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VOL. IX.

"NATURAL HISTORY OF CREATION."

"INDICATIONS OF INSTINCT."

"THE ELECTRIC TELEGRAPH."

"LECTURES AND ADRESSES."

THE NATURAL HISTORY OF CREATION.

BY

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TO

WILLIAM SELLER, M.D.

VICE-PRESIDENT OF THE ROYAL COLLEGE OF PHYSICIANS,
EDINBURGH,

ETC. ETC.

THIS LITTLE BROCHURE

IS INSCRIBED

BY

THE AUTHOR.

ADVERTISEMENT.

THERE are certain starting points in the History of Creation which can only be taken as ultimate facts, or miraculous interpositions of an Omnipotent Will. But in the general progress of events we can trace certain fixed principles, in obedience to which general principles details are subject. The following little book attempts to give an outline of them.

The first part of it endeavours to describe the laws by means of which Chaos gradually became fit for the occupation of plants and animals, such as now exist upon it. The succeeding portions treat of that creation which we see daily going on around us, the transference of dead matter into living beings,—the Creation of Life; and I have tried to give a summary account of the general laws that regulate and characterise matter when it is vitalised. I have particularly dwelt upon the constant passage of atoms of matter from the ground to the plant, from plants to animals, and from them back again to the ground, because I am persuaded that until this great truth is recognised and acted upon, we shall never have a scientific agriculture.

I have also treated of the action of causes of disease upon living bodies. I believe that I am guilty of no breach of confidence in saying that I did this at the suggestion of Sir James Clark. I have added a few lines upon the action of external agents in modifying and removing the bad effects of these causes of disease, as I thought such might be useful to any one investigating the subject of modern irregular medicine, now prevalent under so many forms.

T. L. K.

CONTENTS.

NATURAL HISTORY

OF

CREATION.

CHAPTER I.

THE LIVING AND DEAD OCCUPANTS OF THE GLOBE.

EVERY one is familiar with the fact, that water arising from springs flows through rivers into the oceans; that from these oceans it arises into the atmosphere by evaporation, and forms clouds; that these clouds pour forth their water again upon the earth, and that this water distils through the ground to keep up the supply that the rivers derive from the springs. The same water is continually in circulation from the springs to the seas, and back again from the seas to the springs. This has often and very justly been dwelt upon, not only as a very striking instance of design, but also as an illustration of how the different phenomena witnessed in this world are made to depend upon one another. And when we come to examine all the operations both of living and dead matter, we find that *they* are ALL bound up to one another by ties as close as exist between the different forms of water in the spring, the sea, and the atmosphere. To understand even the little of the actions of living bodies that this work aims to teach, it is necessary to have a general idea of the whole natural history of the world.

The first great truth that it seems necessary to state is, that we have every reason to believe that from the time the earth came out of the hands of its great Maker, no fresh matter has been created in it, and none destroyed. This last statement may seem strange; but the seeming destruction of matter, in burning, in putrefaction, or the like, is only apparent, and not real. There is merely a little change in the manner in which the elements composing masses of matter are combined together, and no waste. Thus, when we throw a log of wood upon the fire, it is not that the heat and blaze render what was something, nothing; but the compact wood is changed into ash, and into gas that goes up the chimney, and which gas will, in all probability, soon form part of another piece of wood. In like manner, when man was made, it was not that he was formed from nothing, but "he sprang out of the dust;" and when the time has come for the spark of life to depart, and for the frame to decompose, it is not that its elements disappear from the world, but "they return to the dust." Constant change, but never destruction, is the universal rule.

The researches of modern science enable us to have a pretty accurate knowledge of the various successive changes that have taken place upon the world since it was first launched into space. At this early day, if any beings besides Him whose word made it from emptiness were connected with it, they were incorporeal spirits, free from matter. The globe had neither animals, nor verdure, nor soil; and yet it contained within itself every bit of matter that was to form the whole substance of all the soil that has ever been, of all the plants that have ever grown, and of all the innumerable generations of animals that have ever lived. The surface of the earth was in all probability a mass of bare rock, rivers, oceans, avalanches, and volcanoes. There is something almost terrible in the picture we are led to form of the world at this date, sullenly rolling on through its allotted space, with none of the associations that we now connect with it save sounds, and those sublime and terrible ones,—the hissing of the water as the volcano ejected its vast and molten mass, the roaring of the cataract down the naked rocks, the booming of the uninhabited ocean, and the crash of the falling avalanche.

Having stated that every atom of matter now present in the world, as it exists at present, with its inhabitants, its animals, its plants, its soil, and everything underneath its soil, was present from the beginning, it seems proper to add what is ascertained regarding this matter. It is found that all the substances present in the creation that can be examined by man (that is, the air, and the substances on and near the surface of the earth), notwithstanding they are so very numerous, and apparently so very different, nevertheless consist of different combinations of a very few elementary substances. An elementary substance, of course, implies one that cannot be separated into two. Thus, by a little management,* water, long regarded, and very naturally, as one of the elements, can be divided into two bodies, to which chemists have agreed to apply the names of oxygen and hydrogen. Do, however, what the chemists like, they cannot separate either of these two latter into anything more. It is therefore usual to call them, and others which, like them, cannot be separated into two, elements or elementary bodies.

The number of substances usually regarded by chemists as elementary in their nature, is about five and fifty. Of these, many occur so rarely that they are of no consequence to any save the professed chemist. Of the remainder, several are of comparatively little importance; and to the general student, particularly to one principally bent upon knowing a little regarding the past and present state of the globe, only some thirteen require to be taken into account. The greater part by far of the surface of the primitive world was made up of them and their combinations; and so likewise of them the surface of the present world, and the structure of the animals and plants formed out of it, are composed. We can do no more here than indicate the names of these elements.

Oxygen is the most important of them. It constitutes more than a fifth of the air that surrounds the globe; eight-tenths of all the water, fresh and salt; an immense proportion of the substance of man, animals, and plants; and at least one-third of the soil and subsoil as far as we are able to go. Yet it rarely or never exists alone, but always combined with some one of the other elements. When combined with one other element, it is called an oxide, if not sour; but, if sour, an acid. But it frequently combines with two or more other elements, and such compounds often receive an arbitrary name, as starch, wine, &c.

Carbon is, perhaps, the element next in importance to oxygen. It entirely composes the diamond, is the main ingredient in coal, and is present in the extensive chalk hills that so often constitute the geology of a country. But it is in the air, and in the substance of man, animals, and plants, that it most preponderates. And, although it is anticipating, we may mention that there is little doubt but that the air of the early world contained much more carbon than the air of the present one, and that this early air parted with its carbon to the animals and plants, as these latter began to multiply, and was, indeed, the main means of building up their structures.

Oxygen and carbon are very much disposed to combine together. When they do so just by their two selves, they usually form the compound called carbonic acid. This is, in an uncombined state, a gas, and is always found when fuel (fuel is always a substance rich in carbon) is burned in air (which, as we said, contains oxygen). Carbonic acid, in its turn, combines with other substances, as lime, soda, and so forth (substances immediately to be noticed); and such compounds are called carbonates, as, for example, carbonate of lime, or carbonate of soda.

Hydrogen is a third and abundantly occurring element. It constitutes a considerable portion of most animal and vegetable substances, and is one of the two elements of that, to us, all-important fluid, water.

This compound, water, is composed of equal equivalents (a chemical word of no matter to us just now) of oxygen and hydrogen. Its appearance and common properties are familiar to everybody.

Nitrogen, or azote as it used to be called, is another element, but by no means so abundant as the other three we have named. It exists in large quantities in the atmosphere, is present in the crust of the earth, and is essentially present in most animal structures, and in a great many vegetable ones.

Nitrogen is very much inclined to unite with hydrogen, and the compound so formed is well known by the name of ammonia. Whenever substances containing these two elements of nitrogen and hydrogen (as is the case with most animal and vegetable structures) become subject to putrefaction, this ammonia is invariably produced. Oxygen is another element for which nitrogen has a strong affinity; and the commonest and most important compound of these is nitric acid, or aquafortis. This compound is very fond of forming other compounds with various substances, and chemists have agreed to give to such the name of nitrates.

We say nitric acid is the most important chemical compound of nitrogen and oxygen. This may seem strange when we recollect that the atmosphere so essential to our being is composed of these two; but it is generally supposed that they are in a state of mixture, that is, mechanically united only. Every hundred parts of pure air contain twenty-one parts of oxygen, and seventy-nine of nitrogen. But, in point of fact, air never is thus pure. It always contains a considerable quantity of carbonic acid; and it is believed, with great probability, that this proportion was, in the world's younger days, much greater than it is now, or indeed has been for a long time. Air, too, always contains some watery vapour, and now-a-days always some ammonia, which has escaped into it from decomposing animal and vegetable matters. But, of course, if we are correct in saying, that, in the early periods of the world's history, neither animals nor plants had a being, originally the earth's atmosphere would contain no ammonia.

Another elementary body is sulphur, or brimstone as it is commonly called. It exists pretty extensively in nature. With oxygen it forms the compound known as sulphuric acid, or oil of vitriol. The compounds which this sulphuric acid form are called sulphates.

Phosphorus is another body which is always considered as an element. With oxygen, it forms phosphoric acid; and the compounds of phosphoric acid are called phosphates. Other elements are potassium, whose compound with oxygen is called potash; sodium, which by uniting with oxygen affords us soda; calcium, the oxide of which is lime; aluminum, which by joining with oxygen, &c. gives us clay; silicon, whose acid or oxide is called sand; iron; and chlorine, the compounds of which last are called chlorides.

Such were the elements of which the atmosphere surrounding, and the surface and crust of, the primitive world mainly consisted. With the exception of a little native iron, none of them, or scarcely any of them, were in an uncombined state. The rocks that formed the surface were composed probably of sulphates, nitrates, phosphates, and chlorides of lime, soda, potash, magnesia, and alum. Very probably they were at first in a condition that would present a hard surface to the atmosphere. Just in fact such a surface as we see now-a-days in the face of a newly-cut quarry. But it is found that, when such a surface is exposed to the air and to moisture (particularly, too, when carbonic acid is present, as we have reason to believe was the case in the earth's early atmosphere), it gradually becomes disintegrated, and crumbles down into a powder. When this was first done to the surface of this world, the first step was made to the formation of a *soil.* Had at this period of the globe's history a spirit, wonderful even for its intelligence, inspected the surface, it would scarcely have been able to conjecture that, out of that apparently insignificant crumbling mass, the great Designer intended to form millions of generations of myriads of living plants, and living and sensitive animals.

It is proper to consider what would be the chemical constitution of this fragmentary covering of the hitherto previously naked rocks. It was, doubtless, various compounds of sulphur, phosphorus, potassium, sodium, aluminum, calcium, silicon, chlorine, and iron. It would have moisture mixed with it, which moisture would consist of oxygen and hydrogen. The atmosphere immediately surrounding it would furnish plenty of nitrogen and carbon.

The creation of an immaterial spirit is so above our comprehension, that we cannot understand anything regarding it. This we are told was the first creation,—the creation of Mind. Then we come to that great, and to us equally incomprehensible act,—the creation of Matter. In this period of our consideration of the world's history, we arrive at another great and miraculous creation,—the creation of Life.

We cannot define spirit, we cannot define matter, nor can we define life. We can only look at certain results and properties. The greater part of the matter of this world is, as it once all was, subject to the laws of chemistry; a portion of it now is subject to other laws,—the laws of life,—which oppose, detract from, and add to the laws of chemistry. Matter, in this state, is said to compose the living kingdom of nature; and the objects of this kingdom are well known by the names of plants and animals.

The first created living material being, belonged, it is believed, to that class of plants called cellular, and of which lichens and mosses are familiar examples. In all probability it was a lichen or a moss that first inhabited this earth. Whichever it was, its creation, as well as the subsequent creation of every new kind of plant or animal, must be considered as a miracle. The creation of life was as wonderful, and as impossible to proceed from nothing, as it was for matter to spontaneously arise from nothing.

The difference in the habits of lichens and mosses, as compared with most other plants, is, that they require to have very little hold for their roots, and that they are nearly all leaf, or at any rate something corresponding to leaf. Now the function of the leaves is to take carbonic acid, to separate its elements, and to add the carbon to its structure, returning the oxygen to the air. The lichen would do this, abstract carbon from the air around it (which air contained an excess of carbonic acid), and fix it in its structure. From the soil, or rudimentary soil, it would obtain sulphur, phosphorus, silicon, potassium, sodium, calcium, chlorine, and iron. From water and air, it would obtain oxygen, nitrogen, and hydrogen.

In a word, it would procure a supply of its twelve component elements, which it would convert into its own structure.

After it had obtained so much of all these, and attained so great a size, in obedience to a law soon to be alluded to, it would perish, and its structure rot. All the elements it had obtained from the ground, it would now restore to it. It would also, most probably, during its putrefaction, give ammonia to the ground, and its carbon, oxygen, and hydrogen would unite to form a substance now-a-days called humus.

Now, when the surface of the earth is covered with a crumbling mass containing sulphur, phosphorus, potassium, sodium, calcium, aluminum, iron, and chlorine, or rather compounds of these with one another, and also ammonia and humus, we have what we call soil, and that kind of soil which a farmer would say will grow anything.

There is every probability that other species of plants were afterwards created; first, those belonging to the endogenous division of botanists, of which we may instance as members the grasses; and afterwards those belonging to the more complex exogenous one, such as oaks and so forth. But there is no evidence, but the contrary, that a cellular plant was ever transformed, or, to use the fashionable word, developed, into an endogenous one, or an endogenous into an exogenous. On the contrary, the only deduction that sound philosophy warrants us in drawing is, that the commencement of every species was produced by an act of the Divine Will—that is, was miraculous. All species of plants have the power of perpetuating their kind; and they would gradually increase and multiply, and more and more of the structure of the earth, that a little before had been bare rock, would pass into the vital world. Moreover, as every year additional plants would be there to die, and become rotten, more humus (and probably more ammonia) would be added to the soil, which would thus become more and more fertile, and this fertility would become increased by the addition of fresh sulphur, phosphorus, potash, &c., from the gradual decomposition of the subsoil.

When a sufficient quantity of forage had been formed, we have a right to conclude that animals would be created. Geologists have been enabled to point out even more details regarding the history of the globe. The surface of the earth, they have discovered, is composed of various formations, as they are called, that have been deposited one after the other. Three of the earliest of these are called the gneiss, the mica-slate, and clay-slate beds. In these no remains of either plants or animals are found, and the time of their formation must be referred to that period that we have described as the first formation of most of the soil by the disintegration of the rock. Next to these come what are often called the transition formations, — coal measure, and red sandstones. These all contain remains of living beings, both animals and plants. The vegetable fossils are those of trees and other plants of large size, all of which are now quite extinct. The animal fossils are shell-fish, zoophytes, crustaceous animals, and a few fish, but no amphibious animals, birds, or quadrupeds. The next formation, in order of time, is the oolite. In this we first find amphibia. Twenty-nine species of these, all now extinct, are known to have dwelt in this formation — among whom are the ichthyosaurus, the pterodactylus, &c. It is probable that the vegetables had not yet cleared the air of its original excess of carbonic acid; and to this day the amphibious animals are characterised by being enabled to live in such an atmosphere. We also find in this formation the remains of a quadruped of the opossum tribe.

The appearance of this opossum animal is an anomaly; for in the next formation, to wit, the chalk, we find no quadrupeds. But in those over the chalk, and which are sometimes called the *tertiary*, there are plenty of remains of both birds and quadrupeds. Then we come to the formation at present going on, called the alluvial; and in it of course we find remains of our own species, man, just as our descendants will find our remains.

Two things should be observed. The structure of the first created animals must have been derived from the vegetables that had obtained theirs from the soil. Afterwards, the carnivorous animals would derive theirs from vegetable-feeding animals. But, ultimately, both carnivorous and vegetable-feeding animals return their structure to the soil. Thus the chemical elements forming the crust of the earth are in a constant state of transition from soil to plant, from plant to animal, and back again from animal to the soil: and thus the expressions, formerly so obscure, that "out of the dust man was formed, and to the dust he returns;" and "all flesh is grass," are intelligible. Farther, as the number of vegetables and of animals is constantly increasing, dead matters obtained from the subsoil are daily becoming vitalised and entering into living structures. It will also be observed, that spirituality and life are two quite different affairs: first (of course we are speaking only as far as this globe is concerned), we have the creation of matter, then of life; but not until man is made is there added, to the union of matter with life, Spirituality.

A few more general principles must be cursorily noticed. All living bodies differ from dead ones (*i. e.* the chemical elements under the control of the laws of vitality differ from those identical elements when under the control of the laws of chemistry and mechanics) in some very important particulars. In the first place, dead matter (as a stone, a piece of mud, ammonia formed from the decomposition of flesh once alive, but now dead) presents a homogeneous structure. On the contrary, all living bodies possess organs, each of these organs performing certain functions; as the heart driving the blood, the root taking in food, and the like. Then, every living being, whether an animal or plant, springs from its parent; obtains its structure by appropriating and assimilating surrounding matter; and, finally, every one of them, invariably, after a time, dies, and then their structures return to the dead or inorganic world.

As long as this vitality exists in an animal or plant, it is necessary that certain conditions be present. First and foremost, it is essential that every animal and plant have a nutritious fluid, which is called sap in plants, blood in animals; and this nutritious fluid parts with its substance, and adds it to the structures of the frame of the being to which it belongs. This, of course, implies a constant diminution of this nourishing fluid, and this waste must be made up by a constant supply of matter from without. This matter is commonly called food. Then, the nourishing fluid must be regularly exposed to the air at the lungs, gills, leaves, &c., and be acted upon by the air in a manner to be afterwards explained. Heat and light are also necessary to the continuance of vital action.

The great difference between animals and plants is, that the former have a nervous system, and therefore feel, and usually they also have the power of locomotion. The food of plants, too, must be derived from the inorganic world, while that of animals must be previously organised matter. Thus, if we give a dog a pound of beef it nourishes him; but it would afford no nourishment to a turnip plant. But if we let this same piece of beef become quite dead and changed into inorganic ammonia, and give this to the dog, it does not nourish him at all; but if we put the same to the turnip, it makes it grow exceedingly. The immense importance of this principle will, in the course of the following pages, become very apparent to us.

CHAP. II.

THE WAY THE BLOOD IS CIRCULATED.

THE ancients were ignorant of the true courses taken by the blood through the human body. Their opinion regarding it was, that the fluid moved backwards and forwards through the veins; while they thought that the arteries were filled with air, or some imaginary subtle aëriform fluid. It was Harvey, in 1616, at London, who first found out and taught the real circulation of the blood. This is from the heart to the arteries, through these to the capillaries, hence to the veins, and from the veins back to the heart, and again to the arteries, and so on. In man there are two circulations—one for the purpose of sending the blood to all and every part of the body, to part with its own substance to nourish the body, and called the greater; and the other for the purpose of exposing the blood to the air at the lungs, and called the lesser. In reality, these are nearly independent of one another; but, as the organs performing both are as a matter of convenience in the human subject joined together, it is almost impossible to describe them separately. It is this that renders the whole subject of the circulation sometimes difficult to beginners; but if our readers will endeavour to keep in mind the fact that there are *two* circulations carried on in the body, we do not despair to render the whole sufficiently clear.

The blood, or fluid circulated, first, however, demands our attention.

The sap, or nutriment fluid of plants, has for its basis either sugar or starch. The blood of animals has for its, albumen, or the same substance of which the white of egg is composed. With the appearance of freshly drawn blood (blood in the body is the same) every one is familiar. It is a clear red fluid, much warmer than the surrounding air, and a good deal heavier than water. After it has been abstracted a little time from the body, it separates into two parts, one a watery, called a serum, the other a clot, to which the name of crassamentum is given.

As before mentioned, the basis, as it were, of blood, is a compound substance, on which the name of albumen is conferred. It is composed as follows:—

Carbon	53
Oxygen	23
Nitrogen	15
Hydrogen	7
	98

The blood, in virtue of its containing these four elements, can supply them to the body; and, as by far the greater part of the body is composed of these four, we can understand that albumen should be the base of the blood. But while these elements preponderate in our structures, our bodies likewise contain potassium, sodium, calcium, magnesium, iron, sulphur, phosphorus, and chlorine. Our system can only get these from the blood; and we would, if otherwise ignorant, have inferred their presence in this fluid. But we now know by direct analysis that they are every one of them present; and we shall afterwards see how the blood receives a daily fresh supply of them.

It is, we should observe, believed, that the albumen of the blood is not at once converted into animal tissue; but that it is first converted into another compound of the four elements carbon, oxygen, nitrogen, and hydrogen, but in somewhat different proportions, called fibrine. The blood also contains ready-made oil or fat, the uses of which will afterwards be considered. The blood, then, contains albumen, fibrine, oil, and different compounds of the dozen elements we have so often enumerated.

If we examine the blood immediately after it has been taken from the body with a microscope, we find that it consists of a clear fluid, with a number of globules suspended in it. These globules are improperly so named, because, so far from being round, they are flattened disks.

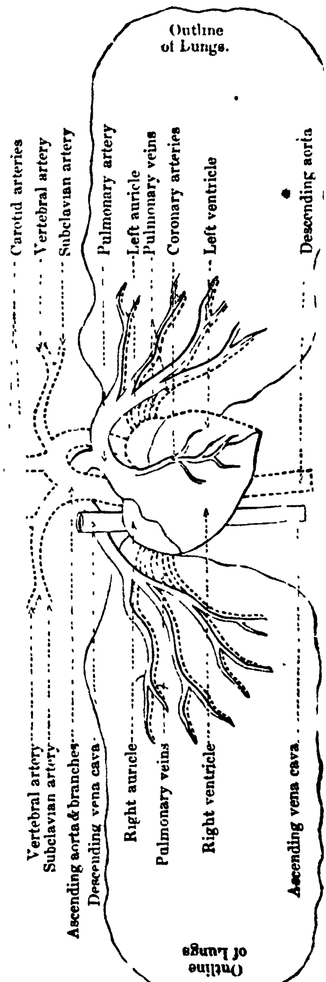
Their diameter varies from the one three-thousandth to the one four-thousandth of an inch. They are remarkable for their flexibility and elasticity, and can pass through a channel less than themselves, and subsequently regain their proper shape. The proportion that these globules bear to the rest of the blood varies in different individuals, — being usually greater in males than in females, and in stout, robust people than in delicate and weakly ones. It also varies in different individuals at different times, according to the state of the health. A deficiency of globules is indicated by lassitude, weakness, and a remarkable degree of pallor in the countenance. The iron in the blood is contained in the globules; and it is found that this deficiency of globules in the blood is cured, at least very often, by administering some preparation of iron.

The coagulation of the blood depends upon the fibrin separating from the serum, and the globules attaching themselves to it. It is by virtue of this power of coagulation that we do not bleed to death every time we receive a cut. When such an accident happens, the blood that is adhering to the edge of the wound gradually stiffens and forms a plug, which hinders any more bleeding. The rationale of putting on a bandage is, to prevent the plug of coagulated blood from being washed away by the pressure of the current of blood from behind. There is a diseased condition, fortunately not common, in which the blood either does not coagulate, or does so very imperfectly. Strangely enough, this seems to be hereditary; and one instance of it is on record in which, in one family, four of one generation and three of the succeeding died from bleeding after trivial injuries.

This property of coagulation of the blood depends upon the blood's vitality, and is not found in cases where the death of an individual has been very sudden. Thus, when a person dies of any ordinary disease, the blood is found coagulated in the heart and great vessels; but if life has been extinguished by something very violent, as in cases of death produced by a stroke of lightning, or extreme mental emotion, it is found to remain quite fluid.

Having now obtained some general notion of the nature and properties of the blood in general, we may proceed to state, that in the human body two varieties of blood are always present, to which the names of arterial and venous are given. The arterial blood is the more perfect of the two, and is just in the act of going to the different parts of the body for the purpose of nourishing them. The venous is the somewhat exhausted blood, that is returning from nourishing the different parts of the body, and going to the lungs, to be there exposed to the air to get a supply of oxygen. Arterial blood is scarlet, contains more oxygen and less carbonic acid, has more fibrin and crassamentum, and coagulates much more strongly than venous blood. Venous blood is of the colour called by painters Modena red. There is nearly three times as much venous blood in the body as there is arterial.

Then, with regard to the circulation of the blood in the human body: first, we may observe that the organs of circulation in man are the same as those of sheep, pigs, &c., and any one can obtain a perfectly accurate idea of the anatomy of the human organs of circulation by examining those of these animals. These organs may be divided into the heart, the arteries, the veins, and the capillaries. The annexed diagram gives a correct representation of the heart, great arteries, and veins, and an ideal one of the capillaries.



The heart is about the size of the closed fist, and is situated between the lungs, at the left side of the chest. It is a hollow muscle, with four chambers or cavities; or, to speak more correctly, it is two hollow muscles (each with two chambers) joined together; that at the left side is for the purpose of propelling the blood in the greater circulation, while that lying more to the right aids in propelling the blood to the lungs in the lesser circulation. These chambers are called auricles and ventricles, and the communication between each auricle and its respective ventricle is defended by a valve, which, while it allows any fluid to pass from auricle to ventricle, effectually prevents any flow in the opposite direction. From the auricles and ventricles the great vessels will be seen to proceed.

Foremost among these great vessels are the arteries, which, with the exception of the coronary artery, are all branches and sub-branches of the aorta. They are flexible, elastic, and cylindrical strong tubes; they penetrate to every part of the body, and the smaller branches anastomose very freely with one another. These latter terminate in—

Capillaries, or hair-like tubes, so called from their extreme minuteness. It is in these that the nutrition of the textures takes place. They form a network that envelopes, as it were, every part of the body. So numerous, indeed, are they, that we cannot run the finest needle into any part of our frames without breaking some of them and causing them to bleed.

As the smaller arteries terminate in capillaries, so the smaller veins may be said to originate in them. Like the arteries, the veins are elastic and cylindrical tubes. The smaller ones freely anastomose together, and gradually unite so as to form larger ones, until the whole are centred in the two venæ cavæ. The veins are provided with valves that prevent any regurgitation of the blood back from the veins into the capillaries.

We can now understand the true course of the blood. We will begin with it in the arterial capillaries. Here the blood is arterial, and in every respect qualified to nourish the body. In these capillaries it parts with as much of its fibrin and other constituents as the part it is at may stand in need of. During this process it becomes a little debilitated and spoilt, and gets charged with carbonic acid (where the carbonic acid comes from will be afterwards explained). It then passes on to the smaller veins, and going gradually along them gets into the two venæ cavæ. From these it passes into the right auricle, and from it to the right ventricle. The right ventricle sends it along the pulmonary artery, which, by its branches and subdivisions, carries it to the capillaries of the lungs. Here it meets with the air, gives off its carbon, and takes in oxygen, and becomes arterial blood once more. It then passes by the pulmonary veins to the left auricle, from this to the left ventricle, and from this to the aorta, which, by its subdivisions, carries it to the arterial capillaries, where we commenced with it.

