give up *any one* of these as a historical fact, is to give up the Bible; or rather, as some have said, to give up our nearest and dearest consolations, and all our hopes for time and eternity.'

In Sir Matthew Hale's time the belief in witchcraft stood in the same relation to churchmen and philosophers that biblical literalism does now. It was the correct, the orthodox thing to believe in witchcraft then, as it is the correct, the orthodox thing now, to believe in scriptural literalism.

Whilst Sir Matthew Hale flourished, there were many among philosophers who not only did not believe in witches, but spoke and wrote as far as they durst in deprecation of the judicial cruelties practised on the unfortunate victims of such belief. The elder Disraeli in his disquisitions praises old Reginald Scot for the sensible and humane part he took; but he begs the reader to remark, that Scot does not dare to deny the existence of witches.

Dr. Cotta, who lived later than Scot, also took the free-thinking side. The doctor evidently wrote under some restraint. He did not absolutely deny, but asked for information, putting questions which, like many of those put to us by our children, are sufficiently puzzling.

In respect to the image of Samuel raised by the hag of Endor, he does not quite see how Samuel could have come decently clad, except he had taken a tailor with him to 'y^{e} grave.' Then farther adverting to the tenet of faith, that a witch could not drown, because water, the sacred element of baptism, would not hold her, the doctor bows—the Church must know best; but he would humbly like to be informed why the other sacred elements, bread and wine, do not fly from a witch's lips by similar repulsion.

Yet I have no doubt that Dr. Cotta and Reginald Scot taught their babies and their womankind the orthodox thing as to witches. There were nursery picture-cards, no doubt, in those good men's houses, of old women done to death by flame and halter, and prayers against witches for little dears to pray before going to sleep. Better err on the side of safety.

The fact must have struck everybody who has dabbled in witch-lore, that first, there have been far more witches than wizards; second, that witches have mostly been females of a certain age. There *have* been young witches too. Who has not read the wild recital of the Baltic Amber Witch? Nay, I have stumbled on a strange record of the young inmates of a lady's school, thirty-four, turned into witches of the most inveterate kind.

The learned Bodin, acknowledging the fact, accounts for this especial proclivity of women to demoniacal influences. For myself, I do not wonder that the belief has prevailed: it has much to countenance it. If ever human being, at any one time more than at any other time, may be fairly assumed to be, from congeniality, under demoniacal influence, that human being should be a worldly-minded woman at the time when the physical charms of girlhood and womanhood have waned, and nothing lightens the shadow of coming old age, brightens the future, fills it with other hopes, or attunes it to other pleasures.

The beauty of youth who doubts? There is a beauty in old age too; but from one stage of beauty to another there is in woman's life a bridge, whereupon standing awhile the passer-on is like to be possessed by evil spirits. Envy, hatred, and malice, and all uncharitableness, there they are. With Bodin, I marvel not at the belief that has made worldly-minded women of a certain age prone to become witches.

One thing extraordinary in old witch-records is the freedom, even amounting to recklessness, with which certain women accused of witchcraft, and in imminent peril of their lives, were in the habit of giving countenance to the belief. I put aside judicial confessions, many of these, I fear, having been induced through torture, though in records of English witch-trials I find no reference to torture. Apart from this, it really seems that many of the women implicated encouraged the belief from a certain sense of pride, that they might seem more potent than their neighbours. English witches were leniently dealt with by comparison with their sisters in puritan Scotland. There witch-torture was reduced to a system, the particulars of which are known. According to Scotch belief, if the witch were obdurate, the first, and it is said the only effectual, mode of obtaining confession was by 'waking her.' They bound an iron bridle or hoop across her face with four prongs, which were thrust into her mouth, and the hoop secured behind to the wall by a chain, so that the victim was unable to lie down. In this position she was sometimes kept for several days, men being with her constantly to prevent her closing her eyes for a moment in sleep.

Partly to accomplish this, partly to discover the insensible mark, pins were thrust into her body. Then to her tortures they added excessive thirst, it being a saying in Scotland, that a witch would never confess while she could drink. Worse tortures were to come—the pennywinkie, the boots, and the caschielawis. Our English witches, so far as I can discover, were subject to none of these.

Having adverted to Wesley's general belief, it may be as well to give his confession in full:

'It is true,' writes he, 'that the English in general, and indeed most of the men in Europe, have given up all accounts of witches and apparitions as mere old wives' fables. I am sorry for it, and I willingly take this opportunity of entering my solemn protest against this violent compliment which so many that believe the Bible pay to those who do *not* believe it.

'I owe them no such service. I take knowledge these are at the bottom of the outcry which has been raised, and with such insolence spread throughout the nation, in direct opposition, not only to the Bible, but to the suffrage of the wisest and the best of men in all ages and nations.

'They well know, whether Christians know it or not, that the giving up witchcraft is, in effect, giving up the Bible. And they know, on the other hand, that if but one account of the intercourse of men with separate spirits be admitted, their whole castle in the air — deism, atheism, materialism — falls to the ground. I know no reason, therefore, why we should suffer even this weapon to be wrested out of our hands. Indeed, there are numerous arguments besides which abundantly confute their vain imaginations; but we need not be hooted out of one: neither reason nor religion requires this.'

THE END.

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