Whenever the blood enters into any of the chambers of the heart, the cavity contracts, and of course squeezes the blood out of it. All these chambers are provided with valves, which prevent the blood from flowing in any other direction than the one we have described, and consequently each contraction of these cavities propels the blood forward. The contractions of the cavities of the heart serve to tilt its apex forward, and cause it to strike underneath the sixth rib. It is popularly called a beat. About sixty or seventy of these beats take place in a minute. Each time the left ventricle contracts, it drives into the aorta about four table-spoonsful of blood. The force exercised is calculated at about fifty pounds, and the velocity of the blood leaving the heart is supposed to be about a hundred and fifty feet a minute. In the larger animals the velocity of the circulation has a magnitude that we can scarcely conceive. Paley says that the aorta of a whale is larger than the main-pipe of the water-works that then were at London Bridge, and that the blood rushes through it with greater impetus than the water rushed through that pipe.

The heart has little or no sensation. In cases of injury or disease, it has been so exposed as to allow people to handle it, and the touch of the hand upon it is not felt. But, strange as it may seem, it is a familiar fact to all of us that it is powerfully affected by strong mental emotion. Indeed, it is affected by almost every change in the body, and doctors, by ascertaining its state, which they do by feeling the pulse, can often obtain a very good idea of the state and condition of other organs. The pulse, we should state, is produced by the column of blood propelled onward by each contraction of the ventricle striking against the elastic artery.

That the account we have given of the course of the blood is the true one, is very certain. Among the proofs of it we may mention, that in cases of injury the auricles, ventricles, and great vessels have been observed to contract in the order stated. In the translucent animals the blood may be clearly enough seen to pass from the arteries to the capillaries, and from these into the veins. Again, if we tie a ligature around an artery, the artery becomes distended with blood upon the side nearest to the heart. But if, on the other hand, we tie one around a vein, the swelling takes place upon the side farthest from the heart. Lastly, the valves of the heart freely permit the blood to flow in the order stated, but effectually prevent it in any other. It was the observation of this fact that first put Harvey upon the right track regarding the circulation of the blood.

The main cause of the motion of the blood is the contraction of the heart. Other causes, however, that we need not here enter into, influence the circulation. As an example of other causes affecting the local circulation, however, we may instance the phenomenon of blushing.

In this a mental cause produces an increased circulation of the capillaries of the face.

The vigour with which the circulation is carried on, and the facility with which it is excited, vary very much in different individuals. In some, all the actions of the heart are performed very forcibly, and a very slight cause greatly increases the rapidity with which the blood is made to rush through the body. Individuals so situated, when they have light hair, have many characters in common both of mind and body, and are said to have a sanguine temperament. If, however, their hair be black, their temperament is named the choleric. On the other hand, in some the functions of the circulation are very feebly performed, and roused with difficulty. When this is combined with light hair, we have the phlegmatic temperament, and when with dark hair the melancholic. Formerly much more attention was paid to this subject of temperaments than now. Still, the theory is based upon truth, and the reader will have no difficulty in understanding the corporeal and mental characteristics, and finding instances of the sanguine, the choleric, the phlegmatic, and the melancholic temperaments.

CHAP. III.

THE WAY THE BLOOD FORMS THE BODY.

THE most striking illustration of the property of nutrition is, perhaps, the growth of the body from the size of the infant to that of a full-grown man. All this increased matter has of course been derived from without, and there is no doubt but that this matter from without is first added to the blood, and that the blood then parts with it to the different portions of the frame. But even in the full-grown man every part is continually receiving nourishment, for every part of it is continually wasting. Wonderful as it may seem, the startling phrase "we die daily," as applied to our physical frames, is scientifically true.

We have seen that the dead matter of the ground passes into the plant, and then into the animal, and that this matter then ceases to be under the influence of the laws of mechanics and chemistry, and becomes subject to those of life. We have also seen that the time comes when every living being, animal or plant, must die. These laws of life are necessarily transitory, and after death those of mechanics and chemistry again assert their sway. But, in animals, the matter composing their structure cannot maintain its vitality for the duration, or anything like it, that it has pleased Him who made us to assign. Were there no provision made for the gradual death, and separation of the dead matter, there is not one of us, perhaps, could live three weeks. The finger of the young man of twenty has probably in that short time been renewed several successive times. It is supposed that the whole body is changed about once in three years, and many parts of it are cast off and renewed much oftener. Should this change, from disease, not be made, the matter retained acts as a deadly poison, and very speedily kills.

In man the whole frame (or nearly so) is permeated by little vessels called absorbents, whose duty it is to take up every particle of matter that has become too old. All these effete matters are poured into the blood, and the blood gets rid of them at various organs. The lungs cast away used-up carbon, the kidneys nitrogen, sulphur, potassium, &c., the liver more carbon and iron; and the skin and other organs likewise assist.

Now, all this continued absorption, and the body never becoming any less, implies continual nutrition. The blood is able to afford a new supply of these elements, because it, as we shall see in Chapter V., is itself daily getting a fresh stock of them by the food. It is believed that all the tissues and secretions of the whole body are formed in the blood, and separated by the vital power in the capillaries of the part that wants them. It is supposed, for instance, that the blood parts with a piece of bone at the growing bone, with bile at the liver, with flesh among the muscles, and so on.

Two simple elements never unite together to form an animal proximate principle or tissue. There must be at least three, and usually there are more. These original proximate principles unite together and form organs. Thus, phosphorus, oxygen, and calcium unite together, and form bone; other elements are made to unite together to form albumen, fat, and several others, and these being joined together make a hand. It will be useful here to consider the composition and properties, first, of the more important proximate principles, which are the products of nutrition from the blood; and then those of the principal compound textures and secretions formed out of the blood.

All the proximate animal principles admit of a very convenient and philosophical arrangement into three divisions. The first one is called the saccharine; and the members composing it consist of carbon, oxygen, and hydrogen, and the two latter are in the same proportions that they are in water. The second one is named the oleaginous; and the compounds included in it likewise consist of carbon, oxygen, and hydrogen, but the two last-mentioned elements are *not* joined together in the same proportions as they are in water. The third class is the albuminous; the objects composing it contain carbon, oxygen, hydrogen, and about fifteen per cent. of nitrogen, and usually some phosphorus, sulphur, sodium, &c. &c.

When we have to consider the subject of food, we shall have occasion to notice that the principles formed by plants out of the sap may also be divided into three groups; and that, indeed, a great many of the proximate principles are common to both animals and plants.

While plants, however, have many instances of saccharine proximate principles, animals have only one, and that, too, only exists in milk,—sugar. Sugar of milk is not exactly identical in composition with cane sugar. It is composed of

Carbon - - - - -	45
Hydrogen - - - -	6
Oxygen - - - - -	48
	99

In the state that it exists in milk it is not susceptible of fermentation, but the action of acid upon it renders it capable of undergoing this process. The Tartars, who cultivate no crops, and consequently who have neither wine nor beer, make themselves an intoxicating drink by allowing the milk of their mares to become sour. Sugar of milk has by no means the sweet taste of cane sugar, and hence probably it is that the homœopathists use it for composing the substances of the greater part of homœopathic globules.

The oleaginous group comprehends all animal fats and oils. They, properly speaking, consist of two nearly identical principles,—margarine or stearine, and oleine. The following is their composition: —

	Margarine.	Oleine
Carbon - - -	37	39
Hydrogen - -	37	36
Oxygen - - -	4	5

Margarine is solid, oleine fluid; in other respects they are almost identical. The solidity of the compound fats is pretty dependent upon the proportion they contain of these two principles. Thus, mutton suet contains about ten per cent. less oleine than olive oil does. The uses of fat are to preserve symmetry and obviate the effects of pressure. But another important purpose that they are put to is, to furnish a supply of food to keep the body warm, as will be explained by-and-by.

Among the albuminous proximate principles we will first mention albumen itself, the one that gives a name to the division. The best example of it is to be found in the white of an egg, which is nearly entirely composed of it. Whenever albumen is heated up to 180°, it coagulates. We have an example of this in the solidification of the white of an egg when the egg has been boiled. Certain acids produce a similar effect upon it, and by means of these two tests we may always distinguish albumen. The following is the chemical composition of albumen: —

Carbon - - - - -	55
Oxygen - - - -	21
Nitrogen - - - -	15
Hydrogen - - - -	7

Casein is another albuminous proximate principle, very similar to albumen. Like that substance, it coagulates when certain acids are added to it. When so coagulated, and properly prepared, it is called cheese. Its composition has been stated as follows:—

Carbon	59
Oxygen	11
Nitrogen*	21
Hydrogen	7

Fibrin is an albuminous proximate principle, formed out of albumen for the purpose of forming the animal tissues, of most of which it forms the basis, or skeleton, as it were. It is thus composed:—

Carbon	52
Oxygen	23
Nitrogen	16
Hydrogen	7

The remaining albuminous proximate principle is called gelatine. Of this, glue is an impure example. It is characterised by its ready solubility in hot water, by its forming a tremulous mass when cold, and by its uniting, with a vegetable principle called tannin, to compose leather. Its composition is this:—

Carbon	47
Oxygen	27
Nitrogen	16
Hydrogen	7

Having now obtained a notion, first of the simple elements that enter into the composition of the human

* The proportion of nitrogen is probably overstated.

body, and next of the compounds that they first of all make, we must go on to consider the still more complex compounds that the farther union of these compounds with one another give rise to. We will begin with

Bone. — This hard dense substance constitutes what is called the skeleton. This skeleton is the foundation, as it were, of our structures; it gives the general form to the body, and serves to afford points of attachment to the muscles, tendons, &c. It likewise protects delicate internal organs from the effects of pressure or external injuries.

The bones of a healthy adult contain thirty-three per cent. of fibrin, albumen, and gelatine. The other sixty-seven per cent. is composed of more than fifty per cent. of phosphate of lime, about ten of carbonate of the same substance, and smaller quantities of magnesia, chlorine, iron, and silicon. In youth, however, the proportion of fibrin, albumen, and gelatine is greater, and in old age less, than this. The structure of the bones, like that of the rest of the body, is constantly changing; the vessels near it taking away effete matter, and the arterial capillaries depositing new osseous substance wherever it is required. If any of our bones be broken, and we can keep them unmoved so as to prevent irritation, the deposition of fresh osseous matter at the broken parts soon makes them unite together again.

The inside of some of the bones is lined with marrow. This substance scarcely seems to be vital. It is oleaginous, and composed of a mixture of stearine and oleine.

Cartilage, or *gristle*, only differs from bone in containing a much greater proportion of fibrin, albumen, and gelatine, and less of the other ingredients just stated to form part of bone.

Cellular tissue, and *fat,* are very common. The former lies underneath the skin, between muscles, surrounds the blood-vessels, and in fact finds its way nearly everywhere. It is composed of cells, which, however, freely communicate with one another; and it is always lubricated with a little serous fluid. It is strong, but soft and flexible; and it is intended to hold those parts of the body together that would be injured by strong constraint. It contains gelatine; and the fluid that keeps it moist is the same as the serum of the blood.

Whenever, as is the case in a great many parts of the body, the cells of cellular tissue are filled with animal oil, we have adipose tissue, or fat.

Fibrous and *serous membranes* contain albumen and gelatine. The former is very strong, and connects bones and joints together. The latter envelopes all the internal organs.

Mucous membrane is another important texture. It lines the mouth, stomach, &c., and secretes a fluid called mucus, that serves to shield the membrane from the injurious effects of acrimonious substances. Mucous membrane and mucus contain a great many substances.

Glands and *their secretions* next demand our attention, and are a very important subject. We have seen that it is in the capillaries that the blood parts with its contents. When this nutrient fluid is merely separating from itself the elements necessary for keeping up the structure of the frame, no particular arrangement of the vessels is necessary. But when the matter secreted is either to serve a farther purpose in the economy, or to be excreted as a poison, the blood-vessels destined to do ether of these are packed together in various ways. Now the name given to such packed vessels is glands.

There are in the human body a great many different kinds of glands. Some of these secrete substances which are intended to serve a purpose in the living body. Among these we may enumerate the wax-glands of the ear, which secrete wax to keep insects from creeping into this delicate organ; those that secrete tears to moisten the eyeball; those that secrete the saliva, the gastric juice, &c. On the other hand, there are some glands at which the effete elements of the body are separated, and which effete elements are afterwards removed from the system. The most important of these are the two kidneys, which separate the used-up nitrogen, potassium, sodium, phosphorus, calcium, magnesium, silicon, sulphur, and chlorine. The liver secretes the excretion called bile. Bile contains a peculiar principle composed as follows:—

Carbon	54
Oxygen	43
Hydrogen	1

This analysis instructs us in the fact, that one use of the secretion of bile is to remove decayed carbon.* Bile also excretes effete iron from the constitution. It likewise excretes, but in small quantity, some of the other elements that enter into the composition of the body.

* In so rudimentary a little book as this, any allusion to other supposed uses of the bile would be out of place. Whether true or not, they are not generally received.

But although the liver rids the system of some spoiled carbon, the glands that, in the human adult, discharge from the body by far the greater quantity of it are the lungs. When we examine the lower animals, we find that the development and the activity of the lungs and of the liver stand in an inverse ratio to one another. Insects have not, indeed, any lungs like ours, but they have an amazingly large and active respiratory system, and scarcely any liver at all. On the other hand, in molluscous animals, we find the respiration by lungs carried on in a very imperfect kind of way, and they have most enormous livers.

When we come to speak of the way people breathe, we shall have occasion to give an outlined account of the lungs. Here we only desire to state the nature of the excretion that takes place from them. Every time we breathe, we send a stream of gas and vapour into the air. The gas is carbonic acid, and the vapour that of water. A full-grown man in this way gets rid of about ten cubic feet of carbonic acid, containing about five and a half ounces of solid carbon, in the course of a day. This carbonic acid is poisonous; but it is removed from the atmosphere by plants, and by them converted into starch and sugar. Animals eat these, and convert the carbon that they contain into their structure; and when this carbon can no longer remain vitalised, it is cast out to again afford nutrition to plants. And thus does the same carbon go on being circulated, from air to plants, from plants to animals, and from animals back again to the air.

Another excreting organ is the *skin*. The skin consists of two layers; the cuticle, which is outside, and the true skin. A third layer was formerly stated to be between the two, of a dark hue, and which is highly developed in men of colour; but it is now ascertained that the colouring matter is situated in the true skin, or rather in pigment cells scattered up and down in the true skin.

The cuticle is easily separated from the true skin by a blister. It is scarcely anything but condensed albumen, and has no sensibility. The function of the cuticle is to restrain the sensitiveness of the true skin. Its thickness, therefore, varies very much according as to whether the part is to be endowed with extreme sensibility, or to be protected from strong impressions. Thus, on the tips of the fingers, which are meant to feel, the cuticle is very thin; on the palms of the hands, that are intended to grasp, it is thicker; and upon the soles of the feet, which are destined to support the weight of the whole body, it is densest of all.

The true skin lies underneath, and is composed of a vast number of fibres, interlacing in all directions with one another; and these fibres are traversed by an immense number of blood-vessels and nerves. It is owing to the great number of these latter that the skin is by far the most sensitive organ that we possess. Besides, the skin contains an immense number of little glands, with canals leading from them to the cuticle, and conveying the excretion of the skin — the perspiration. This perspiration contains water, nitrogen, and some other substances. Of all the excreting organs, the skin is the one that is most liable to perform its functions imperfectly; and the matters thus retained in the system, that ought to be excreted, prove very injurious to the health. A new system of therapeutics, called hydropathy, has of late become fashionable, the intention of which is to restore the healthy action of the skin. But it may reasonably be doubted if a little regular domestic hydropathy would not enable us to dispense with its public performance on a large scale.

Muscles play an important part in the animal economy, and constitute the bulk of the body. They compose what is popularly known as flesh, and they consist of a number of fibres bound together. These fibres have the power of contracting, the result of such contraction being a shortening of the muscle. In this manner, a muscle that has one extremity fixed to one bone, and the other to another, with a joint between, can, by contracting, flex or bend the joint. It is to an extension of this principle that locomotion, and the power of moving the different parts of the body, are owing.

All muscles are well supplied with blood-vessels and nerves.

Muscles are composed of fibrin, albumen, gelatine, potash, phosphorus, and other compounds of the elementary bodies, and a peculiar principle called kreatin, to which the sapid taste of meat is owing. The art of cooking mainly consists in coagulating the albumen by heat. Heat, too, has the power of developing the sapid taste and odour of the kreatin.

Nervous matter is another and very important texture, formed out of the blood. The nervous system of man may be divided into the brain, enclosed in the skull; the spinal cord, enclosed in the hollow of the backbone; and the nerves, distributed all over the body. Each of these demands a little separate notice.

The brain is enclosed and protected from injury by the bony casing named the skull. It is composed of a peculiar substance (or rather two peculiar substances), called nervous matter. In its composition it is mainly distinguished from most other parts of the body by containing an excess of sulphur and phosphorus. In appearance it is soft and firm, and a good deal resembles blancmange. It contains three distinct and important divisions: the cerebrum, the largest and the one lying forward and uppermost; the cerebellum, or little brain, situated lower down and behind; and the medulla oblongata, placed at the base of the brain, where the backbone joins, and communicating with the spinal cord. It is believed, that it is by means of the cerebrum that we understand the impressions made upon our organs of sight, hearing, touch, smell, and other sensations, and that the cerebrum is also the seat of the mental acts. The cerebellum has unquestionably a connection with the function of motion. The endowments of the medulla oblongata will be better understood when we have acquired a knowledge of those of the spinal cord.

The spinal cord is a mass of nervous matter filling the space or hollow in the centre of the backbones. From it, opposite to each backbone, two nerves, an anterior and a posterior, arise. These, however, soon unite; and from branches of these every part concerned in voluntary motion, and every part that can feel pain, is supplied. If the anterior nerve of these backbone nerves be destroyed, the power of motion is altogether lost in the parts that it supplies. If, on the other hand, it is the posterior that is so injured, then the power of sensation is lost. When we lay our hand upon a rough surface, the sensation of roughness is transmitted along the filaments that proceed from the posterior nerve of one of the backbone nerves in our neck to the spinal column up to the cerebrum, and it is when it has got to this last place that we are conscious of the roughness of the object. When we wish to grasp anything with our hands, we have first the will to do so in the cerebrum; this is transmitted through the spinal cord to the nerves of the fingers, which nerves have come from the anterior root, and then the necessary muscular contraction is made, and the thing desired is grasped.

The medulla oblongata, in like manner, sends off nerves with two roots, one destined for sensation, the other for motion. It is the medulla oblongata that supplies the organs of respiration. Whenever the lungs are filled with the venous blood, the posterior nerve conveys to the medulla oblongata the sensation of suffocation; and this sensation causes us, with our knowledge indeed, but not merely in obedience to the will, to make the muscular movements that take in air to the venous blood at the lungs. The impulse to do this is transmitted, from the medulla oblongata, through the anterior nerves.

Whenever the cerebrum receives sensations, wills, or thinks, it is very probable that some change takes place among the particles of nervous matter. Now, it is very likely that sometimes an internal cause produces the same change in the nervous substance of the brain, and therefore conveys the same mental impression as some particular external object does. Thus, in fever, there is often great disturbance in the brain, and a similar change may take place in it as would be produced by seeing a particular individual. In such a case, the fevered man talks as if that individual were present. In the same manner may many of the delusions of insanity be produced. But, in a state of mental sanity and freedom from fever or any violent disease, some derangement of the brain may produce an arrangement of its particles that will give to the mind the idea of internal objects. Thus it is that Spectres are formed. These have occasionally happened to strong-minded and intelligent individuals, and the accounts they have given of them are very interesting. We may give two cases of these spectral appearances; one occurring in a state of fever, and the other to a gentleman otherwise in good health.

The first case occurred to a physician. "Some circumstances had occurred," he says, "to render me anxious and dispirited; of these I took an exaggerated and gloomy view. I had been studying during several months with unusual severity. One day, in the cold weather of January, after having been occupied many hours in the practical duties of my profession, I returned home fatigued. Great as was my bodily exhaustion, the depression of my mind was still more remarkable. My head ached; and, unable to study or to attend to my professional engagements, I laid on the sofa and attempted to read: chance having thrown in my way the American novel called the 'Water Witch,' I became interested in the story; but, the pain and confusion in my head increasing, I requested a friend to read to me, my own eye constantly wandering from the page. The progress of the fever was rapid; its chief force fell upon the organ that had been over excited—the brain, and delirium came on early and somewhat suddenly. Immediately before I became decidedly delirious, I received an invitation to the soirées given by the Duke of Sussex to the members of the Royal Society. The friend whom I asked to return an answer, expressive of my regret that I should be unable to attend on account of illness, used, as I conceived, an expression not strictly correct; this verbal inaccuracy, I thought, was construed into wilful falsehood: the matter was brought before this assemblage of learned men, who unanimously declared that it ought to exclude me from the society of honourable men, and that I should no more be admitted among them. The announcement was brought me from the palace, accompanied with martial music, but of a more solemn and impressive kind than I had ever heard before, in which was predominant the sound of bells, soft and as if of a silvery tone. Remonstrance was vain; the decision, of which I succeeded in obtaining a reconsideration, was confirmed: this confirmation was brought to me in the same manner as the first announcement, accompanied with the same kind of music, only still more solemn and impressive. I saw no persons forming the band of musicians, but occasionally I heard very distinctly their measured step. I now thought myself an abandoned and lost being; and the apprehension that every one about me hated me, and sought occasion to destroy me, took possession of my mind. My physicians, my nurses, my dearest friends, were in league with a malignant spirit, which assumed the shape of the demon of the 'Water Witch.' By an object of my tender affection, who was anxiously watching over me, but in whom I now saw only the willing agent of the demon, I was betrayed, and through this treachery the malignant spirit obtained entire possession of me. No sooner was I in the power of the demon, than she began to suggest to me the commission of crimes abhorrent to my nature; and, at last, there fixed upon my mind the impression that I had really been guilty of the crimes by the vivid picture of which my imagination had been disturbed. I pass over the hurricanes and storms I encountered, evidently suggested by the descriptions in the novel I had just been reading. On the sudden subsidence of these, I thought I stood before an invisible tribunal. I felt a solemn consciousness that an all-seeing eye was upon me, while there was visible to me only a portion of the deck of the 'Water Witch,' and, very obscurely, the shadow of my malignant accuser. Not the crimes falsely laid to my charge, but the actual events of my life,—even the scenes of childhood and of youth long forgotten,—were now called up to me with extraordinary vividness; all the circumstances of place, person, dress, language, and attitude, such as had actually accompanied them, being revived. Of each of these events I was compelled to give a true account, an invisible hand recording every syllable that fell from my lips, and a secret power obliging me to utter the words which expressed the exact truth. During this ordeal I saw the countenances of dear friends, and of secret and of open enemies,—those that had long been dead, and those that were still living; the former cheering me by their attitudes and words, the latter scouting upon me and assuming menacing postures, but uttering no sound. And now, again, I felt myself under the influence of the demon, by whose uncontrollable agency I was compelled to accuse myself of the crimes of her own suggesting; and, while suffering the bitter anguish of self-reproach, and expecting some fearful punishment, I again saw my dearest friends, with their innocent and happy countenances, engaged in occupations with which associations of a highly pleasurable nature had been formed in my mind, but whom I could not make sensible of my presence, and with whom I was doomed to hold affectionate intercourse no more. After this, I have no remembrance of anything that passed until conscious of the nature of some obscure and vague recollections. I had the impression that some calamity had befallen me, but I felt as if a soft and refreshing breeze was blowing gently upon me; and soon I found myself in a vast ocean, in a beautifully constructed vessel, with a fresh and invigorating breeze, sailing rapidly along a coast presenting the most magnificent and lovely scenery, and at length the vessel entered gallantly a port unknown to me, but the strand was crowded with human beings with happy faces, and still happier voices. I had returned from a long voyage, but I could not make out where I had been; I felt hungry and fatigued; and now, for the first time, I recognised individuals of my family, after having been violently delirious upwards of a fortnight, during the last three days of which time I lay in a state of total insensibility, my physicians and friends expecting every moment to be my last."

The other instance is that of Nicolai, the German publisher. His spectres were, as will be seen, by no means the result of delirium; on the contrary, he always knew them to be phantoms. "In a state of mind," he writes, "completely sound, and after the first terror was over, I saw with perfect calmness for nearly two months, almost constantly and involuntarily, a vast number of human and other forms, and even heard their voices.

" My wife and another person came into my apartment in the morning, in order to console me; but I was too much agitated by a series of incidents which had most powerfully affected my moral feeling, to be capable of attending to them. On a sudden I perceived, at about the distance of ten steps, a form like that of a deceased person. I pointed at it, asking my wife if she did not see it? It was but natural that she should not see anything; my question, therefore, alarmed her very much, and she immediately sent for a physician. The phantom continued for about eight minutes. I grew, at length, more calm, and, being extremely exhausted, fell into a restless sleep, which lasted about half-an-hour. The physician ascribed the phantom to a violent mental emotion, and hoped there would be no return; but the violent agitation of my mind had in some way disordered my nerves, and produced further consequences, which deserve a minute description.

" At four in the afternoon, the form which I had seen in the morning reappeared. I was by myself when this happened, and, being rather uneasy at the incident, went to my wife's apartment; but there, likewise, I was persecuted by the apparition, which, however, at intervals, disappeared, and always presented itself in a standing posture. About six there appeared, also, several walking figures, which had no connection with the first. After the first day the form of the deceased person no more appeared, but its place was taken by many other phantoms, sometimes representing acquaintances, but mostly strangers: those whom I knew were composed of living and deceased persons; but the number of the latter was comparatively small. I observed that the persons with whom I daily conversed did not appear as phantoms, these representing chiefly persons who lived at some distance from me.

"These phantasms seemed equally clear and distinct at all times, and under all circumstances, both when I was by myself, and when I was in company, and as well in the day as the night, and as well in my own house as abroad. They were, however, less frequent when I was in the house of a friend, and rarely appeared to me in the street. When I shut my eyes, these phantoms would sometimes vanish entirely, though there were instances when I beheld them with my eyes closed; yet, when they disappeared on such occasions, they generally returned when I opened my eyes. I conversed sometimes with my wife and my physician of the phantoms which at the moment surrounded me; they appeared more frequently walking than at rest, nor were they constantly present. They frequently did not come for some time; but always reappeared, for a longer or shorter period, either singly or in company; the latter, however, being most frequently the case. I usually saw human forms of both sexes: but they generally seemed not to take the smallest notice of one another, moving as in a market-place, where all are eager to press through the crowd; at times, however, they seemed to be transacting business with each other. I also several times saw people on horseback, dogs, and birds. All these phantoms appeared to me in their natural size, and as distinct as if alive, exhibiting different shades of carnation in the uncovered parts, as well as different colours and fashions in their dresses, though the colours seemed somewhat paler than in real nature. None of the figures appeared particularly terrible, comical, or disgusting, most of them being of an indifferent shape, and some presenting a pleasing aspect.

"The longer these phantoms continued to visit me, the more frequently did they return; while, at the same time, they increased in number about four weeks after they had first appeared. I also began to hear them talk; they sometimes conversed among themselves, but more frequently addressed their discourse to me. Their speeches were commonly short, and never of an unpleasant turn. At different times there appeared to me both dear and sensible friends, of both sexes, whose addresses served to appease my grief, which had not yet wholly subsided. Their consolatory speeches were usually addressed to me when alone. Sometimes, however, I was visited by these consoling friends while I was engaged in company, and not unfrequently while real persons were speaking to me."

At another period, the same Nicolai was troubled by spectres, but of a different description. "In the year 1778," he writes, "I was afflicted with a bilious fever, which at times, though seldom, grew so high as to produce delirium. Every day, towards evening, the fever came on, and, if I happened to shut my eyes at that time, I could perceive that the cold fit of the fever was beginning even before the sensation of cold was observable. This I knew by the distinct appearance of coloured pictures, of less than half their natural size, which looked as in frames. They were a set of landscapes, composed of rocks, trees, and other objects. If I kept my eyes shut every minute, some change took place in the representation; some figures vanished, and some appeared. But if I opened my eyes all was gone; if I shut them I had a different landscape.

In the cold fit of the fever I sometimes opened and shut my eyes every second, for the purpose of observation, and every time a different picture appeared, replete with various objects, and which had not the slightest resemblance to those that appeared before. These pictures presented themselves, without interruption, as long as the cold fit of the fever lasted. They became fainter as soon as I began to grow warm; and, when I was perfectly so, all were gone. When the cold fit of the fever was entirely past, no more pictures appeared; but if, on the next day, I could again see pictures when my eyes were shut, it was a certain sign that the cold fit was coming on."

CHAP. IV.

THE WAY WE BREATHE AND KEEP OURSELVES WARM.

We have said that it is necessary for the continuance of life that the blood be exposed to the air. This, in man, as in the higher animals also, is very frequently done at the lungs. Here the venous blood obtains oxygen to qualify it, or to aid in qualifying it to again become arterial blood. Here, too, the venous blood discharges the effete carbon, in the shape of carbonic acid. The process of respiration is likewise subservient to the means provided for keeping the body warm.

It is not known whether heat is a substance itself, or merely a property of matter. It is unnecessary here to consider its laws regarding transmission, &c. We may content ourselves with saying that, unless a certain amount, and in man a very considerable one, be present, life comes to an end. The sources of heat become an important question: one great source is, as every one knows, the sun; and man, by art, has acquired another, artificial combustion. Then, during almost all chemical changes, heat is developed. A very striking instance of this may be got by mixing together a little sulphuric acid and water. When this takes place, a very considerable amount of heat is generated. But the chemical combination that produces the most heat is that of carbon with oxygen. When this is done, the heat produced is very great, and the result is the formation of carbonic acid. A common fire, or a burning candle, is nothing more than the rapid union of the carbon of the coal or tallow with the oxygen of the air.

Now, so necessary is the presence of heat to all vital action, that no living being — no, not the most insignificant moss-plant — is left dependent upon external sources for heat, although, as supplemental, such are necessary. All living beings are provided with means of raising their own temperature. The temperature thus maintained by the human race is about 100° of Fahrenheit. It is produced by the effete carbon of the body uniting with the oxygen taken into the blood at the lungs. Thus, in every crevice of our frame is a kind of languid fire, or slow combustion, going on. Of course, we must frequently obtain a supply of carbon from without, just as a fire, if we intend it to go on burning, must continually receive fresh supplies of carbon. When we consider our food, we shall see that we daily take in a quantity of carbonised food, in the shape of wine, starch, sugar, fat, &c. Were this not so taken in, we should as infallibly go out as the wick of a lamp without oil would do.

The absorption of oxygen by venous blood seems a purely mechanical process. If we take a little of such venous blood and enclose it in a bladder, the portion near the surface soon indicates by its change of colour that the air has passed through the pores of the bladder, and parted with some of its oxygen. Now the lungs are essentially a collection of very little bladders, around which the blood flows; their popular name is derived from their buoyancy, and is lights. They may be said to begin with the windpipe, which communicates with the back of the nose. This gives off bronchi, or air-tubes, and these latter divide and subdivide until they end in the little bladders, or air-vessels, of which the mass of the lungs consists, and to which these organs owe their low specific gravity. These vessels are very minute; not more, probably, than the hundredth part of an inch in diameter. The bronchi and vessels are lined by a mucous membrane, and the lungs are enveloped by a serous one, called the pleura. The lungs, heart, and vessels entirely occupy the cavity of the chest. A strong muscle, called the diaphragm, or midriff, divides the chest from the abdomen, and we can make this come higher in the chest by an act of will, and *vice versâ*. By means of this, and by raising or depressing the ribs, we can alter the capacity of the chest, and thus either expel or take in gaseous matter.

Whenever, as we had before occasion to state, venous blood is present in the air-vessels, a sensation, the feeling of impending suffocation, is produced. This is transmitted along a nerve to the medulla oblongata; and, whenever this sensation is felt, a will is transmitted along the nerves of motion to the diaphragm and muscles of the ribs, which causes them so to act as to enlarge the cavity of the chest. When this is done of course a vacuum is formed, to supply which a quantity of air rushes down the windpipe into the lungs; from which the blood abstracts the oxygen, and gives off from itself carbonic acid. The various muscles are then made to act so as to contract the chest; this drives the carbonic acid and the nitrogen of the breathed air into the air, through the windpipe. These processes of inspiration and expiration, as they are called, are performed some fifteen or sixteen times in a minute.

That there is no difficulty in the blood abstracting a sufficient quantity of oxygen from the air in its rapid passage through the lungs, will be seen when we learn that an adult receives into, and expels from, his lungs every day about 4000 gallons of air, and that the surface of the air-vessels is supposed to be 20,000 square inches.

We can also understand how necessary a due supply of pure air is. Supposing impurities are present sufficient to hinder a due quantity of pure oxygen from being taken into the system, nearly immediate death is the consequence. The most fearful example of this on record occurred in the Black Hole, as it is called, at Calcutta. In this horrible dungeon, only eighteen feet square, and with but two small windows, both on the same side, 146 of our unfortunate countrymen were immured. In six hours ninety-six were dead; and in the morning, for it was not until then that the doors were opened, only twenty-three were found alive.

But when the quantity of carbonic acid is not so great as to produce immediate suffocation, it still produces a very injurious effect upon the system; and when, in addition to carbonic acid, the air that is breathed contains putrefactive miasmata, the effect produced upon the health is very injurious. And when we consider the quantity of carbonic acid perpetually poured into the air from the lungs of man and the innumerable millions of animals, and also the additional quantity which the atmosphere receives from every fire and candle that is lighted, with our necessity for living in closed houses, we can believe that a very great amount of disease is thus induced. To amend this, a proper system of ventilation should be a *sine quâ non* with every one having the control of a household. We are by far too much afraid of drafts of air: a choked atmosphere is more injurious than all the currents of air in the world.

The quantity of oxygen taken in varies in the different classes of animals, in proportion to the muscular exertion that they have to make. Of all muscular exertions flight is the most severe; and hence we find that the respiration is quicker, i. e. a greater supply of oxygen is needed and afforded, and the animal heat is greater, in birds than in animals of any other class. Consequently, we see the evil effects of a vitiated atmosphere sooner in birds than in any other created beings. Almost every one is aware that, if a thin handkerchief be thrown over the cage of a canary, so as to impede the rapid passing away of the breathed air, and access of fresh, it very soon dies. And yet the animal temperature of the swallow, one of the hottest of birds, is only twelve degrees more than that of the human species. In all probability, pestilence and the other great devastators of the human race do not destroy nearly so many men as bad ventilation does in its own silent manner.

The length of time during which respiration may be suspended varies not only in different classes of animals, but in the same animal in different conditions. If a warm-blooded animal, or a man in an ordinary state of health, be submerged under water, and thus prevented from breathing for a few minutes, death is the result. A reptile, whose respiration is much less intense, can be kept under water with impunity for a much longer time. There is a peculiar state witnessed in some of the higher animals, and which used, perhaps, to exist in many more, called hybernation. Of this there are various degrees; some animals lay up a store of food in the autumn, and pass the winter almost entirely in a state of sleepy insensibility, but occasionally awake, and take a little to eat; but others, as the marmot, sleep during the whole of the cold weather. During this state of sleep the respiration is performed very feebly; and it is found that hybernating animals may, during their winter insensibility, be kept under water without being killed for many minutes, although, if they were so immersed during summer, when breathing naturally, they would speedily perish. Although man never hybernates, strong impressions made upon his nervous system produce a similar state of insensibility; such as a violent blow upon the head, or even an extreme fright. Hence, human beings who have fallen into the water may be, and occasionally are, recovered after they have been submerged for an hour or more. In these instances, the individuals fell into the water in a state of insensibility, either from striking against something when falling in, or from the state of fear they were in. The practical deduction to be drawn from this is, to persevere for a long time in attempting to restore sensibility to apparently drowned people.

While upon this topic, we may state that the reptiles and cold-blooded animals inhabiting the land not only hybernate, but do something more. When the temperature is low, they fall into a state of insensibility, from which they recover when the temperature becomes warmer. But they can remain in this dormant state not only for one winter, but apparently for any given length of time. Thus, frogs have been kept in this state in an icehouse for three years, and snails for a much longer period. This power of vitality of remaining dormant for a length of time, and, when the proper stimulus is applied, reviving again, is a very curious one. It is seen more distinctly and powerfully in seeds and eggs than in perfect plants and animals. Seeds, in particular, retain their vitality for a long time. Gardeners, we believe, prefer their cucumber seeds to be twenty years old. And we frequently see, when the subsoil is turned up, vegetation immediately spring from it. In many of these instances, which are of every day occurrence, the seeds from which these plants proceeded must have been in a dormant state in the subsoil for many years. Wonderful tales are told about wheat found in mummies sprouting, but these are probably fables. A small example of this power of life becoming dormant is seen in man in the case of an ordinary fainting fit. In such a case the fainting individual is in a state of perfect insensibility, and the respiration is very imperfectly performed. Fainting fits are always produced by a sudden impression made upon the nervous system, either through the medium of the mind or by abstracting suddenly a quantity of blood from the brain. There is a diseased state of the nervous system, recognised by pathologists, in which there is prolonged insensibility with very trifling activity of respiration, and to which the name of trance is given. That most cases of trance are cases of imposition, is unquestionable; but still the disease really appears to have an existence.

Somewhat, at least apparently, connected with the subject of animal heat is that of animal luminousness. That many of the lower animals have the power of emitting light, is a familiar fact. The ocean is sometimes lit up for miles, and our own country affords us an example of animal light in the glow-worm. But it is not generally known that sometimes, a little before death, our own bodies emit light. As before mentioned, our structure essentially contains phosphorus. When this substance is subject to chemical laws, it combines with oxygen, and luminousness is produced. When the powers of life have become weakened, it is quite possible that the phosphorus is disposed to obey the laws of chemistry. In this manner, perhaps, the instances that have been witnessed of "death lights," as they have been called, may be explained. The following is an instance of one of these cases, not generally known. The individual alluded to was about seventy years of age, and the lights were seen by five persons. We extract the following account from a medical journal: — "About eight o'clock in the evening of the 30th of September, 1836 (two days before her death), two persons attending her, and leaning on her bed, looked to each other and exclaimed, 'What is that?' The exclamation was caused by the appearance of a pale flame about a foot in length, and an inch and a half in breadth, slightly curved and pointed at the ends, moving slowly between the pillow, on which one of her hands happened to be lying, and the board at the head of the bed. The flame was sometimes bright and sometimes faint, and gave a pale yellow colour to the lighter part of the print-hangings of the bed. At times the inside of the bed seemed lighted as by a lantern; and more than once the pillow on which her head lay, and her cap and face, became quite white. She did not seem aware of the light herself, as on one occasion, when she raised her luminous hand towards her eyes, one of the attendants interposed her hand to shade her eyes from the light, when she immediately put it down. She disliked light excessively, and the room was all this time kept as dark as possible. There was a stone wall on two sides of her bed. On one occasion one of her attendants tied her cap, when the nail of the thumb became luminous. There were also dots of light observed on the pillow, face, and cap."

Besides the lungs and heart, the chest contains at the top of the bronchus the larynx or organ of speech; and the air that we breathe is one of the essentials to the production of the sounds of the voice. In order to understand even the elements of the very beautiful provisions made for the production of animal sound, it is necessary to have a general idea of the nature of sound itself.

Sounds are produced by bodies in a certain state of vibration. These vibrations are communicated to the air, and produce in it a number of waves or undulations, which make a definite impression upon the organs of hearing, and are called tones. These tones are compound in their nature, being made up of a succession of shocks, occurring one after the other with such rapidity that the ear cannot discriminate an interval. Tones differ from one another, according to the rapidity with which the shocks or vibrations succeed one another, the name given to this difference being the *pitch*. Thus, if we tie a string by its two ends of such a length that when we strike it it vibrates sixteen times in a second, we have the lowest note appreciable to our senses,—we have the lowest C of our musical scale: when thirty-two times, lowest D, and so on. Some very acute ears can discriminate the sound produced by 24,000 vibrations in a second. This would be four octaves above the highest F in the piano. All the tones between these two are multiples of, or proportions to thirty-two; and, when they follow one another in accordance with certain well-known rules, we have harmony, and, when the reverse, discord.

Sounds likewise differ in their quality or *timbre*, as it is called. Thus, when we sound middle E on a clarionet and on a violin, we have the same note, the same number of vibrations in each, and we recognise them as the same, but still there is a difference in timbre or quality. What is the cause of their difference is not known.

We can, of course, produce every sound in the musical scale from the same string. This we do by altering its tension or tightness, the highest sounds being produced when the string is tightest.

Now, the sounds of the human voice are produced by our making the air strike against two little strings, called the vocal ligaments, situated in the larynx. By means of certain muscles, we can tighten or relax these in a great variety of ways; and, when we have learned to do this, we have acquired the art of producing all the sounds of which the human voice is capable. And yet these two little ligaments are amazingly small. When at rest, their average length in a man is $\frac{73}{100}$ of an inch. When they are stretched as far as we can make them stretch, their length is $\frac{93}{100}$ of one, the difference being just the fifth of an inch. In the female, the size is much smaller; and the difference between repose and the greatest tension only the eighth of an inch. The compass of the human voice is usually about a couple of octaves, or twenty-four semitones. A good singer can make ten intervals in a semitone; consequently, a good singer can produce two hundred and forty different states of tension of the vocal ligaments, and all this within the range of one-fifth of an inch. Miraculous as this may seem, many singers have a voice of much greater compass than two octaves.

The vocal ligaments of boys are short, like those of females. Hence boys, as well as women, sing treble. Men, with ligaments of the ordinary length, sing about an octave lower, or tenor; while those who have very long ligaments sing lower still, or bass.

A great many varieties of sounds are produced by different animals. Snakes are only capable of making one,—a hiss, which they do by drawing the air from their lungs through the windpipe. As their lungs are very capacious, and contain much air, this hiss is often very prolonged. Most animals have different sounds; some indicating terror, some pleasure, and some hunger, &c. Thus, the roar of a bull is very different from his low, the purr of a lion very opposite to his roar. The cries of some animals, as the neighing of horses, or the braying of asses, are certainly sociable. When we come to birds, we have the production of musical notes; some of these are instinctive, but some are undoubtedly acquired by hearing other birds sing. In man, we have this power of producing musical notes altogether acquired; the faculty of making instinctive cries; and in addition, what is peculiar to him, the faculty of language, by means of which one individual can communicate to another what is passing in his own mind.

It is not owing to any peculiarity of the organs that man can speak, inasmuch as other animals may be taught to articulate words, and even sentences. But, in such cases, no idea is connected with the expression. The peculiarity of human language consists in its being a perfect medium of communication between mind and mind. There is nothing that the mind can conceive that the voice cannot utter. The higher animals, as dogs, horses, &c., have a certain but very limited means of communicating with each other; but it rarely happens, although occasionally with dogs it does appear to happen, that anything like an idea is so communicated. The neighing of a horse is probably a mere instinctive acknowledgment of the vicinity of another horse.

Spoken language consists of a number of elementary sounds, some of which are grouped together to compose a syllable. One or more syllables make a word, and a number of words a sentence, which sentence contains one or more ideas. From about twenty sounds, as many combinations may be made as to express all human knowledge, thoughts, and feelings. At a very early period in human history, man would desire to make language intelligible to the eye as well as to the ear. It is extremely probable that hieroglyphics were first used for this purpose. If a man wished, for instance, to communicate the idea of a cow to the mind of another, through the medium of the other's eyes, he drew a representation of such an animal. It is believed that the hieroglyphic characters gradually wore away until they lost their original shape, and became representations of phonetic sounds; first, perhaps, syllables, and afterwards letters.

Accordingly, in a perfect language, each one of the twenty sounds, or of whatever number of sounds the language is to consist, should have its corresponding letter, and no more. But no language is so perfect, and our own in particular is very deficient: for we have many simple sounds that we cannot express by one letter; and, on the other hand, a single letter sometimes represents a compound sound. Thus, the sound expressed by *th* is perfectly simple, and our *i* is a compound sound, being formed in the act of transition from *a*, as sounded in *ah*, to *e* as sounded in *theme*. This is the reason why *i* cannot be sung in a loud note, as it invariably runs either into the *a* or the *e*.

The letters, or vocal sounds, are divided into vowels and consonants. The characteristic of the former is, that they are continuous tones, while, when we utter consonants, we produce an interruption to the breath. This is the reason that we can prolong the utterance of a vowel as long as we please, while the sound of a consonant is very momentary. The difference between one vowel and another depends upon the shape we put our mouth and lips into when the sound is coming out. Of the consonants, some are more momentary in their pronunciation than others. The most so are called explosive ones, and require us, when we say them, to altogether stop our breath. The explosive consonants are *b, d, p, t, k,* and *g,* when hard. The others are more continuous, and do not require such a thorough and immediate stoppage of the breath. Their peculiarities depend upon the sound being modified by the lips, palate, tongue, and teeth; and they are often named accordingly—labials, gutturals, dentals.

Although all these sounds are easily enough acquired by children, yet adults find the greatest possible difficulty in doing so; and hence it is that a man rarely acquires the pronunciation of a language, not his natural one, so perfectly as not to be immediately detected as a foreigner. The inhabitants, too, of many localities are characterised by vicious pronunciation; *i. e.* by peculiar sounds, that they do not seem able to amend. The Northumbrians are famous for the ringing sound of their *r*: many nations substitute a *l* for our *r*, others *d* for our *th*, as dat for that: the Welsh have long been noted for substituting *f* for *v*, and *p* for *b*—"Fery goot," says Sir Evans; "I will make a *p*rief of it in my note-*p*ook:" others, again, are too prone to employ the labial sounds, and are, in common language, said to lisp. But, perhaps, the most distressing difficulty regarding speaking is that of stammerers or manters*; i.e. of those who do not possess the proper and necessary control over the muscles concerned in articulation. Generally speaking, the articulating muscles of such individuals are more or less subject to involuntary spasmodic contractions.

CHAP. V.

THE WAY THE FOOD IS DIGESTED.

CHILDREN, and growing animals, are continually adding to their structure; and adults are daily parting with portions of their frames. The formation of the body, and the keeping it up, is, as we have seen, performed by the blood. This fluid, however, does not in health become diminished in quantity. Had we no other evidence, we should know from this that the blood received constant supplies from without. And as we have seen that the blood is always expending oxygen, carbon, nitrogen, hydrogen, sulphur, phosphorus, potassium, sodium, calcium, magnesium, silicon, iron, and chlorine, we should infer that these supplies from without were composed of these different elements. But, in point of fact, we see supplies daily added to the system in the shape of food, and the

* To mant, is, in Scotland, the common expression indicating to stammer.

eye of science as clearly sees in this food every one of the above enumerated elements. Farther, we have seen that, besides the elements necessary for maintaining its integrity, the body requires a good deal of carbon to burn, in order to keep up the necessary animal heat. This, too, is added to the system in the form of food.

The subject of digestion naturally divides itself into two heads,—the manner in which the food is taken into the system, and there acted upon, and the nature and varieties of food. We begin with the former.

When the blood is becoming exhausted of its elements, a peculiar sensation—hunger—is experienced; and, if it be becoming deficient in fluid likewise, there is also the sensation of thirst. In a proper state of health these sensations are exactly indicative of the wants of the body. The cause of thirst is simply dryness of the coats of the stomach (an organ immediately to be noticed). The sense of thirst is felt about the mouth and top of the throat; but that its true seat is the stomach has been made clear from cases of wounded throat, in which it has been relieved by pouring water into the stomach, through the orifice in the neck. The feeling of hunger is believed to be owing to a distention of the blood-vessels of the stomach, these blood-vessels having become so distended, in order to secrete gastric juice. Whenever this distension is done away with, by the gastric juice having been secreted, the hunger is at an end. The natural way in which this is brought about is by eating; but any substance that comes into contact with the distended vessels, even although it contain no nourishment, causes at least a partial secretion and relief of the hunger. This is well known by many savage nations, who, when they cannot get food, swallow earth, and other indigestible matter.

When, however, hunger is felt, there is a desire for eating nutritious food that has an agreeable and sapid taste. It is found that sapidity is increased, in many instances, by the action of fire; and hence almost every nation, in all time, has practised the art of cookery. When hunger is felt, and these agreeable articles of food are present, they are placed in the mouth to be divided into bits, and crushed by the action of the teeth.

These organs, the teeth, are, as is well known, situated in the two jaws; the upper jaw being fixed, but the lower allowing of motion both upwards and downwards, and also from side to side. Three kinds of teeth are found in the human species: those in the front, called incisors, which are furnished with a thin cutting edge, and whose office is to divide or slice the food; next to these come the canine or dog teeth, larger, and with a sharper point, calculated to tear asunder the food; and lastly, and most in the rear, come the molars or grinders, furnished with an extended and flattened surface, and which are calculated to grind or comminute the food in the same manner as two millstones, one placed above the other, and moving round, crush corn into flour and meal.

When the food is introduced into the mouth, by moving the jaws up and down we cut it into bits with the canine and incisor teeth, and then, pushing it backwards with the tongue, it goes between the two sets of molars; and the lower jaw, by moving from side to side, soon reduces it to a soft mass. At the same time that this is done, two glands underneath the tongue, and four at the back of the mouth, secrete a fluid called the saliva, which is well mixed with the food in the act of chewing. This saliva consists mainly of water, with a little saline matter. It is produced whenever sapid fluid is introduced into the mouth; and sometimes it is secreted at the mere thought of such food. Thus, memories of bye-gone feasts, or anticipations of future ones, are said to make people's "mouths water." The use of the saliva would appear to be principally to communicate the necessary degree of pulpiness to the mass.

When the food is chewed, and mixed with the saliva, it is made up into balls, and, by the action of the tongue and muscles of the back of the mouth, pitched into the œsophagus, or tube leading from the mouth into the stomach. When it has reached the œsophagus, it is no longer under the control of the will, nor are we conscious what is taking place in it.

Drinking is performed partly by holding the mouth a little back, and pouring the fluid in, and partly by sucking; i. e. forming a vacuum in the mouth, and holding the glass containing the fluid to our lips. The pressure of the external air thus forces the fluid into the mouth, in the same manner as it does into a pump.

When the food, liquid and solid, has got into the œsophagus, it is transmitted into the stomach. This is a large membranous bag lying underneath the chest. Its office is partly to secrete gastric juice, and also, inasmuch as from our habits of locomotion we cannot, like plants, be always eating, to serve as a kind of larder for us, and thus enable us to dispense with the necessity of too frequently receiving food. The proportional size of the stomach varies very much in the different classes of animals, being very large in those animals which, like oxen, are intended to live upon food in which the nutriment is not concentrated, and small in those which, like a tiger, are intended to subsist upon very concentrated aliment. In man, who is meant to live on a mixed diet, it is of a medium size.

When the food has reached the stomach, a quantity of gastric juice is poured upon it. The stomach, by its contractions, moves the whole mass about; and in time, usually in from two to four hours, the whole forms a homogeneous thin pulp, to which the name of chyme is given. Gastric juice consists of muriatic acid, which dissolves the food, and a particular principle called pepsin, which has probably the power of inducing albumen to turn into fibrin, in the same manner as yeast induces sugar and water to turn into beer.

The chyme passes from the stomach into the intestines, where it is mixed with bile. It then separates into two portions, one of which is called chyle, which is another name for incipient blood, and which contains albumen, fibrin, serum, and other compounds of the elements of which the body is composed; and another, which is the non-nutritious part of the food. The chyle is taken up by a series of vessels called lacteals, that terminate in a large vessel called the thoracic duct. This thoracic duct pours its contents into the circulating system just where the jugular and subclavian veins unite. Thus, although the blood is every second parting with its elements, it never becomes less in quantity, because it is every moment receiving fresh supplies of these very same elements by the thoracic duct, and which elements are obtained from without in the shape of food. The blood, also, as we saw, receives continually supplies of oxygen from the air.

As every one knows, this process of digestion, although under the control of organic life, and in no respect under the control of voluntary acts of the mind, is very much influenced by mental sensations and emotions; and, in particular, it is deranged by depressing emotions. When this is the case, the chyle is imperfectly formed, the blood imperfectly recruited, and therefore the body imperfectly nourished. The ultimate result of all this is disease or death.

If solid food be abstained from, but water drank, a person may live as long as forty days; but if both solid and liquid matters be not taken, the individual dies in less than half this time.

We now come to our second topic, the nature and varieties of food. As we before had occasion to remark, the food of animals must consist of matter that has previously existed in an organised state, i. e. must consist of either animal or vegetable substances. Like the animal structures, the vegetable are composed of saccharine, oleaginous, and albuminous proximate principles. It will be proper to enumerate the more important of these.

a. *Saccharine proximate Principles in Vegetables used as Food.*

Foremost amongst these is sugar; it exists abundantly in many plants, as the sugar-cane, the maple, beet-root, grass, &c. The composition of sugar has been stated before.

Starch is another very important alimentary principle, of which we consume a great deal. It is composed of—

Carbon	36
Oxygen	40
Hydrogen	5

It is extremely abundant in potatoes, rice, all kinds of grain, turnips, apples, and other fruits. Sago, tapioca, arrow-root, and the like, are entirely composed of it. The following table will indicate the proportion per cent. of saccharine proximate principles contained in some commonly-eaten vegetables:—

	In 100 lbs
Wheat flour	55 lbs.
Barley flour	60
Oat flour	60
Rye flour	60
Indian corn	70
Rice	75
Bran meal	40
Pea meal	50
Potatoes	18
Mangold wurzel	11
Turnips	9

We ought to include in the list of saccharine proximate principles one not found in nature, but produced by art, and greatly taken as aliment. We refer to alcohol, the product of the fermentation of sugar, and known under the various forms of cider, beer, wine, and distilled spirit.

There can be little doubt but that the use of these saccharine proximate principles is to supply the body with carbon, to be expended in keeping up its temperature.

b. *Oleaginous proximate Principles in Vegetables used for Food.*

Like the animal oleaginous proximate principles, the vegetable essentially consists of oleine and stearine. In a pure state the olive and poppy oils are extensively used as food; but of late years it has been ascertained that all our common articles of vegetable food essentially contain a considerable quantity of oil or oleaginous principle. The adjoined table will indicate the proportion contained in the common articles of diet used by man, or the animals upon whose flesh man feeds, namely:—

	In 100 lbs.
Fine wheat flour	$2\frac{1}{2}$ lbs.
Bran	$3\frac{1}{2}$
Barley flour	$2\frac{1}{2}$
Oat flour	$4\frac{1}{2}$
Indian corn	$5\frac{1}{2}$
Beans and peas	$2\frac{1}{2}$
Potatoes and turnips	$0\frac{1}{4}$
Wheat straw	$2\frac{1}{2}$
Oat straw	4
Clover hay	$3\frac{1}{2}$
Meadow hay	$2\frac{1}{2}$

The use of the oleaginous proximate principles of vegetation is the same as that of the saccharine; to wit, to furnish carbon. Whenever men are prevented by accident from obtaining a due supply of saccharine proximate principles, they instinctively eat a large quantity of oleaginous, derived either from an animal or vegetable source Thus the natives of polar regions, whose climate prevents them raising saccharine corn crops, consume an immense quantity of blubber, train oil, &c.

c. *Albuminous proximate Principles in Vegetables used for Food.*

Like the albuminous proximate principles of animals, these are composed of carbon, oxygen, hydrogen, and something like fifteen per cent. of nitrogen; and it is likewise very probable that the sulphur, phosphorus, and other necessary constituents of the human body, are united with them.

One of the most important of them is gluten, which bears a great resemblance to animal fibrine. It is composed as follows; i.e. the proportion of the four following elements are in it as follows:—

Carbon	55
Oxygen	21
Nitrogen	15
Hydrogen	17

Albumen and casein, identical in composition, and therefore in nutritious properties, with animal albumen and casein, are likewise common constituents of most of the vegetables that, under the guidance of instinct or experience, we have used for food. The table we here quote will show the proportion per cent. of albuminous compounds contained in the vegetables that we usually consume:—

	Per Cent.
Wheat flour	10—19
Bran	16
Barley	12—15
Oats	14—19
Rye	10—15
Indian corn	12
Rice	7
Beans	24—28
Peas	24
Potatoes	2
Turnips	1½

The use of the albuminous proximate principles, when taken as food, is not to furnish carbon for fuel, but to afford to the body all those elements of which it is composed, and of which by its constant wasting it is always needing a supply.

It will be seen, by a reference to the above table, that oats contain more real nutriment than any other kind of food that we derive from the vegetable kingdom.

The composition of the different articles of diet that we take from the animal world may be taken from the account of the composition of the animal structures, of which we gave an outline in Chapter III. No saccharine principle is obtained from animals, excepting the sugar contained in milk; but flesh affords plenty of oleaginous and albuminous ones, usually much concentrated. If man subsist upon either animal or vegetable food exclusively, he is apt to fall out of health. This probably arises from the digestive organs being too large for a purely carnivorous, and too small for a purely herbivorous, diet. The proper rule is to employ a varied diet, drawn from both kingdoms.

CHAP. VI.

THE WAY WE MOVE, AND THE INFLUENCE OF THE MIND UPON THE BODY.

THE faculty of locomotion is one of the characteristics of the animal creation; and its exercise, indeed, is indispensable for its existence. Very beautiful contrivances are provided in the different classes of animals for its due and facile performance. In all, except some of the very lowest, the great agent in locomotion is muscle; which, by contracting in obedience to the will, makes the two points to which it is attached come nearer to each other. The simplest method of locomotion is, perhaps, to be found in animals of the worm and leech tribe. These creatures have two sets of muscles, one running along their bodies, and the other passing round them in rings. When they contract the former, they draw their heads and tails together, so as to shorten their bodies; when the latter, they diminish their diameter, and consequently lengthen their bodies. By performing these two actions alternately they get along.

The higher animals, however, besides muscles, are furnished with a hard substance, to which the muscles of locomotion may be attached. This is called a skeleton. In insects, crabs, &c., this skeleton is on the outside; but in all the animals that have a backbone, and therefore in the human race, it is internal, and composed of a number of distinct bones articulated to one another by ligaments. All these articulations or joints admit of more or less freedom of motion. In order to facilitate this motion, the joints are kept well lubricated by a fluid secreted for the purpose. How the contractions of the muscles make these joints move may be easily perceived. Supposing, for example, that a muscle went from the palm of the hand to be fastened into the middle of the lowest bone of the fore finger: when, by an act of the will, this were made to contract, the result, of course, of the contraction would be to draw the fore-finger towards the palm of the hand. If, on the other hand, a muscle went from the back of the hand to be inserted in the middle of the back of the lowest bone of the forefinger, and if this muscle were made to contract, the result would be that the finger would be straightened,—made to point, in fact.

To make intelligible the different bones, joints, and muscles of the human body, would occupy by far too much space; nor, indeed, could it be done at all without numerous illustrations. And it will, perhaps, be as interesting to describe the various attitudes of the body, and the various kinds of locomotion witnessed in the vertebrated animals.

A very few of the vertebrated animals, as the serpents, lean upon their whole body, which altogether rests upon the ground; but by far the greater number are supported upon extremities or limbs: and when an animal rests upon its limbs, it is said to stand. The muscles in this act of standing are by no means passive; on the contrary, those whose business it is to stretch out or extend the limbs must be in continual action. Hence standing is more fatiguing than walking, inasmuch as during the latter the extending muscles only contract alternately with the bending ones, and therefore both get a rest, and only do half as much work as when standing.

In standing, however, something more is necessary than keeping the extending muscles contracted. The body must also be kept balanced. It is clear that this will be more easily done by an animal that has four limbs to stand upon than by one that has only two. To compensate for this, animals that have to stand on two extremities only have always their feet very large, so as to afford a greater base of support. The difference between the feet of a man and those of a horse, or those of a duck and a cat, in this respect is very striking. The smallness of the extremities of quadrupeds is one reason why they cannot maintain an upright position when placed upon their hind legs.

It is not, however, quite correct to say that quadrupeds cannot stand upon their hind legs, for some can. Monkeys and bears are examples of this; dogs and horses can also be taught to do so for a little. But this habit of standing upon the hind legs in quadrupeds, whether acquired or natural, is very imperfectly performed. Even monkeys seldom use it when walking; and the ourang-outang itself, when standing, likes to avail himself of a long stick.

Sitting is a much less fatiguing attitude than standing, as the extending muscles of the neck and body only are in action. In lying, no muscular contraction of any kind is necessary; and hence this attitude is the one chosen for reposing from fatigue.

The various kinds of motion are performed by alternately contracting and expanding the limbs. When a man walks he is continually performing the evolution of standing upon one leg, and then putting the other forwards; he then stands upon the latter, and moves the one he did stand on forwards. A quadruped goes upon the same plan, only he stands upon a pair of limbs at a time, and then moves the other pair, and so on. Running is managed somewhat differently, and the body altogether quits the ground at intervals; and a running man springs through the air, rests on his right leg, springs through the air, rests on his left leg, and so on. Of all two-legged animals the ostrich is the swiftest. "Their speed," says a naturalist, writing regarding them, "is great; the swiftest greyhound cannot overtake them; and even the Arabian and his horse are obliged to have recourse to cunning as well as speed to close the chase, by throwing a stick dexterously between the legs, or otherwise to disable it. In its flight it spurns the pebbles behind it like shot against the pursuer. Nor is this its only mode of annoyance. Dr. Shaw, who gives a pretty account of the airs which the ostrich plays off in a domesticated state, fanning itself with its expanded wings, and seeming to admire its own shadow, states, that though tame and tractable to those familiar with them, these birds were often very fierce to strangers, especially those of the poorer sort, whom they would try to run down and attack with their feet. They are capable of striking with great force, and the same author gives a melancholy account of a person who was ripped up by a stroke of the pointed and angular claw."

Another form of motion is found in quadrupeds, and is named the amble. This pace is natural only to the giraffe, but horses can be made to acquire it. It is a fast kind of walk, the two legs of one side being moved together, while the animal rests upon the other two. We believe that ambling horses are liable to lose their balance and tumble down. Trotting is a much superior pace, and is performed as follows: the fore foot of the right side and the hind foot of the left are raised and advanced, and when these are set down, the fore foot of the left side and the hind foot of the right are raised and advanced. A gallop is performed in the same manner, but faster. In cantering, a horse first puts down its left hind foot, then its right hind foot, next its left fore foot, and then its right fore foot.

In leaping, the extremities are suddenly contracted, the force of the contraction being to drive the body into the air. The distance that a man can leap is comparatively little, but that of some of the other animals is very great. In the kangaroo, for example, the muscles of the hind extremities are wonderfully large and strong; in fact, the animal looks all hind legs together, and it can jump a very long way; indeed, its mode of progression is by a series of jumps. We, too, in this country have jumping animals, of which the squirrel is the best example. The rabbit, also, has very strong hind legs, and when it is moving along it jumps with them like a kangaroo, although it walks with its fore pair.

Swimming and flying are two other modes of locomotion. All animals, save man, can swim naturally, and man himself can acquire the art. Some animals, as ducks and others, are intended to spend much time in the water; and in order that they may bring a greater extent of surface to paddle with, their toes are joined together by a web. Some water-dogs are also web-footed; but when the extremities of an animal are intended solely for swimming, they are considerably modified. All quadrupeds have an arm, a fore arm, and a hand, or parts corresponding to these. In the case of the animals in question, the arm and hand are little developed, but the bones of the hand are made very large, and to extend over a wide space; the hind legs, on the other hand, almost disappear. Thus, in examining the skeleton of a whale, we can scarcely perceive that lower extremities exist. In swimming, whales and seals scull themselves with their tails. In the fishes, the action of the tail is also predominant; but they are assisted by the fins, of which the side fins may be taken as representatives of the hands and legs. A man in swimming propels himself by his hands and legs, which he uses something like oars.

Several quadrupeds possess a *quasi* power of flying; that is to say, they can go through the air a considerable distance, being helped by what look like wings: but in the instances to which we refer no propelling power is given by the wings; the impulse is all taken from a spring or bound, and the organs that look like wings act merely as parachutes. There is a species of squirrel called the flying squirrel, the members of which have a web of skin extending from the fore extremities to the hind ones and to the tail. This membrane supports the animal in the long jumps it takes from tree to tree. The bat possesses the perfect power of flying, although this animal, being a mammal, has no true wings. In it the bones that should be the fingers are wonderfully developed; and what we call the wing of the bat is the web that extends between the fingers. Every one has heard of the flying fish, as they are called: these sometimes skim along the air for a hundred yards, and are often so high above their native element as to clear the deck of a ship.

When we come to birds (insects we are purposely leaving out of the question), we arrive at true wings. These consist of feathers attached to strong muscles belonging to the arm, fore arm, and breast. These are all so arranged that the air is struck with greater force during the down-stroke than during the up-stroke. But even with this contrivance the amount of force expended in any living structure propelling itself through the air is most amazing, far greater than that expended in the severest draught or the strongest exercise. It is supposed that a swallow, when merely sustaining itself in the air, exercises a force to prevent falling equivalent to what would raise its own weight to a height of twenty-six feet in a second. When we consider that it takes so much simply to maintain it where it is, what must it require to raise and propel it? And yet what a distance some birds fly in a short space! A hawk, for example, can traverse the air at the rate of a hundred and fifty miles an hour, and many swallows probably fly a thousand miles in the course of a day.

It is this enormous amount of muscular exertion that is necessary for flying that renders any attempt of man so to travel quite out of the question. We extract Dr. Carpenter's calculations regarding this point: — "It is impossible," writes this physiologist, "for a man to sustain himself in the air by means of his muscular strength alone in any manner that he is capable of applying it. It is calculated that a man of ordinary strength can raise $13\frac{1}{4}$ lbs. to a height of $3\frac{1}{4}$ feet per second, and can continue this exertion for eight hours in the day. He will then exert a force capable of raising ($13\frac{1}{4} \times 60 \times 60 \times 8$) 381,600 lbs. to a height of $3\frac{1}{4}$ feet, or one-eighth of that amount, namely, 47,700 lbs., to the height of 26 feet, which, as we have seen, is that to which the bird would raise itself in one second by the force it is obliged to exert in order to sustain itself in the air. Now if we suppose it possible that a man could by any means concentrate the whole muscular power required for such a day's labour into as short a period as the accomplishment of this object requires, we might find the time during which it would support him in the air by simply dividing this amount by his weight, which we may take to be 150 lbs.; the quotient is 318, which is the number of *seconds* during which the expenditure of a force that would raise 47,700 lbs. to a height of 26 feet will keep his body supported in the air, and this is but little more than five minutes. There is no possible means, however, by which a man could thus concentrate the force of eight hours' labour into the short interval in which he would have to expend it when supporting himself in the air."

All these muscular movements are produced by acts of the will. Their rapidity is sometimes very great. Thus, some men are able to pronounce 1500 letters in a minute. This implies 1500 distinct movements, and 1500 distinct acts of the will.* It is calculated by Haller, that a dog, when running, will exert as many distinct volitions, or acts of will, in a second, as 200. All this is very wonderful; and it is not surprising that young animals perform these voluntary movements very imperfectly at first, and that it is not until after repeated trials, and repeated failures, that they acquire the proper method of doing them.

In this latter respect, these voluntary movements differ very strikingly from what are called instinctive actions, or those actions of which the performer is conscious, but which he performs whether he wills or not. These are done from the very first as accurately as afterwards; and a child, for example, sucks the moment it is born quite easily. So also does it swallow with ease from the first. Besides these actions of sucking and swallowing, few of the movements performed by the human species are instinctive. Perhaps

* Alison.

throwing the hand before us when we fall, and winking when an object approaches the eye, are the only other examples. But among the lower animals very striking illustrations of very complex instinctive movements are to be seen. One or two of these may be interesting.

The ant lion, a little insect that feeds upon ants, affords a good example of curious instinctive acts. It moves slowly, and is not able to catch its prey unless it can entrap them. To do this, it digs a pit in the sand about twenty inches deep and thirty across. This pit it so constructs, that the sides gradually slope from the top to the bottom. The ant lion conceals itself at the bottom of this pit, and when an ant slips over the sides, casts a quantity of sand upon it, which insures its rolling to the bottom. The unfortunate ants, in falling, frequently destroy the side of the pit a little; but the ant lion invariably restores it to its proper angle of slanting. In all this there is no reason to believe that the animal reasons; but in all probability it does it all in obedience to a blind instinct. There is a spider called a Mygale, that constructs a very curious house for itself to live in, lines it with a silky substance, and puts in it a door with a hinge; and if any person approach and try to open the door, the insect tries to keep it shut by holding on to the door opposite the hinge, and fixing its legs into some holes, or staples, that it has made. There is an insect of the wasp species, called a Pomphilus. This insect lives upon flowers, but its larva is carnivorous in its diet. Now before a pomphilus lays her eggs she goes and kills a spider or a caterpillar, and places it beside the egg, so that when the young is hatched it may have a due supply of food. This insect, however, cannot know what it is doing this for. The ingenuity that birds display in building their nests must suggest examples of instinct that are very wonderful. But perhaps one of the most complicated instinctive acts is afforded by the manner in which beavers build their huts. In the summer, these animals live alone in country quarters, but as winter approaches they congregate together to construct a winter residence. About two or three hundred unite, and select a river or lake, preferring the former. Their first work is to insure the water being kept at a uniform height, by means of a dam. This dam they construct of branches of trees interlaced into one another, the intervals being well filled with stones and mud. Now if the dam go across running water, it is convex towards the current,—the very form that gives greatest stability. But if the water be still, the dam is made straight. When this dam is finished, the beavers of the colony divide themselves into a number of groups or families, and the animals employ themselves in building houses. The material that they use is wood, which they cut down with their strong incisors, and cast into the river above their locality, so that the stream may float it down. They daub over their walls a coating of mud, which, when the cold weather comes on, freezes and forms a hard and solid casement; and it has been noticed that they perform this operation late in the season, so as to insure frost.

All this—and had we space we might narrate much more—looks like the result of reasoning; but there can be no doubt but that it is all pure instinct, i. e. that these actions are performed, not on account of observation and reflection, in the manner that man does, but in obedience to impulses of which the animal knows nothing, save that he feels them. Thus, when a beaver is placed in circumstances where he can have no possible motive, and secure no possible end in building, he still builds. Of this we have a rather remarkable instance. It relates to a pet beaver belonging to Mr. Broderick, who thus narrates: "The animal arrived in this country in the winter of 1825, very young, being small and woolly, and without the covering of long hair that marks the adult beaver. It was the sole survivor of five or six which were shipped at the same time, and it was in a very pitiable condition. Good treatment quickly restored it to health, and kindness soon made it familiar. When called by its name — Binny — it generally answered with a little cry, and came to its owner. The hearthrug was its favourite haunt, and thereon it would be stretched out, sometimes on its back, sometimes flat on its side, sometimes stretched out on its belly; but always near its master. The building instinct showed itself immediately it was let out of its cage, and materials were placed in its way, and this before it had been a week in its new quarters. Its strength, even before it was half grown, was very great. It would drag along a large warming-pan, or a sweeping-brush, grasping the handle with its teeth, so that the load came over its shoulder, and advancing in an oblique direction till it arrived at the point where it wished to place it. The long and large materials were always taken first; and two of the longest were generally laid crosswise, with one of the ends of each touching the wall, and the other ends projecting out into the room.

The area formed by the cross brushes and the wall he would fill up with hard brushes, rush baskets, books, boots, sticks, cloths, dried turf, or anything portable. As the work grew high, he supported himself on his tail, which propped him up admirably; and he would often, after laying on one of his building materials, sit up over against it, appearing to consider his work, or, as the country people say, to 'judge' it. This pause was sometimes followed by changing the position of the material 'judged;' and sometimes it was left in its place. After he had piled up his materials in one part of the room — for he generally chose the same place — he proceeded to wall up the space between the feet of a chest of drawers, which stood at a little distance from it, high enough in its legs to make the bottom a roof for him, using for this purpose dried sticks and turf, which he laid very even, and filling up the interstices with bits of coal, hay, cloth, or any thing he could pick up. This last place he seemed to appropriate for a dwelling; the former seemed to be intended for a dam. When he had walled up the space between the feet of the chest of drawers, he proceeded to carry in sticks, cotton, hay, &c., and to make a nest."

There is, however, one instance on record where a beaver seems to have modified his building propensities to meet a present emergency. One was confined in the menagerie at Paris. The season was winter, the cold was intense, and his cage door shut very imperfectly. It was the custom of his attendant to supply him with apples, and other vegetables, to eat, and with branches to amuse him with pulling to pieces. One night there came on a fierce snow-storm, and some of the snow was blown into his domicile. The poor animal took his boughs, and interlaced them through the bars of his cage, and filled up the vacant place with his apples, carrots, &c. He then covered the whole with snow, which the frost soon stiffened, and thus formed an effectual shelter for himself.

Besides these voluntary muscular movements, performed in obedience to the will, and the instinctive ones that we have just considered, the muscular system is also often involuntarily affected by the mind. Thus the feeling of the ridiculous excites those complex movements of the muscles of the face that we call laughing. In like manner grief induces weeping. The muscles of the face are even slightly affected by nearly every mental act; and as each man has a peculiar mental identity, so do these mental acts produce a little difference, which soon becomes permanent, in the relative contraction of the individual faces. To discover by these appearances of the face the mental character, is the business of the physiognomist.

Some violent mental emotions sometimes affect the whole muscular system quite without our willing it. Thus great fear often produces trembling of the whole muscles, and the sensation of horror occasionally brings on writhings, as they are called. Thus, some mental emotions have actually the power of strengthening, and frequently do so strengthen, to a very remarkable extent, the force of the muscular contractions. Of this nature are anger, military enthusiasm, fanaticism, &c. On the other hand, grief; and particularly despair, diminish the muscular strength, and the latter sometimes temporarily altogether paralyses it.

The mind powerfully affects other parts of the system besides the muscles. The following is a summary of some of the more striking of such.

The exciting emotions that act permanently, but without violent agitation, such, for instance, as the "emotion of pleasure that attends any occupation which interests and occupies the mind,—the emotion of hope from the prospect of lasting enjoyment or of returning health,—the emotion of benevolence which attends the conferring, or that of gratitude which follows the receiving, of benefits; even the excitement produced by a certain degree of the feeling of indignation," have several very decided effects upon the system. They cause a permanent glow upon the face; they increase the secretion of the eye, and thereby augment its glistening; they render the skin far less liable to feel the sensation of cold; they are said to increase the quantity of carbonic acid thrown off at the lungs; they unquestionably promote the digestive powers; and they fortify the body to a most remarkable degree against the effects of contagion and malaria.

But if any of these exciting emotions act very suddenly and violently, none of these beneficial effects are to be seen. On the contrary, the heart's action is usually much excited, and a temporary fever produced. So fearfully has the heart's action sometimes been increased, by anger for instance, that immediate death has resulted. The local effects of some of the sudden exciting passions are extraordinary enough. Thus surprise causes the blood to congeal in the internal organs, and to desert the skin, and thus to render it pale and constricted; while shame produces the opposite effect, making the blood gorge in the skin of the face and neck, or causes blushing. Then sorrow causes the secretion of tears.

On the other hand, the depressing emotions, when they act permanently and without violent agitation, such as the feeling of ennui from want of occupation, the feeling of depression from continued disappointment and hope deferred, or the reproaches of a conscience ill at ease, produce just the opposite effects from the exciting passions. Thus they render the face pale—who does not remember the pale face of sorrow?—the eye dull, the skin readily chilled; they also diminish the excretion of carbonic acid from the lungs, impair the digestion, and in a very marked degree render the body prone to yield to contagion and malaria.

The depressing emotions, when they act suddenly and violently, as extreme horror or grief, tend to produce stoppage of the heart's action, which stoppage is sometimes fatal; and others belonging to this class produce strange local effects. Thus, fear acts on the skin, anxiety stops the secretion of mucus about the mouth, &c.

Besides producing involuntary motions, and influencing the organic functions of the body, emotions sometimes produce sensations. Thus fear brings on a peculiar sensation of chilliness and a constriction of the skin, and horror brings on nausea. Also, various emotions excited in the mind bring on various and sometimes very anomalous sensations. We may cite, as instances of this, the strange sensations experienced by individuals when touched by metallic tractors, and which were just as vivid and intense when fictitious ones made of painted wood were used; and when subjected to the manipulations, &c. of Animal Magnetism.

Not only has the mind an involuntary action upon the body, as exemplified by involuntary muscular movements, and the influence of the emotions, but *sensations* produce effects upon the system that may easily be perceived. Thus the sensation of pain tends to produce weeping, and that of tickling laughter; the sensation of weariness or listlessness produces yawning—a pretty complex operation; and other sensations bring on coughing, sneezing, hiccupping, &c. A peculiar idiosyncrasy often exists in individuals as to the effect of sensations; and what has no effect upon one person, as, for example, various odours, may excite nausea or fainting in another.

It is a very singular fact that all the involuntary actions of the mind upon the body are instinctively interpreted by a spectator. No sooner does an emotion or a sensation produce its effect upon the countenance, and its appropriate gesture, attitude, &c., than a bystander at once understands the nature of that emotion. We say that they are instinctively interpreted, i. e. that the interpretation is not the result of reasoning, for they are very easily understood by young children, moreover they affect us more powerfully than words can do; and, indeed, the expression of the countenance, the sound of the voice, and the whole appearance of an unaffected person under the influence of strong excitement, express more meaning and more shades than words can express or experience learn.

Every body can understand the external effects of emotion and sensations, but a few only of us can successfully imitate them, particularly when these effects are not present before us. To do this, constitutes the art of Acting.

But every one has to a certain extent, when he witnesses these changes in the body produced by emotions, an instinctive desire to imitate them. Thus children almost invariably acquire the gestures, &c. of their companions. The catching nature of yawning, laughing, and crying, is a matter of notoriety. But more striking illustrations of this may be seen in the case of the rougher passions; and very decided imitations of these may be witnessed. The degree to which this imitation is carried depends a good deal upon age and sex, and also upon the nervous temperament of an individual. But, perhaps, the most powerful predisposing cause of all to imitate these expressions is the presence of numbers. In this manner is not only to be explained the rapid propagation of nervous diseases in schools and the like, but also many absurdities of religious fanatiscism, violences of party politicians, and the extreme excitement of courage or depression of panic amongst soldiers.

CHAP. VII.

THE CAUSES OF DISEASE.

Medicine, perhaps, knows more about the causes of diseases and their prevention than about any other subject that comes under her province: and were circumstances such that it were possible she could enforce her rules upon this subject, there can be no doubt but that human life would be very much extended, and much suffering and sickness avoided. We have an instance of what has been done in this respect in the prevention of small-pox. Save in remote districts in the Highlands, where vaccination is either not known or will not be submitted to, this loathsome and fatal scourge of the human race is almost annihilated. But, excepting in this case, the medical men have it rarely in their power to prescribe for the prevention of disease; and their advice is only sought when the malady is formed, too often, indeed, when it has taken too deep root. It is, then, of the greatest consequence that the general public should know something of the causes of diseases, in order that they may avoid and counteract them.

A dozen men, we will suppose, are out shooting together. A storm comes on, and they have to walk home in the rain, which thoroughly drenches them all. Next morning eleven may be none the worse, but one may be laid up with inflammation of his lungs. A dozen men may, habitually, take every day too much wine and butcher's meat; eleven may not take the gout in consequence, but one may become a martyr to it. Twelve men may walk into a fever ward, and only one catch the infection.

That is to say, there are two kinds of causes of disease, existing and predisposing; and that to set up a disease, both must be present. The one in the twelve in whom cold excited the inflammation was predisposed to the disease, the one in the twelve who took gout had probably a hereditary tendency to it, and the one in whom contagion set up fever had the predisposing causes of fever in his constitution. It is often quite impossible to avoid both the predisposing and existing causes of disease; but in a great majority of cases it is possible to avoid one set, and this is quite sufficient for the purpose.

Among the predisposing causes of disease, a foremost place must be given to the hereditary tendency; that is to say, the tendency to particular diseases which is transmitted from parents to children. This is only part of a general law that the offspring inherit the peculiarities of those from whom they are descended. Of this many illustrations must occur to every one. The thick lip of the Austrian dynasty is to be observed in all the portraits of members of the family. The ladies of the Duke of St. Alban's family are said to be striking resemblances to their beautiful ancestress, Nell Gwynne. The members of our own royal family have for generations preserved the same cast of feature. Perhaps the most striking illustration of such hereditary transmission occurs in those cases where something unusual is present in the conformation of some part of the body. Thus the American calculating boy Zerah Colburn had six fingers and six toes, instead of the proper number, and so had a number of his kin; all having derived this peculiarity from a common ancestor four generations back. Haller describes a web-footed family who had inherited the peculiarity from a mother; and Dr. Watson knows a musician whose father, grandfather, and great-grandfather were web-footed.

The diseases, a hereditary tendency to which is transmitted from one generation to another, are insanity, gout, scrofula, and asthma, and, but less certainly, a few other diseases.

Now, if both parents have a hereditary predisposition to the same disease, this predisposition becomes so strong in the offspring that the slightest exciting cause is sufficient to set it up. It is owing to this that marriages between two near relations, i. e. between two individuals with probably the same predisposing tendencies, is so very objectionable.

Any individual with a predisposing cause to any disease will, of course, if he is wise, take great precautions against being exposed to the exciting cause or causes of it.

Another predisposing cause of disease is a state of too great plethora, as it is called. This is caused by too high living and too little exercise. The diseases to which it most predisposes are apoplexy and the inflammations. Its means of prevention are obvious; a diminution of food and drink, and an increase of exercise.

A cause, or rather a set of causes, of a different nature from the above, and which produce deficiency of the circulation, and increase the susceptibility of the nervous system, predispose very extensively to disease, and especially to fevers. These causes are, deficient nutriment, a deficient supply of pure air, long-continued depressing passions of the mind, and excessive and too long continued exertion. Thus it is that we see those fatal epidemics of fever, &c. commit their ravages among the poor inhabitants of our large towns, by far the most wretched class in the community, and not among the same class in the country, the members of which are not exposed to the above predisposing causes: thus they attack the very poor, and scarcely ever the rich; beaten armies, and not victorious ones; distressed and broken-hearted men, and not more fortunate ones, &c.

This cause, or set of causes, is probably the source of more disease than any other in this country, particularly in large towns. Every epidemic of fever that we have had for many years past has been clearly preceded by a state of unusual poverty; and there never has been a state of unusual poverty, but it has been followed by an epidemic and fever.

That in isolated cases, a depressed circulation and susceptible nervous system are the predisposing cause of fever, has been witnessed hundreds of thousands of times. The same has been nearly as often observed in cases of intermittent fever or ague. Thus, soldiers that have been exposed to the exciting cause of it have kept free from the disease when strong, but have taken it after having been weakened by exertion and fatigue. Dr. Gregory used to tell a case in point. His brother-in-law commanded a battalion in the West Indies. He was a strong active man, and did not take fever, although those around him were suffering severely from it. At length he received a wound, and, against the advice of the regimental surgeon, insisted upon resuming his military duties before his strength was restored. The consequence was, that he took so violent an attack of fever, that his life was despaired of.

That a certain amount of suffering, both of mind and body, must be endured in this world, is undoubted; but it may be believed that philanthropy could relieve so much of it as to lessen the mortality at present produced by the cause of disease just mentioned.

Then certain causes predispose to particular diseases, as long-continued exposure to heat, to liver affections and dysentery, — mental emotion to heart complaints, —

mental exertions to diseases of the brain,—and long-continued damp to the formation of tubercles.

Another predisposing cause of disease is previous disease. Whenever a person has had a disease (with some exception, as small-pox, measles, hooping-cough, &c.), he is always more liable to take it over again.

The above may serve as an outline of the predisposing causes of disease. The exciting ones are very numerous. To use the words of Dr. Watson: "Whatever ministers to life, health, or enjoyment, may become the medium, under changing circumstances, of pain, disease, or death. The atmosphere in which we are constantly immersed is full of dangers. Both the organic and the inorganic world of matter around us abound in poisons; they lurk in our very food, which becomes pernicious when taken in excess, or when it consists of certain substances, or certain admixture of substances; so that there really was much truth, as well as some humour, in the startling motto to Mr. Accum's book on Adulterations, 'There is death in the pot.' Our passions and emotions also, nay, even some of our better impulses, when strained or prevented, tend to our physical destruction. The seeds of our decay are within as well as around us."

The following is a list of the most important exciting causes of disease. After enumerating them, we will comment on some of them. First, mechanical and chemical injuries produce disease. Then there are atmospherical changes and conditions,—extreme heat, extreme cold, excessive moisture, excessive dryness, sudden variations, different electrical conditions, different states of the barometer, and too little light. Further, the atmosphere often contains impurities that have the power of exciting disease: these are the matter of malaria, inducing ague; contagion, causing various fevers, &c.; and noxious gases. Excess in eating and drinking are fertile sources of maladies. Various trades and professions have their peculiar sicknesses. Too little exercise sets up disease, and so does too much, as also too little sleep. To the list we must add violent and unrestrained passions, over-solicitude, and excessive mental exertion. Of these, the most important, and those regarding which most is known, are the effects of heat and cold, some dietetic errors, and the action of malaria and the matter of contagions. All these demand a little expatiating upon. We begin with the effects of heat and cold.

The human species can live, and be in health, under a wide range of temperature. In some parts of India, where, too, the white man can exist, the temperature is as high as 120° of Fahrenheit, and during the winter of the Polar regions it has been known to sink to 50° below zero. A little beyond either of these two extremes life is probably impossible. But, for a *short* time, a much higher degree of heat may be borne with apparent impunity. The famous Fahrenheit, whose scale of the thermometer is in common use in this country, was one of the first who experimented upon this subject. He shut up a sparrow, a cat, and a dog in a sugar-baker's stove, of which the temperature was 146°. The sparrow died in less than seven minutes, the cat in fifteen, and the dog in twenty-eight. But, in all probability, the animals did not die from the heat, but were suffocated by the impure air of the stove. The truth upon the point came out by accident. Nearly a century ago, in Angoumais, in France, the corn was found to be consumed by an insect, and Duhamel and Tillet were appointed to investigate the subject, with the view of discovering a remedy. They found that they effected this object by exposing the grain to a sufficient degree of heat to kill the insect, but not sufficiently intense to injure the grain. When they were heating some of the corn in an oven they introduced a thermometer at the end of a long shovel, to find out the exact temperature. This was found to be more than 212°. But Tillet perceived that as the thermometer was coming towards the mouth of the oven the mercury fell. While he was endeavouring to fall upon some plan of determining the real temperature in the centre, a young woman who waited upon the oven offered to go in and mark the height of the mercury with a pencil. She did so, and found it to be 280°. She declared that she felt no inconvenience, and stayed in the oven ten minutes, at the end of which time the mercury was found to be at 288°; that is, 76° hotter than boiling water. Emboldened by finding no bad effect result from her boldness, she ventured into the oven again, and remained there for five minutes, when the thermometer indicated a temperature of no less than 325° of Fahrenheit.

This experiment was published, and various scientific men made further trials with their own persons. One of the most conclusive of these was made by Drs. Fordyce and Blagden. They exposed themselves to a temperature of about 260° without experiencing any inconvenience; and yet this temperature was such as to make their watch-chains so hot that they could scarcely be touched;

and eggs were roasted and beefsteaks cooked by their sides. Their animal heat was not materially affected; and a thermometer placed under their tongues did not indicate much above 100°. Accordingly, when they breathed upon their fingers, it cooled them. In all their trials, however, they found the pulse much accelerated, being sometimes doubled in frequency.

In these trials the exposure to the heat was of short duration. Some cases have occurred which go to prove that a considerable degree of heat, although nothing approaching to the above, may be borne with impunity for a considerable length of time. Thus Sir James M'Gregor, in his account of the passage of our army from India to Egypt, states that although the heat was uniform, and the temperature of the tents kept at 118°, the men were healthy.

But, in general, long exposure to excessive heat produces disease. Of this we witness but too many examples in what happens to our countrymen who have to reside in India and other very warm countries. Three distinct diseases are produced in them by the heat. The enormously additional work thrown upon the skin produces disease of that organ; and every griffin, or new comer to India, has to submit to an eruption of pimples, attended with excessive tickling, and which goes by the name of the *prickly heat.* Then the action of excessive heat is sometimes to produce a concussion and paralysis of the brain. This is called a sun-stroke. But it is upon the liver that the bad effects of heat are most conspicuously visible. The secretion of bile is not only increased in quantity, but vitiated in quality; and various violent and often fatal disorders of the stomach and bowels are the result. The great congestion thus brought about in the liver also predisposes it to various inflammatory affections, which often end in becoming chronic. So extensively are hepatic diseases produced by heat, that few Europeans settled in hot countries escape them.

In considering the effects of *cold* upon the human body, it is necessary to bear in mind whether the cold air is in a state of motion or quiescence. When it is still, so bad a conductor of the heat (produced by the body) is air, that a very low degree of temperature of it may be suffered without inconvenience; but if it be in motion, of course every particle of it that passes over our frames takes away its portion, and its bad effects become very manifest. As an instance of the accuracy of this, we may quote Captain Parry: "With the thermometer," says this distinguished officer, "at −55° (*i. e.* 87° *below the freezing point*), and no wind stirring, the hands may remain uncovered for ten minutes or a quarter of an hour without inconvenience; while with a fresh breeze, and the thermometer nearly as high as zero, few people can keep them exposed so long without considerable pain."

The result of the application of excessive cold is to cause the extremities, and ears, nose, &c., to become frostbitten, i. e. their vitality is destroyed, and they fall off. Cold, likewise, produces general effects. There is, obtuseness of the senses, and often a strong tendency to sleep. If this tendency be indulged in, the obtuseness becomes greater and greater, and the individual at length expires. The adventure of Sir Joseph Banks and Dr. Solander is a classical illustration of this: and at the risk of being liable to the imputation of repeating a thrice-told tale, we subjoin an abstract of it.

Sir Joseph, then Mr., Banks and Dr. Solander, a Swedish physician and naturalist, accompanied by some servants, including two men of colour, went botanizing among the dreary hills of Terra del Fuego. They were returning from the interior towards the coast to rejoin their ship, and were much wearied, having been compelled to travel through swamps for a considerable way. As ill-luck would have it, the weather became very bad and cold, and snow began to fall. A swamp intervened between them and a fir-wood, to which latter it was deemed the best plan to push, for the purpose of erecting a hut to shelter them and kindling a fire. Mr. Banks undertook to bring up the rear, and Dr. Solander, having had experience of the effects of extreme cold in his native country, conjured the company that if they felt drowsiness creeping over them, on no account to yield to it, but to keep moving, concluding his warning with the emphatic expression, "Whoever sits down will sleep, and whoever sleeps will wake no more." Thus admonished, the party proceeded. The cold became still more intense, and the accuracy of Dr. Solander's prediction became manifest. He himself was the first to succumb, and he insisted upon lying down. Mr. Banks entreated and remonstrated in vain; Dr. Solander laid down upon the snow. His friend, however, succeeded in keeping him awake. One of the men of colour named Richmond was the next to succumb; and, in answer to all the reasonings of the others, declared that he wished for nothing but to lie down and die. The rest of the party attempted to carry the doctor and the black man, but found it impossible to do so. They accordingly laid down in some bushes, where they fell into profound sleep. They had been in this state for about five minutes, when one of the advanced party returned with the welcome news that a fire was lighted about a quarter of a mile on. Upon this they attempted to arouse the two sleepers. With Dr. Solander they succeeded, but their exertions on behalf of poor Richmond were useless.

It has been observed by Dr. Watson that many of the cases of supposed drunkenness in poor wretches picked up in the streets by the police are often, probably, instances of stupefaction produced by cold. He quotes an anecdote related by Captain Parry that bears upon this point. This officer, we should observe, had sent a party in search of a missing seaman, who was found, quite benumbed, in the snow: — "The effect which exposure to severe frost has in benumbing the mental as well as the corporeal faculties was very striking in this man, as well as in two of the young gentlemen who returned after dark, and of whom we were anxious to make inquiries respecting Pearson. When I sent for them to my cabin they looked wild, and spoke thick and indistinctly; and it was impossible to draw from them a rational answer to any of our questions. After being on board for a short time, the mental faculties appeared gradually to return with the returning circulation; and it was not till then that a looker-on could easily persuade himself that they had not been drinking too freely. To those who have been much accustomed to cold countries, this will be no new remark; and I cannot help thinking, and it is with this view that I speak of it, that many a man may have been punished for intoxication who was only suffering from the benumbing effect of frost; for I have more than once seen our people in a state so exactly resembling that of the most stupid intoxication, that I should certainly have charged them with the offence had I not been quite sure that no possible means were afforded them on Melville Island to procure anything stronger than snow-water."

The above extreme effects of excessive heat and cold are, however, rarely seen in this country. We have, it is true, derangement of the abdominal organs during summer, produced by the action of heat upon the liver; but these are seldom of much consequence. In the winter, too, in the pastoral districts of Scotland, and occasionally in the cases of vagrants, we see or hear of the fatal results of exposure to excessive cold. But such instances are so rare as to have no effect worth noticing upon the general mortality or amount of sickness. Nevertheless, the influence of the temperature in causing disease in this country, and indeed in all countries, is very great.

Now it is found that a great many diseases are liable to be produced, or excited, in the human constitution if the body, having been hot, is, *while cooling*, or after having been cooled, exposed to cold. Upon this action of cold, however, two erroneous opinions are prevalent.

One of these is, that this action of cold in producing disease is most prevalent in cold or temperate countries like our own. This is quite erroneous. It does not matter whether the temperature be high or low, to begin with: if it fall some ten degrees or so, the sensation of cold is experienced; and if the body be cooling, it is liable to the effects of cold. And, indeed, more disease and more death are induced in tropical countries from this very cause than in Great Britain. Thus, Dr. Johnstone, in his work on the diseases of tropical countries, in speaking of the coast of Coromandel, says, that although the temperature of the day is uniform, and that of the night, as indicated by the thermometer, high, yet the soldiers and sailors are eternally exposing themselves, when tired, to an open port, &c., to enjoy the coolness of the night breeze; and that this exposure is frequently bringing on inflammation of the liver; the liver being the organ attacked, because, from the heat, it is predisposed to disease. In all probability the night breeze, that thus on the Coromandel Coast feels cool, and produces the effects of cold, is 80° of Fahrenheit,—a temperature that would be considered very warm indeed here. In like manner, Dr. Walsh states that after the crew had been for some time accustomed to a temperature of 72°, they happened, as they were sailing along the coast of Brazil, to meet with a strong breeze that brought down the temperature to 61°,—a temperature which we, in this country, regard as very comfortable in our houses. "But," says the Doctor, "the sense of cold from the sudden transition of temperature was quite painful. After bearing it for some time, shivering upon deck, it became intolerable; and we all went below, put on warm clothing and dreadnoughts, and again appeared with thick woollen jackets and trowsers, as if we had been entering Baffin's Bay, and not a harbour under one of the tropics."

Similar results are experienced when the case is reversed. Thus, when a person, after having been for long in a very low temperature, comes into one which is not quiet so cold, but which we would regard as excessively frigid, he feels too warm. Captain Parry gives us an illustration of this. He was in the Polar regions on the 21st of October, during the night of which the temperature fell to 13° below zero. "The wind," writes this distinguished officer, "veering to the south-east on the 24th and 25th, the thermometer gradually rose to 23° (i.e. 9° lower than freezing point). I may possibly incur the charge of affectation in stating that this temperature was much too high to be agreeable to us; but it was, nevertheless, the fact that every body felt and complained of the change. We had often before remarked that considerable alterations of the temperature of the atmosphere are as sensibly felt by the human frame at a very low part of the scale as in the higher. The difference consists only in this, that a change from −40° upwards to about zero is usually a very welcome one; while from zero upwards to the freezing point, as in the instance just alluded to, it becomes to persons in our situation rather an inconvenience than otherwise."

The second erroneous opinion is, that any sudden change from heat to cold is injurious, and that it is to the application of cold to the body when it is much heated that the bad effects known to proceed from cold are to be attributed. This opinion would appear to be altogether unfounded. As is well-known, cold is applied to the heated surface in fever, not only with impunity, but with advantage. The Russians are in the constant habit of rushing from the extreme heat of the vapour-bath to cold water, or even a bath of snow, and are never the worse for it. Captain Scoresby tells us that he often went from his cabin, which had a temperature of 60°, to the mast-head, where the temperature was only 19°, without any additional clothing, save his cap, and felt no injury. In the experiments of Dr. Blagden, before noticed, both he and his co-experimenters came from a temperature of 260° to a cold room without any precaution and without any injury. Innumerable other instances might be multiplied. As long as the body is strong, and generating heat from recent exercise, &c., no harm follows an exposure to a lower degree of temperature; but it is when the hot body is, from weariness or other causes, incapable of maintaining its temperature that disease is induced by the application of cold. Thus, if a person walk in a hot summer's day to a river to bathe, and become heated by his walk, he will, if he immediately take off his clothes and plunge into the stream, sustain no injury; whereas, if he wait to cool, and then go into the water, he very likely will.

The application of cold either to the skin or to the mucous membrane of the stomach, as in the case of a draught of cold water, is injurious, not when applied to a hot body, but to a body, as before stated, either cooling or cooled. The dangerous effect of cold thus applied may unfortunately be witnessed every day. We may give an instance of death or severe disease being induced by a person, having been hot, and being weary and cool, drinking cold water.

Dr. Currie relates a case that fell under his own observation. A young man, who had violently heated himself by playing a game at fives, sat resting himself upon the ground, covered with perspiration. He ordered a servant to bring him a pitcher of cold water from an adjoining pump. The servant did. He took a long draught; he then laid his head on his shoulder, his countenance became pale, his breathing difficult, and in a few minutes he was dead. Quintus Curtius relates that Alexander's army reached the river Oxus, wearied, perspiring, and thirsty, after a march of forty-six miles across the torrid desert. The soldiers rushed to the stream and drank, and the consequence was, he says, that more died from that cause than ever fell in one of his battles.

But the usual effect of the application of cold to the cooling body is not to produce immediate death, but inflammation of some internal organ. Which of the internal organs it shall be, depends upon which is predisposed or congested. In hot countries, as we have seen, the liver is oftener so inflamed than any other. Here, the respiratory organs are, perhaps, the most constant sufferers; but every internal organ of the frame may have inflammation set up in it from this cause.

Dr. Watson, in his lectures to his pupils, advises them how to direct their patients in this respect. His observations,—like, indeed, every thing he says,—are so sound and so impressively worded, that we extract them. "Thus," he says, "you may tell the sportsman that wet feet or a wet skin need cause him no apprehensions, so that he continue in active exercise, and changes his clothes, and avoids all further application of cold as soon as his exercise ends. You may admonish the bather, that, after walking in a hot day to the river's side, he had better *not* wait to cool himself a little before he plunges into the stream; and, in like manner, you may venture to counsel the young lady, who has heated herself with dancing, not to linger in the entrance-hall till the glow has somewhat subsided, but to make the best of her way to her carriage and thence to her bed; and you may tell your male friends who happen to be similarly circumstanced, that the best thing they can do is to walk briskly home in their great coats. The main points to be remembered are, that the heat which is preternaturally accumulated by exercise is held with little tenacity, is dissipated by profuse perspiration, and is speedily lost when to this perspiration is added a state of rest after fatigue; and that in these circumstances the application of cold is apt to be prejudicial."

Hence it is that anything that weakens the body makes it far more liable to take inflammation after exposure to cold. Among the causes that facilitate the evil effects of cold may be enumerated sleep, long study, excess in wine, great fatigue, and the like. Children have far less power of generating heat than adults; and hence it is that an amount of cold that a grown-up person scarcely perceives is often sufficient to produce fatal pneumonia or some mortal inflammation in them. Then, for a reason before stated, cold is much more prone to become injurious when it is accompanied by a wind or draft; and if to the draft moisture be added, then is it most injurious of all. In fact, an individual exposed to wet, cold, and fatigue, is almost sure, unless he can contrive to keep up his natural heat by exercise or stimulants, to suffer.

Several circumstances render the frame less liable to suffer from the effects of cold. We will only mention the force of habit, as it is called. This means, that by custom the body can become, to a great extent, fortified against the injurious effects of cold, and even against feeling the sensation of cold. Perhaps we cannot take a better instance of it than this: if we men, who wear cravats, went for a single day with our neck and the upper part of our bosom uncovered, we should feel very uncomfortable, and, perhaps, catch cold; while many delicate young women can do it with impunity, and without experiencing any disagreeable sensation in consequence.

Now advantage may be taken of this fact, both in the physical education of children and in the physical management of adults also, to harden and fortify the body against the effects of cold. To do so requires great management and skill; but it may be done. It never should be tried upon any body not in perfect, nay, even pretty vigorous health. It consists in habitual exposure to cold, taking care that those conditions that render cold injurious — fatigue, or anything weakening the body — are absent. The two most effectual means of thus fortifying the system are, plenty of out-door exercise, and taking the cold bath at that hour of the day when the body is most rested from fatigue, namely, upon getting out of bed in the morning. If, after the cold bath, however, any chilliness be felt, it must be taken as a clear indication that the system is not able to stand this hardening process. Sometimes when the cold bath, particularly the cold shower bath, cannot be borne, a tepid one can, and can also produce good results.

That a deficiency of pure air is a very powerful predisposing cause to disease, is very evident from the greater amount of disease in large towns as compared with the country, and from the recovery from disease that so often follows removal from the impure atmosphere of the town to the purer of the village. It is probable, too, that impure air aids in exciting scrofulous diseases; although there must, for this end, be conjoined with it hereditary tendency and dampness. Of late it has been decidedly maintained that bad air can *excite* typhus fever. Those who believe that typhus fever always originates in contagion, as the writer of this, in common with almost all who received their education in the Edinburgh school, do, regard this impure air as a powerfully *predisposing* cause to the disease in question. So that, practically, both are anxious to see the bad air of large towns, the dwellings of the poor, workshops, &c., as well ventilated as possible.

Before proceeding to attempt a popular outline of what is known regarding contagion, we will offer a few remarks regarding malaria, the undoubted cause of ague or intermittent fever. This malaria is a certain invisible emanation from the earth, or rather from particular portions of the earth, whose existence we recognise on account of the effects we see. It is necessary to discriminate between this malaria and merely foul or impure air.

Now in order that this malaria may be produced, a certain amount of temperature is necessary. In the Arctic regions it is never found at all; nor, indeed, farther north than the fifty-sixth degree of north latitude. Even in these temperate countries it is not generated during the winter's cold; and it is believed to require a continuous temperature of sixty degrees. As we get nearer the equator, not only does its quantity increase, but so likewise does its virulence; and those of us who live at home can form little idea of the dreadful scourge that intermittent and remittent fevers are in high latitudes.

Besides a certain amount of heat being necessary to the formation of malaria, there must also be moisture. In this country ague is never known excepting in the immediate neighbourhood of undrained fens and bogs; and when these fens are drained, the ague goes away with the water. Draining, moreover, has diminished the mortality of this island on a large scale. The neighbourhood of London used to be very marshy; and ague, and death from ague, were, in consequence, very common. James I. and Oliver Cromwell, for instance, both died in the English metropolis of ague. Now-a-days, the disease is almost unknown in London; and the few cases that do, from time to time, occur, are probably of foreign origin.

Land, also, is necessary for its production. However hot it may be, sailors at sea never suffer from it, although, when they get to land in these low latitudes, they often do so most severely.

Now when heat, moisture, and earth were seen to be necessary for the production of malaria, and also that when these meet together there is usually excessive vegetation, and much decomposition of vegetable matter, it was very natural to conclude that malaria proceeded from decomposing vegetable matter. But this conclusion has been arrived at too rapidly, and is not true; and the decomposition of vegetable matter, although it frequently accompanies the malaria, is only an accidental, and not a necessary companion. We might have suspected this, had we considered that every summer we see vegetable decomposition going on, with moisture and heat, and yet no production of malaria follows. But the merit of proving the unsoundness of the opinion, and of proving that malaria can be produced without any vegetation at all, is due to Dr. Ferguson, whose service with our army gave him ample means of making observations upon malaria.

He found that for the production of malaria a surface capable of absorbing moisture was necessary; also that this surface should be well soaked, and very rapidly dried under considerable heat; and he could not find that anything else was necessary. This chapter is already getting so long, that we cannot do more than quote one of his illustrations. In the year 1809, several of our regiments, then in Spain, encamped in a hilly ravine that had been a water-course. Although the stream had ceased, many pools of water remained, whose contents were so pure, that the men desired to bivouac close to them that they might have their water handy. Before the next morning many were attacked with ague. "Till then," says Dr. Ferguson, "it had always been believed among us, that vegetable putrefaction (the humid decay of vegetables) was essential to the production of pestiferous miasmata; but in the instance of the half-dried ravine before us, — from the stony bed of which, as soil never could lie for the torrents, the very existence even of vegetation was impossible, — it proved as pestiferous as the bed of a fen."

After an individual predisposed to take ague is exposed to malaria, he may take the disease at once, or the poison may remain lurking in his constitution for some time. That this should be so, seems strange; but the fact is undoubted. Another most remarkable fact regarding the malaria is, that it appears to have no influence whatever over men of colour. White men, indeed, sometimes become acclimatised, as it were, to it, but such are invariably sickly and short livers; but a black man not only does not take the disease, but, in the midst of the greatest malignity of it, remains sound in health and long-lived.

Then various and repeated observations have established certain properties of the malaria. One of these is, that it is much more malignant by night than by day. The reason of this, perhaps, is, that the bodily functions are more feebly performed at night, owing to the fatigue of the day, and that the system is thus more predisposed. Whatever may be the cause, the fact is certain. We have but space for one illustration. It has often been noticed, that sailors on a malaria shore may visit it by day with impunity, but not so at night. The "Phœnix" man-of-war was off the coast of St. Thomas, in the Gulf of Guinea, close upon the equator. Of her crew, 280 went on shore, in parties, every day, diverted themselves with shooting, and so forth, and at night returned to sleep in the ship. All these remained in good health. But the whole crew, numbered 296, and the remaining sixteen slept on shore. Of these sixteen, the whole took the ague; and thirteen of them were killed by it. Next year the same ship returned to this island, and the crew again visited it, returning at night to the ship. All remained healthy save ten, who imprudently remained on shore; and of these ten, eight died of ague.

Of course, any one in the neighbourhood of malaria should avoid being out at night.

Another thing ascertained regarding malaria is, that it is very superficial in its action, and has no bad effect whatever a little way from the ground. Those occupying the upper flat of a house situated in a malarious district have often been known to keep their health, while those living below have caught the disease. At Spanish Town, Jamaica, for example, we have, or had, two barracks, one situated higher than the other; and the soldiers living in the low barracks were far more liable to ague than the others.

Still the malaria is borne from one part of the surface to another by means of winds; and a knowledge of this fact may sometimes be of much use to those who have to select the site of encampments, &c. in malarious countries, where trade winds, and the like, often blow for a long time in one direction.

Still greater advantage may often be taken of two other well-ascertained facts regarding it,—that it is neutralised by passing over water (1000 yards of water between the source and a ship have often been known to be sufficient), and that it is absorbed by trees. We have a very striking example of the truth of the latter, in what is done by the inhabitants of New Amsterdam, in Berbice (six degrees from the line). This place is situated on the banks of a swampy forest, to remain in which, at night, would be death to an European. But a strong trade wind blows there day and night. The town is situated on the lee side of the malaria source, and the trees at the edge quite protect the residents.

The last peculiarity of malaria that remains to be noticed is very well ascertained, but quite inexplicable. If, in a malarious country, the soil previously lying waste be cultivated, the ague generally disappears; and, on the other hand, if the country again go out of cultivation, the ague comes back again. Thus, for instance, when East Lothian was but partially cultivated, the disease was common there, to such an extent, indeed, that the reapers of such harvest as there was took an attack of it as a matter of course, while now, in the same district, we suppose, there has not been a single case for twenty years. Now-a-days, the district of the Marumna, in the Papal States, is almost, or nearly, uninhabitable from malaria; and this is believed to have been caused by its depopulation from plague about three centuries ago. We have an instance of a country becoming malarious from depopulation, narrated by Bishop Heber. He says, "At the foot of the lowest hills, a long black level line extends,—so black and level, that it might seem to have been drawn with ink and a ruler. This is the forest from which we are still removed several coss, though the country already begins to partake of its insalubrity. It is remarkable that this insalubrity is said to have greatly increased in the last fifteen years. Before that time, Ruderpoor, where now the servants of the Police Thanna die off so fast that they can scarcely keep up the establishment, was a large and wealthy place, inhabited all the year through without danger or disease. The unfavourable change is imputed by the natives themselves to depopulation. The depopulation of these countries arose from the invasion of Meer Khan, in 1805. He then laid waste all these Pergunnahs; and the population, once so checked, has never recovered itself."

As the exciting cause of intermittent fever is a peculiar substance to which the name of malaria is given, so the exciting cause of continued, or typhus, fever is a particular principle called contagion, which does not emanate from the earth, but from the body of a fevered person. This is taken in usually at the lungs, and is supposed to undergo a process similar to what yeast does in fermentation, whereby its quantity is much increased.

The evidence of a disease being thus contagious lies in this, that when we investigate the history of cases of fever, we find that the majority have been in close and continued intercourse with people sick with fever, and that others living in the same place, and otherwise precisely similarly circumstanced, but who have not held such intercourse, escape.

With regard to this being the case with fever, appears so plain and manifest, that it seems incredible that any person should deny it. The writer of these pages was for long clerk in two fever wards in the Edinburgh Infirmary. During that time, of every twenty fever patients that came in, nineteen stated that they had held communication with individuals suffering from fever; and even the twentieth had often, to his, i. e. the writer's, own knowledge, been so exposed; but, from an unwillingness to allow himself to believe that he was taking so mortal a malady, determined not to admit it.

Upon this head, however, we extract some most conclusive evidence from Dr. Alison. "During this epidemic," (he is speaking of the one in 1828), he writes, "as well as in that of 1817–19, many of the clerks and nurses employed in the Royal Infirmary have taken fever. Since November last, six of the clerks employed in the clinical wards, four of those employed in the ordinary wards, and twenty-five nurses or servants, have taken fever. All these persons had necessarily frequent and close intercourse with the fever patients in the house, having been employed more or less constantly in the fever wards, excepting only four of the servants. Of these four, two had been employed in the laundry, where the linen from the fever wards was washed; one was a porter employed at the gate, who would of course have communication with the fever patients at their entrance or dismissal, as well as with their relations coming to visit them; and one was a nurse employed in the servants' ward, but who was in the habit of visiting the fever ward." So much for positive evidence in favour of contagion. Then comes the reverse side of the picture. He continues: "In this very place and season those of its inhabitants that have *not* had intercourse with fever patients have almost uniformly escaped the disease. Of the inhabitants of the ground floor of the house, none but those already mentioned as having washed the linen from the fever wards, and the barber who shaved the heads of the fever patients, have taken the disease. No one of the nurses whose duty has confined them to the medical and surgical wards, where no fever patients are admitted, has taken fever, with the single exception of the woman in the servants' ward above mentioned. And of the numerous *patients* in these ordinary wards, the only one who has taken the fever within my knowledge during the present year was a patient in the man's clinical ward, who lay in the bed next the door that communicates with the clinical fever ward."

Then, in another place, the same eminent physician says: "Some years ago, at a time when there was no great number of fever cases in Edinburgh, I met with a case in the son of a shoemaker, who was lying in a room in which the father and two apprentices were at work. I could not prevail upon the father to remove his son to the hospital, although I stated the danger of the apprentices being affected. Within two or three weeks after, I found that the two apprentices were lying ill of fever in their own houses; one of them two hundred yards, the other half a mile, distant from the workshop, and widely distant from each other. These young men, likewise, lay at home during the fever, and each of their cases was speedily followed by a succession of others in the inhabitants of the rooms that they occupied, and of those immediately adjoining, who had never been at the workshop. In one of these houses seven, and in the other twelve, were so affected. Now, on the supposition of the fever being contagious, all this was to be expected, and all corresponded to the predictions which were hazarded on that belief. But on the supposition of such succession of fever cases depending on miasmata (those who deny the cause of fever to be contagion affirm that it is miasmata from putrid matter, foul air, &c.), there must have been two, more probably three, separate and accidentally consuming miasmata to explain the phenomena here observed,—one at the workshop, and one at each of the houses of the apprentices; and there must have been this extraordinary coincidence, that at each of these last the malaria sprang up just at a time when a patient was lying ill there of fever, which he had apparently contracted elsewhere. Further, the three houses in which these succession of fever cases were observed are in situations very different from one another; and all of them have been, to my knowledge, perfectly free from fever for years together, both before and since that time, notwithstanding that fever has been much more generally prevalent, and that they have been inhabited by successive families. What probability is there that three separate miasmata should have arisen in these three houses just at the time when their presence was required in order to produce an effect which had been foretold as the consequences of another cause undeniably operating on all."

Besides the contagion of fever, there are other contagions that excite respectively the plague, small-pox, measles, scarlatina, and influenza. The following observations apply partly to the diffusion, &c. of all these, but more especially to that of continued fever.

The matter of contagion is diffused amongst air, and when much diluted with it, loses its poisonous properties. Thus air about thirty yards distant from a fever patient is harmless. Then it unquestionably attaches itself to clothes, furniture, &c.; and may there retain its malignant influence for a long space of time. A temperature of 120° effectually destroys it; and this is perhaps the reason why continued fever is unknown in tropical countries. It appears to have much less influence over a person who has had fever than over one that has not; and in the case of small-pox, measles, and scarlet fever, one attack renders the person safe from another. The very curious discovery that immunity from small-pox was obtained not only by having that disease, but the very trifling one of chicken-pox has saved the lives of thousands.

Then, among other exciting causes of disease, errors in diet occupy a prominent place. Deprivation of fresh vegetables for a length of time excites scurvy, too much meat and wine, gout; and intemperance, disease of the brain and other organs. Further, not taking a due mixture of albuminous, saccharine, and oleaginous principles for a continuance, produces different states of the system that induce disease. But we have dwelt so long upon the causes of disease, that we must here close this interesting and very important subject.

CHAP. VIII.

THE WAY PEOPLE DIE.

As we before mentioned, all individual vital action is essentially temporary in its nature; and every living thing, whether a simple moss, an oak, a worm, or a man, must die. The material elements that fôrm our structure lose their power of exercising those peculiar vital actions that characterised them, yield to putrefaction, and serve to furnish food for plants. We also stated that two general conditions were essentially necessary to be present in order that life may be continued in an individual,—the circulation of the blood, and the exposure of the same blood to the air. Now it is evidently one of the intentions of Nature, that by diseases, or by that rare malady, old age, obstacles should be put to this circulation of the blood and its aëration. It is these stoppages that terminate our existence in this world. They are the causes of that which we instinctively dread, which we drive so from our thoughts, and which we strive so to avert: they are the causes of Death.

The aim and end of the art of the physician is to combat this death; and accordingly the exact nature of the different ways in which these stoppages to the two important functions of circulation and respiration take place have been much investigated. We here present a very rapid summary of them.

There are three ways in which people die: when the blood will not circulate,—and this way of dying is called fainting or syncope; when the air cannot get to the lungs,—and this is called choking or asphyxia; and when we do not know that we ought to try to breathe,—and this is called stupor or coma. Each of these three ways in which people die demands a little separate attention.*

One of the most striking illustrations of death by syncope is to be seen in cases where a very large blood-vessel is wounded, and when, to use the popular phrase, "the person bleeds to death." The blood does not circulate, for the very best of all reasons, there is none left to circulate in the body. The appearances witnessed in a death of this kind are paleness of the face, cold sweat

* Perhaps the ways in which people die would be more intelligible, if the reader would re-peruse chapters II. and IV., on The Way the Blood is Moved, and the Way we Breathe.

on the brow, a weak pulse, a feeble breathing, a sigh, a gasp, a convulsion or two, and all is over. The sensations felt are, probably, a singing in the ears, a flash of light before the eyes, followed by dimness of vision, and then a placid insensibility.

But the blood may cease to exist in the blood-vessels from another cause than from the blood being taken out by a wound. We have seen that the body is always abstracting from the blood. If, then, the daily supply of new materials to the blood be cut off, the blood diminishes in quantity, and by-and-by death by syncope comes on. The most perfect example of a death brought on in this manner is in a case of death by starvation. But when, as in many diseases, the digestive organs cannot assimilate a sufficient quantity of food to keep up the normal quantity of the blood, death is produced in this way.

Further, if the quantity abstracted daily from the blood be greater than the digestive organs can, even if acting pretty well, make up for, although death is not, as in the case of bleeding to death, sudden and instant, it is as certain, and brought about in the same manner. In this way, people often die in cases of dysentery, and other exhausting and lingering disorders.

Again, certain violent concussions of the nervous system, and pain in the abdomen, have a powerful depressing effect upon the circulation, and sometimes bring it to a stand. People do not very often die from the first of these causes; but in cases of fatal inflammation of the bowels, and of cholera, the circulation is thus brought to a stand, and thus death is produced. When death takes place from lightning, or intense mental emotion, it is owing to, in part at least, the violent concussion upon the nervous system.

The simplest illustration of death, in the way of choking or asphyxia, is witnessed when a mechanical obstacle around or in the windpipe obstructs the passage of air to the lungs. When this is done suddenly, the symptoms witnessed are tremendous attempts to move the midriff or diaphragm, and violent clutching with the hands; the eyes seem as if they would protrude from the head: these symptoms, in a very little time, cease; then there is insensibility and convulsions; then irregular tremors of the muscles; and, lastly, the scene closes. The sensations, for a moment or so at first, are extremely painful,—absolute agony; but this soon ceases, and the feeling becomes, it is believed, not painful at all: then there is vertigo, and this is followed by total unconsciousness. If, however, the obstruction to the air getting at the lungs comes on by degrees, none of the above violent and distressing symptoms are to be seen.

In cases of disease, the obstruction to the breathing is rarely brought on with sufficient rapidity, so as to produce the violent symptoms; although, in cases of inflammation of and rapid effusion in the windpipe, &c., it sometimes is. But death in the way of asphyxia, but produced in a slower manner, is common. Many diseases of the lungs, as inflammation, consumption, &c., render these organs quite unable to perform their functions, and induce death in this way.

The last way in which people die is by coma, or stupor. We have before said that the reason we inspire, or breathe, is because the venous blood in the lungs gives rise to a sensation which is transmitted to the medulla oblongata by means of nerves; and that whenever this sensation is experienced, the movements that take a supply of air into the lungs are made. If, from the medulla oblongata being diseased, this impression is imperfectly felt, only imperfect attempts at breathing are made; and if this impression be not felt at all, no attempts whatever are made to breathe. When such is the case, the individual so affected is said to die in the way of coma.

The symptoms witnessed in a case of this kind are slow and irregular acts of inspiration; and the individual so affected with such imperfect breathing snores: there is complete insensibility to all external impressions, or internal acts of the mind; the breathing becomes slower and slower, and at length no blood becomes arterialized, and the man dies. No painful sensations, or, indeed, sensations of any kind, are felt.

In water in the head, apoplexy, and fatal cases of diseases of the brain, the death is usually in the way of coma.

We possess means which, in a great many cases, are able to obviate these fatal tendencies in diseases to death in the way of syncope, asphyxia, and coma; and it is in finding out, in each individual case, and sometimes in long foreseeing, the particular fatal tendency, and in administering the proper remedies against it, that the skill of the physician is based; and upon this depends the safety of the patient.

CHAP. IX.

THE WAYS THE DOCTORS HAVE OF PREVENTING DEATH.

It is very difficult to decide with certainty upon the real effect of remedies. Every one is too prone to ascribe the good effect which is seen to follow their administration to his own interference, and not to something collateral, or the very strong tendency always shown by nature to bring about a spontaneous return to health. It is the difficulty of discriminating, or, indeed, perceiving this latter, that renders people so deceived by quacks and quack medicines. But that remedies, scientifically administered, do cure disease, and ward off death, is unquestionable. Of these remedies there are two or three whose action we cannot explain, and which may be said to *cure* disease. Of these, the best example is Jesuits' bark, which certainly cuts ague short. The popular opinion is, that all drugs act in this way, and so cure disease. This, however, is not the case. The correct way of treating disease is to look beforehand, and perceive in what way the malady threatens to prove fatal, and then to excite in the system an action opposite to the fatal tendency.

Thus we possess a class of remedies called stimulants, the members of which have the power of exciting and invigorating, for a time, the circulation. Are we, then, in fear of immediately losing a patient in the way of syncope, we administer stimulants; but if we have more time before us, and we perceive that the sick man has a wasting disease which will ultimately end in syncope, but not for weeks, or perhaps months, we employ another class of remedies called tonics, which do not stimulate the circulation so violently at the time as stimulants, but whose stimulating effect is more permanent.

On the other hand, we may have too strong a state of the circulation, tending to coma, or, in conjunction with inflammation, tending to asphyxia. We then use sedatives, as they are called,—a class of remedies that depress the heart's action. Of all the sedatives, perhaps, bloodletting is the most effectual; and when there is no immediate hurry, abstinence from food has a powerful effect in this way.

Sometimes our object is not so direct as we have hitherto supposed it to be. If a man, for example, swallows a poison, we possess a class of remedies,—emetics, that have the power of ejecting it from the stomach. Then we possess a class of remedies, of which diaphoretics (producers of increased perspiration) may serve as an example; these diminish the quantity of the blood, draw off the serous part, and in other respects weaken the circulation; and hence may be used in a variety of maladies. Sometimes the danger to be feared in disease is death by syncope, brought on by debility from excessive secretions. We possess a kind of remedies called astringents, that can often prevent this.

Another very important set of remedies, the narcotics, alleviate pain and procure sleep. Antispasmodics remove spasms; and those called stomatics are believed to act through the nervous system, and improve the digestion and appetite.

Many more classes of remedies might be enumerated; but our object is to show the principle upon which therapeutics, or the art of treating disease, should be based. The value of experience in it is owing to it giving a facility of seeing long beforehand the changes that will take place in disease; and in being able, when one class of remedies is wanted, to pick out the individual member of that class most suited for a particular case.

We have now completed the task we assigned to ourselves in compiling this little book. We meant to give, in popular language, an account of creation, not merely as it was, but as it is going on daily around us. We take the first creation, or formation of the world, as the first creation of each plant and animal, to be the result of miraculous power. We have seen that probably the world was first made without life upon it, and only gradually prepared for life, at first of a very humble nature, to dwell upon it. We have also endeavoured to trace the wanderings of the same particles of matter from the inorganic world to the vegetable; and from that to the animal, and then back again. We have then considered the more important functions of animal life, and likewise enumerated the causes of disease in man, also not only the certainty, but the modes of death in him, and the action of remedies upon his frame. With two remarks we now close this essay.

Although we have of necessity been very brief, we believe that we have given a tolerably faithful account of the most recent discoveries of physical science, upon the topics of which we have treated. This physical science has too often been, and even yet too often is, considered as teaching something different to, and opposite from, the truths contained in the Sacred Writings. To those who have said this, it has been remarked, and with great propriety, that the object of the Sacred Writings was to teach religious truths and moral duties, not principles of science. But in many cases, the supposed discrepancy between Scripture language and scientific deductions has been discovered to be no discrepancy at all. Now, without assigning too much value to it, we may point out that many expressions used in the Bible, some of which were thought metaphorical, and some of which were unintelligible, express, in a manner at once clear and emphatic, the very scientific principles we have attempted to explain. Thus we may instance: "In the beginning God created the earth;" "The Lord God made man out of the dust of the earth, and breathed into his nostrils the breath of life; and man became a living soul;" "In the sweat of thy face shalt thou eat bread till thou return to the ground; for out of it wast thou taken: for dust thou art, and unto dust thou shalt return;" "The blood is the life;" "We die daily."

Our second remark is this. We have seen that every living being inevitably ends in death; and that every one of us is carrying within him, and causing to germinate, the seeds of his own destruction. Nor is this constant change going on only in the living world: the very ground on which we dwell is in a state of eternal transmutation. As our elements are always being replaced, and our appearances altered, so also is the globe always undergoing revolutions. This land on which we live once formed the bottom of an ocean; and where the wild waves of the Southern Ocean roll along in their vast expanse was once probably a huge continent. And causes are, perhaps, now at work, tending to again submerge this northern end of the globe, and once more to drive the ocean from the south. As everything is evidently formed on one great and uniform plan, as the operations going on in the framework of the earth, and in the living bodies upon its surface, have so many strong analogies, and as all these living bodies end in death, is it not probable, it may be asked, that the time will come when the globe itself will come to an end? And if it be so, can science detect the provision that is possibly made for this consummation of all things?

We have seen that the atmosphere has for long been undergoing a change; that, at a very early period, it was charged with carbonic acid, the carbon of which now forms part of animal and vegetable structures. We saw, also, that at first it contained no ammonia. But since vegetation and decomposition began, the nitrogen that existed in the nitrates of the earth, and some of the nitrogen of the atmosphere, have been gradually entering into new combinations, and forming ammonia, — and the quantity of ammonia, a substance at first non-existent, has gradually increased; and as it is volatile, the atmosphere now always contains some of it. The quantity has now become so great in it, that it can always be detected by chemical analysis. There is an evident tendency of it to increase in the atmosphere. Now supposing it to go increasing up to a certain point; it forms with air a mixture that, upon the application of fire, is violently explosive. An atmosphere charged with ammonia is liable to explode whenever a flash of lightning passes through it. And such an explosion would doubtless destroy, perhaps without leaving traces of, the present order of things. Do any expressions of Revelation seem to refer to such an end of the present creation? We dislike, in a popular book, to quote too much from the Sacred Writings; but we may, perhaps, be allowed to extract the following detached passages:—

"And there came down fire from God out of heaven; and I saw a great white throne, and him that sat on it, from whose face the earth and the heaven fled away: and I saw the dead, small and great, stand before God, and they were judged every man according to their works: and I saw a new heaven and a new earth, for the first heaven and the first earth were passed away, and there was no more sea. And he that sat upon the throne said, 'Behold, I make all things new.'"

THE END.

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INDICATIONS OF INSTINCT.

A SEQUEL TO

"THE NATURAL HISTORY OF CREATION."

BY T. LINDLEY KEMP, M.D.

Out of the eater there came forth meat.—SAMSON.

LONDON:
LONGMAN, BROWN, GREEN, AND LONGMANS.
1854.

ADVERTISEMENT.

THE main object of this small book is to attempt to present to the traveller a little popular scientific reading, which, it is hoped, may be interesting to him; but in writing it I have also had another intention before me.

If we consider the history of physical science since the time of Bacon, we find that, from time to time, some branch of it has been held to be in opposition to principles that are derived from another source. This has particularly been the case, in succession, with astronomy and geology. Hitherto, as the subjects have been more investigated, and looked at in a broader light, this discrepancy has turned out to have no existence. Of late, the general contemplation of nature has been maintained to establish materialism, and not to accord with the doctrine of a creative cause, or a future state of human existence; and this has, somewhat strangely, been most insisted upon by those who, in other respects, are so credulous as to believe in follies so unsupported by evidence as the doctrines of animal magnetism and the like.

My belief is, that the general contemplation of nature leads to deductions the very opposite of those referred to above, and my second intention in writing this little book has been to try to indicate this.

INTRODUCTION.

Man is so apt to exaggerate his own importance, that we are in the habit, even when speaking pretty accurately, of defining the history of science as the history of the human mind's becoming acquainted with its principles. We sometimes talk as if gravitation had no existence until it was discovered by Newton; and we use expressions as if chemical affinities were brought into play by the French philosophers of the last century, or as if that, perhaps, most remarkable power of all —that of catalysis—was called into being but a few years ago. And yet it is evident that all these were producing their wonderful results long ere mankind appeared upon the scene; and the true definition of the history of science is that which gives an account of the successive developments or creations of scientific principles. To do this is almost above the powers of the human mind, and little beyond a very feeble outline can be guessed at. Still we may safely conclude that science is not eternal, and that, moreover, of the scientific principles that are now in full operation, all are not equally ancient. Neither does any known scientific principle seem to be a necessary property of matter, but only temporarily communicated to it by an act of arbitrary will.

For instance, when with the geologist we study the history of the matter of this planet, we can perceive that there was a time when there were no laws of vitality in operation. We may go further, and affirm that at one time there was no chemistry, nothing but mechanics, or the principle of gravitation. Indeed, at the present day, by such a heat as we can produce, we can alter and annihilate chemical affinities. And the intensity of heat that we know at one time prevailed, was such as was quite incompatible with the play of chemical affinity. The matter that formed the globe then was that which forms it now, but every element must have been by itself in a state of vapour; and in the vast nebulous mass that the world would present no alliances were possible. Accordingly when we come, at the present day, to examine those elements that we know would first cease to be vapour and solidify, we still find them alone. Gold and platinum never occur in ores.

Indeed, it is possible that there have been two chemistries—the one that now is, and one, possessing other affinities, that intervened between its occidence and the time when gravitation ruled alone. At any rate, while we can synthetically construct almost all minerals, there is one which we have no power of artificially forming. Let us torture carbon as we will, we cannot obtain a diamond; and that gem must have been formed under the influence of laws of which we are altogether ignorant, and which perhaps do not now exist. The diamond is to the chemist what the mastodon is to the geologist—a thing of the past. Nay, although it is perhaps refining too much, it is not unlikely that, ere matter was endowed with gravitation, it was subjected to other laws, and that a science was then in existence, the nature and principles of which, at least as mortal beings, we shall never know.*

* The idea suggested in the text, of the successive creations of sciences, or endowments of matter, seems to accord with the Mosaical

However this may be, we are entitled to affirm, that at one time the only great scientific principle that was at work was that of gravitation, under the influence of which the gases and vapours that constituted this globe were held together, and prevented from flying off into space. And also, that subsequently matter, or at least the elements that compose the crust of the earth, was endowed with those wonderful chemical properties by means of which some elementary bodies (for all practical purposes some dozen only in number) unite together in such proportions as to form the infinite variety of compounds that are to be found in the earth, the water, and the air.

Both these two principles of mechanics and of chemistry may be regarded as the development of the powers of motion. Gravitation is a property possessed equally by all particles of matter, and which makes

cosmogony. According to Moses, "in the beginning," as far as relates to this planet, or rather planetary system, matter was called into being —"in the beginning, God *created* the heaven and the earth." The next recorded step is the creation of light; after that a separation of the elements, or the birth of chemistry; and then vegetable life or physiology appears upon the scene.

them tend to fall towards a common centre. Chemical affinity, again, is a property with which the different elementary principles are variously endowed, and which make the particles of any two (or more) elements, if they are very near to each other, approach still nearer, and form an union. How long the world rolled on with its substances affected by none but these two powers, it is impossible to say; but about the epoch when the greywacke was in process of being deposited, a new science was created, one characterised by new motions—that of vitality, of life; or, to use the modern expression, physiology.

Under the influence of this science, portions of these dozen elements just noticed, and which constituted the greater part of the vast cloud of the mechanical world, and subsequently of the crust of this planet, when it had been put under the control of the laws of chemistry, were grouped together, and made to form separate existences—plants and animals—and which separate existences were endowed with very new and characteristic properties. Among these was a suspension or obliteration of the laws of motion, as witnessed in merely mechanical or chemical bodies, and the substitution of altogether new laws of motion. The elements composing a plant or animal, although taken from the crust of the earth, do not, as constituting that separate existence, tend to fall towards a common centre; neither do the sulphur and iron which they all contain, however close they may be put, unite and form pyrites, as in the world of chemistry. Still they have very definite and wonderful motions.

All these motions of vitalized beings may perhaps be arranged into two divisions. The one includes those movements which take place only in their own structures, without reference to any other external object, as the circulation of the sap or blood, and so forth. Of these, the little book of which this is a sequel, the "Natural History of Creation," attempted to give a feeble outline. The other division takes in those movements which are invariably performed when some other external object is near, and in consequence of the presence of that external object, and which are called instincts. Thus, when certain species of *Confervæ* wander about in the ocean until they find a sufficiently shady spot, where they take root and remain fixed until they die; when the chick knocks a hole with its beak in the thick end of the shell in order to escape; when the bee constructs its cell; or when the *Dionæa* catches a fly, we have instances of those peculiar movements called instincts.

Many who have not particularly investigated the subject, are apt to shrink from the belief in a vitality without consciousness. But it is plain that conscious ness has no necessary connection with life. All the powers of life are common to the plant and to the animal; and, as plants are more numerous than animals, there are more living beings that have not consciousness than that have. Indeed, many of the lower animals can and do remain alive while in a state of complete unconsciousness; and even in the higher a portion of their time is passed in a state of nearly complete (not, however, of quite complete) unconsciousness or sleep.

Nevertheless, there is a prevalent belief that instinctive motions only take place in beings that are cognizant of them. This it may be safely maintained is not the case. On the contrary, evidence will be brought forward in the following pages, that seems to indicate that instinctive movements are more complex and intricate in plants than in animals—perhaps more in the lower animals than in the higher—and that, as we advance in the scale of animal life, they gradually diminish until they disappear. All these "indications of instinct" are surely not only interesting in themselves, as being, like gravitation or affinity, examples of peculiar properties of matter; but likewise as contrasting strongly with, and differing from, the operations of reason and of spirituality.

INDICATIONS OF INSTINCT.

CHAPTER I.

THE INSTINCTS OF PLANTS.

THAT varied and complicated movements take place in many plants has long been known. But such have been little investigated, and the nature and end of them have generally been passed over in silence. They are, however, very clearly examples of instinctive movement, and in many cases serve highly important and essential ends in the vegetable economy, although from our imperfect observation we cannot always point out decidedly the results that they produce.

A very familiar instinctive movement that occurs in plants, is the opening and shutting of the flowers. Generally, these organs are spread open so as to expose the stamens and pistils to the action of light during the day, and closed during the dark, so as to protect from external injury these delicate organs. A good deal of variety, however, prevails in this respect. Some plants, as the *Portulaca oleracea*, only open their flowers for about one hour daily, and this at midday. The *Oenothera biennis*, on the contrary, keeps its flowers shut all day, and only opens them when night comes on; and when the sun rises the flowers close again unless it be a very cloudy day, in which case the plant only shuts its flowers partially, or not at all. The flower of the common dandelion generally lives two days and a half. On the first two days it is awake, and is expanded in the earlier part of the day, and shuts at night; but on the third day it closes about midday, and this closing is followed by the death of the corolla. Moisture appears necessary to plants of the *Carlina* species, (a near relation of the thistle;) and accordingly, on a dry day, the flowers shut, and thus lose no water by evaporation. When the atmosphere becomes charged with moisture, the flowers re-open. Still more remarkable is the *Nymphæa alba*, or water lily, which, when night comes on, not only closes its flower, but gradually lowers it until it is beneath the surface of the water, and thus reposes submerged.

Another example of an instinctive movement for a very definite end may be noticed in the common berberry. The flower of this plant contains six stamens which surround a single pistil; the stamens being inclined back upon the petals, and so away from the pistil. If, however, any of the stamens be touched near the base, it immediately starts forward to the pistil, and strikes the top of that organ with its anthers. It soon resumes its original position. Of course, the same effect is produced whenever an insect alights upon them. Whenever the anther is ripe, and an insect enters the flower, the filament strikes against the pistil with such force as to burst the anther, and thus scatter the pollen upon the pistil, and thereby produce a seed. There is another plant, the *Cactus tuna*, which, whenever an insect enters its ripe flowers, immediately inclines all its stamens over the pistil. In a somewhat similar manner, if the stalk of the stamen of the *Cetasetum* be disturbed, it springs up with such violence, that the top of it is broken off, and actually darted to a very considerable distance.

The motions of the leaves of plants must have been noticed by every one. The most common instances of such are called, in ordinary language, the sleep of plants, although the expression is a bad one. The phenomenon was first noticed by Linnæus. He was carefully cultivating some lotus plants, or birds'foot trefoil, one of which had two flowers. Chancing to look at the plant one evening, the flowers were not to be seen, and Linnæus supposed that some one had plucked them. The next morning, however, they were again visible, but on returning at night they had once more vanished. The plant was then carefully examined, and it was found that the leaflets had altered their position, approached one another, and by so doing concealed the flowers. Extending his observations, Linnæus found that something analogous to this occurred in all plants. Generally this folding of the leaves takes place as darkness comes on, but is in reality performed independently of light and darkness; and it has been ascertained, that plants kept constantly in the dark, open and close at regular intervals. It by no means follows that the leaves of plants close in this manner at the same hour that the flowers do. Berthollet watched an acacia, the leaflets of which closed at sunset, and unfolded at sunrise, while its flowers closed at sunrise and expanded at sunset.

The manner in which leaves change their position is various. Some raise their leaflets so that their upper stalks are brought into contact, while others depress theirs so that their under surfaces meet together. Others, again, undergo other contractions.

The sensitive plants afford very striking illustrations of movements performed by vegetables. The most common of these is the *Mimosa pudica*, an annual, the leaves of which fold up on being touched, the phenomenon taking place at so early a period in the existence of the plant as from when its cotyledons have expanded. If the stimulant be applied in sufficient intensity—as if, for example, a leaflet be touched with a burning candle, or if the sun's rays be concentrated upon it by means of a line, this leaflet immediately moves, and also the one opposite to it; both bringing their upper surfaces into contact, and at the same time inclining forwards or towards the extremity of the small petiole on which they are seated. Then other pairs of leaflets, nearest to that pair first touched, close one after the other in a similar manner, and next the partial petioles fold together by inclining upwards and forwards, after which the common petiole is affected, but it bends downwards, having its point directed towards the ground; that is, in an opposite direction to that in which the previous movements have been made.

Many other plants possess this property of taking on them extraordinary motions when any thing comes into contact with them. The object effected by them all is, probably, to shake off slugs and similar vermin. Among these other plants, the leaves of which assume these contortions, are species of *Smithia* and *Biophytum;* and, in Senegal, a plant grows called by the natives "how dy'e do," on account of its performing a sort of salaam or bow on being touched.

In some species of plants the mere contact of the air apparently seems sufficient to excite a continual degree of spasmodic action, if the expression may be allowed, for the sake probably of protecting themselves from the depredations of insects. There is, for example, the *Desmodium gyrans*, a native of Bengal, where it is called *gora chand*, and which was brought into notice by the younger Linnæus. "No sooner," wrote he, "had the plants which he raised from seed acquired their ternate leaves, than they began to be in motion in every direction: this movement did not cease during the whole course of their vegetation, nor were they observant of any time, order, or direction; one leaflet frequently revolved while the other on the same petiole was quiescent, sometimes a few leaflets only were in motion, then almost all of them would be in a movement at once; the whole plant was very seldom agitated, and that only during the first year of its growth, and was not at rest even during the winter." Examples of this plant that have been cultivated in our greenhouses, although they have exhibited very well these strange movements, have not been agitated so much as when growing in their native country, or as those brought thence by Linnæus. This is probably owing to the careful culture of our gardeners, and to the climate, both of which preserve them from the more active of their insect tormentors. Burnet, who watched their movements in a glass conservatory, made the rather remarkable discovery, that although they might be temporarily restrained by force; yet that, when the restraint was removed, they immediately moved about with increased velocity, so as to make up for the time which they had lost. Decandolle also observed them, and he related that their leaves consist of three leaflets, two lateral, and one central and terminal. Their movements, he describes, take place by little starts, like those of the second hand of a watch; and he further remarked that the one at one side went up, so as to form an angle of about fifty degrees over the level of the petiole, and the other on the opposite side went down as much. This process was then reversed, and repeated alternately. The terminal leaflet is also continually inclined first to one side and then to the other.

There is a natural family of plants principally inhabiting tropical countries, and abounding at the Cape of Good Hope, where they are objectionable on account of the extremely fœtid nature of the odour of their flowers, examples of which are occasionally cultivated here. The members of this family afford very extraordinary instances of instinctive movements. Plants belonging to it are known from all others by having their pollen grain contained in bags, from which their escape seems almost impossible. However, when the time comes for their seeds to be formed, a small tube grows from each pollen grain, and these tubes all direct themselves towards a thin spot of the bag which holds them. This they pierce, and then direct themselves towards the stigma. To effect this object they have sometimes to ascend, sometimes to descend, and at other times to proceed outwards at right angles; but they invariably hit the exact direction, according to the position of the flower, and arrive at the stigma, and thus the seed is fertilized.

A plant grows wild in Carolina called the *Dionæa muscipula*, or Venus' fly-trap. "The leaves of this," says Henslow, "consist of a flattened petiole, at the extremity of which two fleshy lobes, which lie, when expanded, in the same plane with the petiole. These lobes are capable of being elevated and brought together into a position perpendicular to the surface of the petiole. They are furnished with *cilia*, or bristles, round their margins, which stand nearly at right angles to their upper surface; and there are, besides these, three little short bristles placed upon the upper surface of each lobe in a triangular order. When a fly or other insect, crawling over the surface of the lobes, touches either of these latter bristles, the irritability is excited, the lobes suddenly close, and the insect is imprisoned like a rat in a common gin. Some little time after the death of the insect, the lobes unfold, and wait for another victim."

It appears probable that the plant makes use of the fly, although it is difficult to conceive in what manner. Mr. Knight experimented upon a number of these plants, all of which were placed so that no insects could get at them. He furnished the leaves of some with scraped beef, leaving the others without any such provision; and he found that the plants supplied with the beef flourished more than the others.

We possess in this country three species of *Drosera*, or sun-dew, all of which exhibit similar instinctive movements, the result of which is to catch insects. The upper surface of their leaves is furnished with long hairs, which terminate in glandular and viscid globules. An insect alighting upon them first gets entangled in the viscid matter, and then the hairs begin to move in, close upon it, and hold it until it is dead.

But perhaps the most extraordinary of the fly-catching plants is the one described (somewhat obscurely) by Mr. Drummond, who found it in the Swan River colony. The lower lip of the flower of it, he states, is a boat-shaped box, in which the anthers are situated, and the upper one, which he thinks is a stigma, forms a door or lid, which exactly fits it. The hinge upon which this lid moves springs from the upper part of the flower, and "when it opens, the upper part turns round within the box, comes out at the bottom, and turns up and back, so that when fully expanded it stands fairly over the flower. The moment a small insect touches the point of the lid it maks a sudden revolution, brings in the point of the lid at the bottom of the box, so that it has to pass the anthers in its way, and makes prisoner any small insect that the box will hold." He adds that, if the insect be caught, the box remains shut for some time; but that, if the animal has managed to fly out, it soon opens again.

Still more surprising acts of motion take place in the lower plants. Among the *Confervæ*, or jointed *Algæ*, is a genus called *oscillatoria*, the members of which might almost be mistaken for a number of worms writhing together. These shift their position with very considerable alacrity. If, for example, a patch of them be placed in water in a plate, and a black bell glass be inverted over them in such a manner as not to quite touch the bottom of the plate, the *confervæ* in a very short time will be found to have glided out at that side of the bell glass most exposed to light. They have been observed to travel in a few hours to a distance of ten times their own length. The young of certain species of them, too, when separated from the mother plant, move onwards in the water with velocity until they reach a shady spot, when they take root and remain fixed.

The climbing plants also appear to have a kind of instinctive motion, and those of the same species move always in the same direction. Those that move from right to left, never, under any circumstances, move from left to right, and *vice versa.* Thus the hop invariably turns from the left to the right, and the stem of the convolvulus or bindweed always turns from the right to the left.

It is probable that still more remarkable instinctive movements take place under ground. The structure of plants consists of about a dozen elementary substances, all of which are present in fertile soil; and it is from the soil (and also, with regard to one or two elements, from the air) that they obtain them. The roots send forth radicles, which move on until they arrive at particles of the different elements that the plant stands in need of. And the distance to which one of these radicles will so travel is often very great. Moreover, the difference between different plants mainly depends upon the varying proportions of these elements of which their structure, and consequently their food, is composed. The ash of bean, for example, is found to contain nearly fifty per cent. of potassa, and about six of silica; while that of barley has not eight per cent. of potassa, and more than fifty of silica. If the half of a field, the soil of which is quite uniform, be planted with beans, and the other half with barley, the rootlets of the bean and barley plants wander along under ground until they come into contact with just the requisite quantities of those two substances, and when they have obtained the requisite quantities seek no more. Those of the bean plant wander on until they have formed the large amount of potassa, and those of the barley of silica; while the bean roots are content with having found the small quantity of silica, and the barley ones the comparatively small amount of the alkali.

As is familiar to every one, there is a regular gradation in the different classes of living beings. We are in the habit of pronouncing cryptogamic plants as less perfect than flowering ones, polypi as inferior animals to reptiles, reptiles to birds, birds to mammals; and among mammals we assign various degrees of rank, esteeming a dog or an elephant as superior to a sloth or a mole. It must not be supposed, however, that all the endowments go on increasing according to the scale of increasing perfection. Indeed, in one respect, in that which now employs us—the instincts—the very reverse is the case, and some of the most striking of the instinctive arts are to be witnessed in the beings that are ranked as lowest. This being the case, we should expect to find that these instinctive movements in search of food are most energetic in the lowest plants; and such is certainly the case. A fungus, as a common edible mushroom, may be at sunset a mere dot of matter, scarcely or not at all appreciable to our senses, and may by next morning be a large plant that weighs a pound. This indicates an immense activity of its radicles during these few hours, and a degree of instinctive movement and instinctive selection that is very extraordinary.

CHAPTER II.

THE INSTINCTS OF ANIMALS LOWER IN THE SCALE THAN INSECTS.

ALTHOUGH not in accordance with the usual classification, we may regard all the other non-vertebrated animals as lower in the scale than insects. The number of these is almost infinite, and the complexity of their instinctive movements very great. They are, indeed, much greater than is known, for most of them inhabit the depths of the ocean, and the observations of their habits have necessarily been very imperfect.

Several orders of these amimals are so very low in the scale, that they were long thought to be plants; and indeed, although they are known to be animals, their nervous system has never been discovered. They manifest very complex instinctive movements, and the result of some of such is very important, being in one instance actually to produce a new geology.

One class, that of the *Infusories*, consist of animals so minute that they cannot be seen by the naked eye, some of them being so very little as not to be longer than the one two-thousandth part of a line. They are, nevertheless, universally diffused, being found in the sea, in fresh water, in the air, in blood, in animal and vegetable substances, &c. Their number too is infinite, and hundreds of thousands may exist in one single drop of water. They exist, too, in immense variety. Most of them have bristles, or tentacles, around their mouths; when hungry they rotate these, and thereby create a current of water, which flows into their mouths and brings along with it their food. It is rather remarkable that the instinctive movements by means of which these, the smallest of the inhabitants of the ocean, obtain their prey, is analagous to the instinctive art of the largest, the whale, for the same purpose. This huge animal pursues a shoal of herrings into a bay, and, by beating the water with his tail, produces a whirlpool of great violence and extent, in which the herrings are tossed to and fro. He then opens his vast mouth, into which the herrings are washed, and precipitated down his throat.*

The *Polypi* are very vegetable-looking entities, but are unquestionably of an animal nature. The marine ones generally fix themselves upon rocks; and it is noticed

* The whale that has been noticed to do this is probably the *Borqualis borealis*, or the finner of the whalers. The smaller Greenland whale is supposed to live on small molluscous animals.

that they instinctively attach themselves to those portions of the rocks where they will not be exposed to the direct shock of the tide, or to violent currents. Usually they seem to select a hollow, or "submarine grotto." When a polype has fixed itself in such a situation it commonly remains fixed by one extremity, and really looks amazingly like a plant. If, however, it do not receive plenty of light, it changes its quarters, and moves along, by alternately fixing its head and its tail upon the adjoining substances until it has reached a lighter place. It then remains fixed and motionless, save that it moves its long arms or branches to and fro. This it does in order that it may catch hold of grubs, &c., on which to feed. It has been observed, too, that, although reasoning is quite out of the question with respect to these animals, it only sends out as many branches as are necessary to master the object it requires for food, and puts one or more into requisition as the case may be. Having grasped the food, the branch gradually curves in until it presents it to a sort of mouth, which then gradually opens and receives it. The food of polypi is of an animal nature, and consists of slugs, worms, or even small pieces of meat, if they are thrown near it. All these movements, for the apprehension and selection of food, are purely instinctive.

One of the most important of these lowly organized creatures, and one that manifests surprising instincts, is the *Madrepora*, or coral polype. This insignificant little animal is actually revolutionizing the existing state of things; it has created by its little but continuous labour almost all the islands of the Pacific Ocean that have now become of such importance, and it is still creating fresh ones, that are doubtless destined to be of importance, not only in themselves, but, by displacing a portion of the ocean, submerge existing lands. It is not easy to guess at the exact time; but, unless the economy of nature change her operations, the period is coming when that southern continent, so often assumed, will really arise from the waves, and all owing to the instinctive movements of the insignificant polype now under notice.

These coral polypi not only obtain from without the food necessary for their own structures, but they separate from the sea-water, or more probably from the sea plants, calcareous matter. This they elaborate, and form a structure to which they and succeeding generations of them gradually add, until a vast tract of territory is put down, which at last emerges from the ocean. When this is the case, they can no longer add to its surface, for coral polypi taken out of the sea die instantly. But the surface thus exposed becomes the site of vegetation, a soil is gradually formed upon it, and then it is taken possession of by man.

It does not appear that in making these coral reefs the coral polypi serve any purpose of their own, but it would seem that they work on blindly in obedience to a law of instinct; and yet the polypi construct these depositions in such a manner as is best calculated to resist the destroying effects of the ocean upon them, and when danger from this source is imminent, actually constructs breakwaters. Captain Beechy particularly observed a coral island, and noticed distinctly that it took the shape of a truncated cone, having its base downwards, that being the very form most suitable to protect it from the sea. Farther, he remarked "the north-eastern and south-western extremities are furnished with points, which project under water with less inclination than the sides of the island, and break the sea before it can reach the barrier to the little lagoon formed within it. It is singular that these buttresses are opposed to the only two quarters whence their structure has to apprehend danger, that on the north-east, from the constant action of the trade wind—and that on the other extremity, from the long rolling swell so prevalent in these latitudes; and it is worthy of observation, that this barrier, which has the most powerful enemy to oppose, is carried out much further and with less abruptness than the other." In fact, the instinctive labour of this semi-vegetable, the coral polypi, that scarcely appears to have sensation, is as much more elaborate than the far-famed honeycomb of the bees, at it is more important in its results.

Nor is this all. When these little beings are constructing their island, they invariably leave a hollow place in the centre, which, when the island is completed, forms a lake. But when depositing the coral they always leave an opening into this from the sea, so as to let the tide in and out; the reason of this act that they instinctively perform being, that without this access of the tide they cannot obtain a due supply of food and of building materials.

The sea *Anemone*, as it is called, is in many respects a remarkable animal. It fixes itself to a rock, and sends out a number of what appear to be stalks, which terminate in apparent gaudy flowers. These latter are in fact germs of young ones; and those who have descended in diving-bells have sometimes been astonished to find the submerged rocks covered with what seemed brilliant blossoms. When all is quiet these apparent flowers come to the surface, but upon the slightest indication of danger they are immediately withdrawn; and on looking into the water nothing is to be seen save a fleshy-like mass, into which the animal has converted itself. The sea *Anemone* sticks so fast to the rock, that it cannot be separated without lacerating its structure. When tired, however, of its position, it unlooses itself, and commits itself to the waves, until it is washed against some other surface, to which its instinct teaches it to attach itself.

There is a class of plant-like animals, called *Salpes*, which are luminous. Their structure is very frail, and resembles a thin jelly, and, on being touched, dissolves into a colourless fluid. When young, these *Salpes*, in order to protect themselves from the action of the sea, instinctively unite themselves together. "Every individual," says Bosc, "is attached by its sides to two others, the mouth of which is turned to the same side; and by its back also to two others, when it is turned to the opposite side." This union is effected by means of certain lateral suckers. When the *Salpes* have grown older, and when their structure has probably become firmer, this instinct of association ceases, and the different individuals separate.

These jellies do not adhere together when young, or separate when older, in consequence of any experience or reasoning, but both movements are purely instinctive; and, as an instance of how each different species of animal has its peculiar instinct, it may be remarked, that although these *Salpes* are so very low in the scale of creation, yet that they are the only known animal, members of which group together in this manner for mutual support.

We have seen that the coral is creating new islands and continents. Another animal, equal insignificant, is aiding in destroying existing rocks and stones. This is the stone-borer, or pholad, various species of which are common on our coasts. They are litttle bivalve shell animals, and, to look at them, they would appear devoid of all power of progression, and yet they can penetrate the hardest rock. The mode in which they bore is not indeed well known:—"These animals," says Kirby, "are defended by two very fragile shells, strengthened indeed by supplementary pieces, and rough like a file, inhabited by a very soft animal, which appears to be furnished with no organ adapted to boring so hard a substance as a rock. When the young are disclosed from the egg, being cast upon the rock in which their mother resides, they bore a hole in it, which they enlarge daily, and which they never leave unless compelled by force. This hole always communicates with the water." Reaumur made observations upon their mode of boring: he says that "it is by the rotation of the two valves of their shells, which form a rasp, and continually wear away the rock which surrounds them. The surface of the valves of the shell is wedged longitudinally and transversely, and rough with asperities at the intersections of the ridges, which seem to fit it for such an office; but still it is usually so tender and friable, that we would not expect it to act upon a rock." The end fulfilled by this boring is to obtain a secure habitation; but the animal is so low in the scale—inferior to a cockle—that it cannot know at all why it is boring, but it works away in a definite manner, entirely in obedience to an instinct.

One of the lowest of the shell-fishes, as they are called, although they are not fishes at all, is the oyster. This animal seems, rather unfortunate, and besides being preyed upon by man, barnacles attach themselves to it, and crabs rush into its shell when it opens it to take in sea-water, and devour it. The oyster, however, has an instinct by means of which it often protects itself from the last intruder. It keeps a quantity of water in reserve in its shell, and, when the crab is about entering, squirts it out with such violence against him as to dash him back.

Indeed, were the habits of these bivalve animals accurately observed, it is probable that very wonderful instincts would be witnessed. They have no organ of sight, of hearing, or of smell, and no apparent means of motion, and yet they perform complicated movements. The oyster, for example, so far from being, as often thought, very apathetic, moves about a good deal. The cockle can and does burrow to a considerable depth in the sand. But the most remarkable in this respect of these creatures is, perhaps, the *Pecten*, and its ally, the

Venus genus, the members of which have extraordinary powers of locomotion; and, when those of the latter come to the surface, they use one of their valves as a boat, and hoist the other as a sail against the wind, which wafts them along.

Several molluscous animals, it may be observed, instinctively expand a portion of their structure, in order that the wind may propel them. The *Hyalæa* has an organ, or rather two organs, apparently intended purposely for sails. These it unfolds, and, aided by the wind, moves with great velocity. The *Tethys*, too, is provided with a long mantle, which it probably uses for a similar purpose.

The manner in which the common garden snail proceeds about its hybernation, affords a striking instinct of complex instinctive movements. In the autumn, these animals are led by their instincts in great numbers to the banks of ditches and similar places. There each forms a cavity in the grass, or among dead leaves large enough to contain it. This cavity it then lines with a mixture of slime and earth. "When it has succeeded in bringing the aperture of the shell to nearly a horizontal position, it stops. The foot is soon contracted within the shell, the snail then expands so as to completely cover it; the collar of the mouth, which is at this period very white and thin, inspires a quantity of air, after which it closes the respiratory hole. When this is done, a fine transparent membrane is formed with its mucus, and interposed between the mantle and any extraneous substance lying above. The mouth then secretes a quantity of very white fluid over its whole surface, which sets uniformly like plaster of Paris, and instantly forms a continuous covering about half a line thick. When this is hardened, the animal separates its mouth from it by another and stronger mucous secretion; and after a few hours, expelling a portion of the air it had previously inspired, it is enabled to shrink a little farther into its shell. It now forms another lamina of mucus, whence more air, and then retires farther into the shell; in this way sometimes a fourth, fifth, or even a sixth partition is formed, with intermediate cells filled with air."* The process occupies about three days, and when it is finished the snail becomes quite torpid, and ceases to breathe. With the warmth of April it awakes, and gradually breaks its way out, inspiring while doing so the air which its instinct had taught it to store up for this very purpose.

There is a little condylope called the pest of the perch, which is found in fresh water. When hatched, it is led by its instincts to wander about until it finds the mouth of a perch, into which it enters and fastens itself. Here it dwells, holding firmly on, sometimes to the palate and

* Penny Cyclopædia, quoting Gaspard.

sometimes even to the tongue, and maintaining its grip so fast that it cannot be removed by force without rupturing its arm-like suckers. That this little parasite should seek out a fish's mouth for a habitation, and not any fishes, but only that of one of two species of perch, is a very singular instance of an instinct. To make the matter still more remarkable, there is a species of small mite which seeks out the pest of the perch, which, when it finds, it fixes upon and there resides.

An amimal low in the scale, a kind of crab, constructs burrows in the sand in which to dwell during the winter. It is much preyed upon by numerous animals; and, to protect itself, is led by its instinct to fortify itself by closing up with sand the entrance to its subterranean abode. When the increasing warmth tells it that the spring has returned, it reopens its connection with the external world. A nearly allied species, the hermit crab, has a still more remarkable instinct. A great portion of it being undefended by any external crust, it obtains possession of the shell of some other animal, suited to its size, and dwells in it, constantly carrying it about. These hermit crabs are said to leave the shell at the time of their moult, and to seek for bigger ones suited to their increased size.

This moulting, which all crustaceous animals perform from time to time, is in itself a curious instinct. Crustaceous animals live several years, and continually go on increasing in size (unlike the insects, that never grow any larger,) and consequently the horny case which has been formed for their protection becomes too strait for them. Reaumur carefully observed this operation in the crayfish, which appears to shed its shell annually, and commonly about the end of summer. The animal fasts for a few days previously, and then returns to some place of seclusion, where, by means of puffing itself out, and then contracting itself, it gradually contrives to split its old envelope, out of which it writhes itself. That it should fast, should retire to a place of safety, and perform these contortions, are all clearly instinctive.

Some indications of instinct witnessed in a class of animals usually considered insects, although they are not—the spiders—may perhaps not inappropriately conclude this chapter. And nothing probably can better suit our purpose than Evelyn's account of his observations of the hunting spider.

"Of all sorts of insects there is none that has afforded me more divertisement than the *venatores* (hunters), which are a sort of *lupi* (wolves), that have their dens in rugged walls and crevices of our houses; a small brown and delicately spotted kind of spider, whose hinder legs are longer than the rest. Such I did frequently observe at Rome, which, espying a fly at three or four yards' distance upon the balcony where I stood, would not make directly to her, but crawl under the rail till, being arrived at the antipodes, it would steal up, seldom missing its aim; but if it chanced to want any thing of being perfectly opposite, would at first peep, immediately slide down again, till, taking better notice, it would come the next time exactly upon the fly's back; but if this happened not to be within a competent leap, then would this insect move so slowly, as the very shadow of the gnomon seemed not to be more imperceptible, unless the fly moved, and then would the spider move also in the same proportion, keeping that just time with her motion as if the same soul had animated both these little bodies; and whether it were forwards, backwards, or to either side, without at all turning her body, like a well-managed horse; but if the capricious fly took wing and pitched upon another place behind our huntress, then would the spider whirl his body so nimbly about as nothing could be imagined more swift, by which means she almost always kept her head towards her prey, though to appearance as immovable as if it had been a nail driven into the wood, till by that indiscernible progress, being arrived within the sphere of her reach, she made a fatal leap, swift as lightning, upon the fly, catching him in the pole, where she never quitted hold till her belly was full, and then carried the remainder open."

Another class of spiders are not hunters, but weavers, and entangle small insects in the nets that they construct for the purpose. These weaving spiders, as is very familiarly known, put together, under the guidance of their instinct, webs, among the lines of which flies, &c., become trapped.

CHAPTER III.

THE INSTINCTS OF INSECTS.

THE instinctive arts of insects have been more attended to than those of any other class of living beings. This has happened from two circumstances: first, because their actions are principally performed upon land, and near the dwellings of man, and not in obscurity, or in the ocean, as almost all those previously noticed are; and, in the second place, because all the actions, or nearly all the actions, of insects are wholly and purely instinctive, and in no degree mixed up with reasoning and experience, as we will soon find is the case with animals higher in the scale than they are. And, of all insects, none exhibit such wonderful indications of instinct as those that live in societies do, and therefore as full an account of them as is consistent with the plan of this little book will be attempted.

Of those insects that live together in societies, not the least interesting are the ants, large colonies of whom live together in nests or ant-hills. These societies consist of females, males, and neuters, the last of these doing the work. Generally, in each nest, several females or queens live together, between whom the greatest harmony seems to prevail. Some time before any of these lays her eggs she is actuated by a strong desire to leave the ant-hill and escape from her palace—a desire, however, which she is prevented from carrying into effect by the neuters, who, upon such occasions, hold them firmly by the legs, and never quit their royal mistresses. They treat them, nevertheless, with great kindness, assiduously feeding them, and conducting them to that part of the habitation where the temperature is most suitable to them. By degrees this desire of the queen to quit the nest disappears; and when she begins to lay, by a most remarkable instinct she cuts off her own wings, and determinedly settles to her domestic duties. She is still, however, constantly waited upon by one ant, who appears to be ready in case she should require any thing. This attendant is from time to time relieved by another, who takes his place. When the queen has laid some eggs, the honour in which she is held is still further increased; all the ants of the colony come to present their respects to her, and to offer her food. If she desire to pass along a steep bit of the dwelling, they press to assist her, and sometimes altogether carry her, a number of others attending and shewing their joy by dancing around her. And if she chance to die they still treat her corpse with respect, and often for months continue to brush and lick it.

As soon as the queen has laid her eggs, some of the working ants seize them, and carry them in small parcels until they obtain a heap, which is deposited in an apartment for the purpose. Until these eggs are hatched the attention of the workers to them is incessant; according to the temperature, they remove them from one part of the nest to another, and sometimes brood over them, as if to communicate warmth to them. When the eggs hatch, and the grubs appear, their labours and cares become even more severe. Every evening, an hour before sunset, they carry the whole brood down to cells situated deep, and where they will be protected from the cold. Every morning, unless the day prove wet (in which case they allow them to remain below), they replace them in a higher part, and the period at which they do this is entirely regulated by the rising of the sun.

The labour which the workers expend in feeding these grubs is very great, the young animals being very voracious, and requiring several meals in the day. Their sustenance is derived from the half-digested food of the ants themselves, who disgorge it into the mouth of their young, the latter eagerly stretching out to receive it. They also pay great attention to keeping the grubs clean and tidy, and are perpetually licking them and rubbing them with their mandibles. When the grubs become pupæ, and surrounded by a cocoon, they still require feeding, and they are still removed every night and morning. All this is performed by the working ants, excepting in the case of a new colony being founding, in which their number is small, in which case the queen casts aside her dignity, and acts as a nurse to her progeny.

Contrary to what happens in other insects, the young ant, when it has attained the perfect form, is not strong enough to burst its cocoon. By a most wonderful instinct, the workers know when this time has arrived. A great bustle then prevails in the apartment: three or four of the ants surmount the cocoon, and pull off a few threads; they then carefully cut an orifice sufficiently large to abstract the young ant, an operation which they perform with great caution. The next step is to remove the pellicle, which still surrounds the young animal. This done, the workers carefully feed their newly-born step-children, conduct them up and down the colony, to show them, as it were, the paths and roads; and, when the time comes for them to swarm and depart, they accompany them a little way, feed them for the last time, caress them, and even when they have gone, they linger a little over the parting scene, as if indulging in a refined grief at the loss of those for whom they have laboured so kindly and assiduously, and whom they will never more see.

Besides attending to the young, the working ants are very busily employed in forming and keeping in order the streets, galleries, and apartments of the colony. Different species of ants vary in the manner in which they instinctively construct their habitations, although all display great adaptation of means to ends. They may, in this respect, be arranged into masons, carpenters, and weavers. The common red ant of our woods belongs to the first of these, although the outside of the hillock is composed of wood, bits of straw, or any thing of that nature that the insect can get at. The interior is composed of a number of small apartments, arranged in separate stories, and communicating with one another by means of galleries. Some of these stories are considerably elevated above the surface of the earth, while others are very deep; the object apparently being, that the workers may have choice of varying temperature in which to put the young. All this is constructed of earth; other galleries lead to the outside, but these are shut at night, when all the ants retire to repose save a few sentinels, who are stationed by the gate ready to give the alarm to the sleepers in case of danger. When it rains, the ants close their outer doors with pieces of wood, leaves, &c. Another ant, the *Formica brunnea*, may be said to be a bricklayer. It constructs its nest in a great many stories, sometimes as many as forty, of which the half are above the surface, and the other half below. In the construction of these it employs clay, which it scrapes from the bottom after it has been a little moistened by a shower. Each ant brings a particle of this clay between its mandibles, with which it spreads and moulds it to the shape that is requisite. Each story contains large saloons, smaller apartments, and communicating galleries, and the larger rooms are strengthened and prevented from falling by means of pillars and buttresses. So skilfully and industriously do these ants work, that they can finish a whole story, with its apartments and streets, in eight hours. This ant has been noticed to work generally at night. Among the carpenter ants, the most conspicuous place belongs to the black emmet, which is not uncommon in old oak and willow trees in this country. It gnaws the wood into a great many horizontal stories, the ceilings and floors of which are about six lines apart, and the former are supported by partitions and pillars. In some manner unknown, this ant paints or stains its house black. No weaving or manufacturing ant exists in this country; but in New South

Wales there is a variety that construct their nests of leaves, which they fasten together. Sir Joseph Banks, when watching this animal, saw thousands uniting their strength to hold down a leaf; and, when he disturbed them, he was amazed to see the leaf spring up with a force much greater than he could conceive them able to conquer by any combination of strength.

But the internal economy of the ants is still more surprising. They have the power of making instinctive signs and motions, which are instinctively interpreted by their neighbours; and in this manner pretty complex pieces of news are communicated from one to the other. Strange as this seems, there is no doubt of its being the case. If those at the surface be alarmed, the intelligence is at once transmitted to those in the interior, and the larvæ and pupæ are immediately carried to the lowest apartment, as being the place of greatest security. Indeed, some species regularly post sentinels; and two species, whose war expeditions will soon be noticed, send out spies to collect information. These explore the country, return to the nest, and then, if their report prove favourable, the army sets out on its invasion; and during the campaign messengers or aides-de-camp are continually passing, evidently bearing communications from the front to the rear. Nay, if the invaders find the resistance that is made too much for them, they despatch couriers to their nest for reinforcements, which are invariably sent immediately. Huber, to whom we are indebted for the greater part of our knowledge regarding the habits of ants, observed, that when he disturbed those that were at the greatest distance from the rest, that these ran towards the others, struck their heads, and communicated the danger. Upon this the working ants prepared for resistance, while the queens and males (both of which are timid creatures) ran and hid themselves. A curious experiment, bearing upon this point, was performed by Gould. He put a colony of ants into a flowerpot, which he kept surrounded by water, and thus prevented the ants from leaving it. In a few days, he put threads from the upper part of the flowerpot to beyond the water. This bridge was soon detected by one of the ants, and the intelligence instantly communicated to the others, and in a short time the threads were covered with busy labourers passing to and fro.

In making these communications together, ants* do not employ sounds. When one wishes to give another intimation of danger, it strikes its head against its neighbour's trunk; but the antennæ appear to be principally employed for the purpose. The military ants, for example, give the signal to march to one another, by touching the trunk with the antennæ, and the spies

* Kirby and Spence.

and aides-de-camp, in some way or other, communicate their messages by blows with the antennæ.

Ants are armed with very formidable weapons of offence. Their mouth is furnished with two strong mandibles, and they have a poison-bag which secretes the irritating substance, called by chemists formyle, and which, when combined with chlorine, gives us the very useful anæsthetic agent, chloroform. When their enemy is beyond the reach of their mandibles, they eject the formyle upon him. Thus weaponed, the working ants, or rather the neuters (for some species of neuters are very lazy), are extremely pugnacious. Not that those of one nest fight among themselves; for, on the contrary, in the same colony the best understanding seems to prevail. The only exception to this rule that has been noticed, occurs among the red ants. A number of these may sometimes be seen to attack an ant, and tear it to pieces, or cut its head off. Some have supposed that this proceeding is not the consequence of a quarrel, but because the ant has some disease; while others imagine that it is a police enforcement, and that the decapitated ant has been committing some sin. "If," says an old writer, "they see any one idle, they not only drive him without food, as spurious, from the rest; but, likewise, a circle of all ranks being assembled, they cut off his head before the gates, that he may be a warning to their children not to give themselves up, for the future, to idleness and effeminacy."

Much more serious encounters take place between different colonies of the same species, the cause of battle in such cases being usually territorial; although war is sometimes entered into for the possession of *aphides* (for what use will soon be mentioned), or even for a dead fly, or a quantity of bits of sticks. In such cases, the fighting men from each encampment leave their nests, and meet midway between their respective habitations. The ants range themselves upon elevated summits, and the opponents lay hold of one another, wrestle, bite, and eject their formyle. If an individual on one side appear to be getting subdued, others of his party come to his aid. The utmost fury is excited: in many of the combats, one of the parties is put to death on the spot, and in others, the vanquished are made prisoners, for the purpose of being taken to the enemy's camp, and there killed and eaten; for in these wars the ants are perfect cannibals. As night comes on, each party returns to its nest, but at daybreak they both march out to resume the contest, and continue so to do until rain fall, which appears to have the effect of subduing their violent passions. The appearance presented by these contending colonies is said to be very astonishing. The field of battle is seldom more than a yard square; it is covered with dead bodies, and the living are all engaged in the most fierce and deadly combat, and, notwithstanding the confusion and the excitement, never mistaking a friend for an enemy. In the meantime, the work of the nest is duly performed, and those that are left behind for that purpose, execute their work with due philosophy and composure; and nothing can be observed to be the matter there, save the occasional visit of an aide-de-camp, and the consequent despatch of a reinforcement.

Sometimes wars take place between ants of different species. In such cases, it would seem that the larger generally attack the smaller, although their bullying intentions are often defeated. Campaigns of this kind have been observed for many centuries. One of them is recorded by Olaus Magnus to have taken place in Sweden, in which the small ones succeeded in beating their adversaries, and in which he declares, that the conquerors buried the bodies of their own party, but left the corpses of their larger opponents to perish with corruption, or to be consumed by birds. However this may be, there is no doubt of such battles, several of which have been witnessed by Huber. He relates that the big ones generally attempt to attack the small by surprise, and, seizing them by the upper part of their bodies, strangle them. If, however, the small ones have time to foresee the assault, they frequently assemble together in such numbers as to master, and either kill or take prisoners, their gigantic adversaries. If the smaller ones decide that resistance will be unavailing, they desert their nest, and seek other and undisturbed quarters. They do so with order and decorum, and the retreat is covered with large rearguards, which often succeed in making captive, or in cutting off parties of their invaders.

What follows with regard to the wars of the ants is so amazing, that had it not been observed, beyond the possibility of a doubt, it would appear a wild fable. Certain species of ants undertake warlike excursions against other species, not for the purpose of obtaining territory or *aphides*, but to make slaves, whom they carry off with them, and compel to do their menial work. There are two kinds of ants that are guilty of those kidnapping atrocities, the *Formica rufescens* and the *Formica sanguinaria*. Neither, however, are so barbarous as man; for they do not steal their victims when they have obtained adult age, but they only take the larvæ and pupæ, whom they bring up and train to serve them.

The rufescent ants make their sallies at from two to five in the afternoon, and generally a little before five.

They first send out scouts, who, as before mentioned, communicate the intelligence they have picked up to the others, by means of their mandibles. When the expedition is determined upon, the signal for advance is given, and every thing, although there is no leader, (Solomon's account, "no captain, overseer, or ruler," being literally true,) with order. An advanced guard of eight or ten precedes, but these are continually being relieved; those who have been in the advance wheeling round in a semicircle to the rear, one object of the proceeding being, probably, to communicate intelligence.

These predatory excursions are chiefly directed against the young of the black or negro ant. The rufescent ants seem to trust to carry their object by a *coup-de-main*, and sometimes go in small bands. As soon as they come upon a negro settlement, they dart upon it, and, notwithstanding the gallant defence of the sentinels at the gate, almost always succeed in overpowering them, and driving the remainder of them, and the other inhabitants of the nest, into the lowest stories; while the more advanced are engaged in this, the others make with their mandibles a breach in the walls, and the warriors entering by it, each seize a larva or pupa. When they have obtained their spoil, they return home in triumph.

Sometimes, instead of the black ant, they attack another species, the *Formica accumularia,* and attempt to trepan its young. This kind, however, is more courageous than the black ant, and makes a determined, and often successful resistance; and it is probable, that it sometimes regains its stolen progeny. In all these attacks, a number of the besieged may be seen attempting to escape, and carrying away the queen and the young ones; and after the spoil has been taken away, the gates are barricaded, and a large body of sentinels stationed, as if in apprehension of a renewed attack.

The *Formica sanguinaria,* or sanguine ant, is another species that makes slaves. One of their expeditions was observed by Huber. At ten, in a July morning, he noticed a small band of them emerge from their nest, and march rapidly towards a nest of negroes, around which it dispersed. A number of the blacks rushed out, gave battle, and succeeded in defeating their invaders, and in making several of them prisoners. Upon this, the remainder of the attacking force waited for a reinforcement. When this came up, they still declined further proceedings, and sent more aides-de-camp to their own nest. The result of these messages was a much larger reinforcement; but even yet the pirates appeared to shun the combat. At last, the negroes marched out from their nest in a phalanx of about two feet square, and a number of skirmishes began, which soon ended in a general melée.

Long before the event seemed certain, the negroes carried off their pupæ to the most distant part of the nest; and when, after a longer encounter, they appeared to think further resistance vain, they retreated, attempting to take with them their young. In this, however, they were prevented, and the invaders obtained possession of their nest and the booty. When they had done this, they put in a garrison, and occupied the night and the succeeding day in carrying off their spoil.

The fact is, that all ants are not industrious, and the slave-making ants in particular are excessively lazy; and the end of these instinctive moments by which they take these prisoners, is to get servants who do all the hard work, make the dwellings and keep them in order, collect the food, attend upon the queens and young, bring meat to their masters, and also actually carry them about the nest upon their backs.

So dreadfully idle, indeed, are those rufescent ants, that if left to their own resources they will rather starve than procure food. Huber shut up in a box about thirty of them along with some pupæ of their own kind, and some negro pupæ, and in a corner of the box he also placed some honey. At first the ants did take the trouble to move the pupæ a little about; but th y soon determined that they were far too dignified to feed themselves. In two days most of them died, apparently from want of food, and the remainder looked extremely weak and languid. Huber then introduced a negro ant, which immediately set to work, dug a cell for the young, in which it placed them, assisted the larvæ about to be developed, and fed the surviving rufescents.

The sanguine ants are not quite so indolent, for they may be seen assisting their negroes in house work; and, moreover, when danger attacks the colony, they place their servants in the place of greatest security, and then prepare to defend them. Sometimes, indeed, the rufescent ants take a fit of industry, and have been noticed, when they wish to migrate, to take their slaves, and, instead of being carried, carry them to their new abode, which, however, they compel the poor blacks to construct.

Another instinct of the ants which, although it has been questioned, seems certain, is their making a property of, and keeping as domesticated animals, *aphides*. A saccharine juice exudes from these animals, and passes out by two tubes or nipples. When no ants are near them, this trickles out and is wasted; but the ants when present, and when the saccharine liquor is about to escape, apply their mouths and suck it in. But this is not all: by means of their antennæ they rub the sides of the aphides, and cause the juice to exude at will, or, to use the expression of Kirby, the ants *milk* the aphides. Sometimes a particular colony of ants lay claim to all the aphides on a plant or tree, and, if any stranger ants come near, attack them with great ferocity. At other times, again, they enclose the aphides for security in a tube of earth placed near their nest. But the yellow ant adopts the most extraordinary expedient. It takes the aphides into its own nest, and carefully feeds it with grass. It is a breeder of its stock, too; it takes great pains to spread in the sun the eggs that the aphides lay. Occasionally the inhabitants of one nest make a foray for the purpose of stealing the aphides of another, and when this is the case a very bloody battle is the result.

Emigrations sometimes take place from an ant-hill, during which curious instances of instinctive movements may be observed. The following is Kirby and Spence's very graphic account of the manner in which these are managed:—" Some of the neuters having found a spot which they judge convenient for a new habitation, apparently without consulting the rest of the society, determine upon an emigration, and thus they compass their intention. The first step is to raise recruits; with this view they eagerly accost several fellow-citizens of their own order, caress them with their antennæ, lead them by their mandibles, and evidently appear to propose the journey to them. If they seem disposed to accompany them, the recruiting officer, for so it may be called, prepares to carry off its recruit, who, suspending himself upon his mandibles, hangs coiled up spirally under his neck. All this passes in an amicable manner, after mutual salutations. Sometimes, however, the recruiter takes the other by surprise, and drags him from the ant-hill without giving him time to consider or resist. When arrived at the proposed habitation, the suspended ant uncoils itself, and, quitting its conductor, becomes a recruiter in its turn. The pair return to the old nest, and each carries off a fresh recruit, which, being arrived at the spot, join in the undertaking; thus the number keeps progressively increasing till the path between the new and the old city is full of goers and comers, each of the former laded with a recruit. What a singular and amusing scene is then exhibited of the little people thus employed! When an emigration of a rufescent colony is going forward, the negroes are seen carrying their masters, and the contrast of the red with the black renders it particularly striking. The little turf ants, *F. caspitum*, upon these occasions carry their recruits uncoiled, with their heads downward and their body in the air.

"This extraordinary scene continues several days; but when all the neuters are acquainted with the road to the new colony, the recruiting ceases. As soon as a sufficient number of apartments to contain them are prepared, the young brood, with the males and females, are conducted thither, and the whole business is concluded. When the spot thus selected for their offspring is at a considerable distance from the old nest, the ants construct some intermediate receptacles, resembling small ant-hills, consisting of a cavity filled with fragments of straw and other materials, in which they form several cells, and here at first they deposit their recruits, male, female, and brood, which they afterwards conduct to the final settlement. These intermediate stations sometimes become permanent nests, which, however, maintain a connection with the capital city.

"While the recruiting, is proceeding, it appears to create no sensation in the original nest; all goes on in it as usual, and the ants that are not yet recruited pursue their ordinary occupations; whence it is evident that the change of station is not an enterprise undertaken by the whole community. Sometimes many members set about the business at the same time, which gives a short existence (for in the end they all reunite into one) to many separate formicatories. If the ants dislike their new city, they quit it for a third, and even for a fourth; and, what is remarkable, they will sometimes return to their original one before they are entirely settled in the new station; when the recruiting goes on in opposite directions, and the pairs pass each other on the road. You may stop the emigration for the present, if you can arrest the first recruiter and take away his recruit."

Another insect that lives in societies, and that affords us many indications of instinct, is the wasp. A full colony of wasps consist of males, neuters or workers, and two kinds of females, one a large kind, which lays both male and female eggs, or a queen, and the other not bigger than a worker, and which only lays male eggs. All these, except a few females, are killed by the cold of the beginning of winter. These few females remain torpid until the return of spring, when the warmth resuscitates them, and each flies off alone to form a colony. Unassisted, and directed by her instinct, she erects a small house, often in the nest of a field-mouse, and at other times in a cave which she has laboriously excavated, in which she deposits her eggs. When these are hatched, she assiduously feeds her young until they attain maturity. Three other broods are successively born; but the queen-mother is not any longer under the obligation of labouring herself, and her children faithfully execute all the labour of the nest. If by some accident, before any more females are hatched, the queen be destroyed, all the neuters lose their instincts, cease to work or gather food, and consequently perish.

The male wasps are smaller than the females, but larger then the neuters. Unlike bee drones, immediately to be noticed, they are active and industrious. They act principally as scavengers, sweep the streets and passages of the nest, and carry away any dirt. If any of the wasps die, they also remove the body, and conduct the funeral. In consequence, doubtless, of their utility, the other wasps are not instinctively led to destroy them, as these do drones; but, on the contrary, the workers who collect all the food faithfully give the due share of this to the male wasps.

These workers are the wasps that come to our houses, and annoy us by their robberies and their stings. Nothing comes amiss to them; fruit, preserves, meat, and they greedily attack flies and other insects. The food that they obtain appears to undergo a partial digestion; they then return to the nest, where each of them is surrounded by a number of queens, drones, and of workers, who have been engaged in the nest in building, mounting guard, &c. Each of these returned workers then disgorges a drop or two of this same digested food, which is swallowed by one of those who surround it, then another drop, which is taken by another recipient, and so on. When the food that they have obtained is the body of an insect, as a fly or a bee, they do not swallow it, but carry it home entire.

When the cold weather begins, a most astonishing indication of instinct may be witnessed in the nests of these sociable wasps. They at other times appear to have the greatest affection for the young; but after the first frosty night, they drag all the grubs out of their cells and mercilessly destroy them. The end obtained by this summary proceeding is doubtless the saving the grubs a lingering death from the cold.

The extending the nest from the foundation laid by the queen-mother, until it can contain thirty thousand or more inhabitants, that a colony sometimes numbers, gives constant employment to a great number of the workers. The nest of the common wasp, as before mentioned, is usually situated under ground. It is of an oval shape, and is about eighteen inches long, and twelve broad. The outside is composed of several (fifteen or sixteen) layers of a grey paper. These layers are not placed close together, like the layers of a piece of pasteboard, but with intervals between each; the object of this instinctive mode of building being to prevent the rain from penetrating. The interior of the nest consists of twelve or more circular combs, arranged in parallel stories, each of which is composed of a number of hexagonal cells, made of the same kind of paper or papier-machée as the internal covering.

Wasps are taught by their instincts, also, to place sentinels at the entrance to their nests, and, if these can be suddenly surprised, the remainder in the nest do not come out and attack the invader; but if the sentinels be allowed to give the alarm, all the workers come out ready to do battle.

Humble bees also live in societies. The name is given to them owing to the loud dull hum that their workers make when flying, but they really are humble or homely creatures, and appear to be the most rustic of all the *Hymenopterous* societies. Unlike the wasps, they store up both honey and wax, but, unlike the bees immediately to be brought under our notice, they are not instinctively profound mathematicians, but construct their abodes in a clumsy and village-like fashion. They seem, too, to be of a credulous and soft disposition; and honey bees can wheedle them out of the honey that they have gathered, although they refuse to part with it, or seek refuge in flight, when wasps make similar overtures. Humble bees have actually been known to permit bees to take the whole honey that they have collected, and to go on gathering more, and handing it over, for three weeks.

A nest of humble bees consists of large queens, small females, males, and workers. The large females are hatched in the autumn, and pass the winter in a state of hybernation, in a little apartment that they have instinctively prepared and lined with moss and grass, near the nest. Very early in spring the queen-founder awakes, constructs cells, lays eggs in them, gathers food, and feeds the young grubs when hatched. So energetic is she as an architect, that she can construct a cell in so short a space of time as half an hour, although quite unaided, and, of course, without any aid from previous experience. Her family and subjects at first consist of workers, which are born in May and June; afterwards males and females are hatched, and it is noticed that the young of these are instinctively fed with a different kind of food from the young of the workers: the grubs that are going to be workers, receiving a mixture of honey and pollen, while those that are going to be drones and queens, receive pure honey only.

Very singularly, the queens in the autumn, although they collect honey and make themselves useful, never construct cells; and it is only when they arouse themselves in the spring, that this instinct of building is developed and in force. In like manner also, in the autumn, they, and the small queens who are destined to become the mothers of the drones, are no ways jealous of onė another, although in summer time the antipathy that the queen-mother shows to the latter is very great. Indeed she drives them as much as possible from the cells, and destroys, if she can, all the eggs that they have deposited in them.

The male of the humble bee is industrious, and assists in making and repairing the nest; but it is upon the workers, or neuters, that the principal part of the labour falls. They, as soon as they are brought into being as perfect insects, begin and construct the vault that covers and defends their nest; they go about collecting honey; and they are born with the curious instinct of making an aperture in the base of the corolla of a plant, so as to get directly at their food, when they cannot enter by the expanded flower; they feed the young grub, and when it has become a perfect humble bee, they store up the cell that it had occupied with honey.

The honey or hive bee, however, is the insect that affords the most complicated observed indications of instinct; and although these have been so often described that they are familiar to most people, the instinctive movements of bees are so complex and so clearly the result of instinct, and not reason—the bee just brought into life possessing them as well developed as an old bee—that it is impossible in any work having a reference to instinct to pass them over.

A hive of bees consists of one queen, several hundred drones, and many thousand neuters, or working bees, all differing from the other in size and appearance. They also differ in the period that they take from the time that the egg is laid to their becoming perfect insects. Thus the queen passes sixteen days in the preparatory stages; three days the egg remains unbroken; the grub, when hatched, feeds for five days more; one day is occupied in spinning the cocoon; she then remains still for two days and sixteen hours, and continues as a pupa for four days and eight hours. A worker requires twenty days, and a male twenty-four. These facts are given, in order to render intelligible two very remarkable instincts.

A queen bee is necessary for the very existence of the hive, and yet she is so jealous of a rival that two cannot exist in a hive. It sometimes happens that the queen dies, and that, also, there is not in the hive a comb containing the egg or larva of a queen. When this calamity occurs, the bees take from a common cell a grub, that would, if left in that cell, have turned out a worker, and the grub they instinctively fix upon is never more than three days old. This they place in a royal cell, to do which they mercilessly destroy the surrounding grubs; and during the days that it requires sustenance, a bee incessantly watches over it, and feeds it with royal food; the result of this treatment being, that it is developed into a queen, and has a totally different structure, and totally different instincts, from what it would have had if it had not been so treated. This, however marvellous, is an undoubted fact, and it is brought forward as affording indication of two instincts. The one is the complex movements which the bees take when deprived of their queen, in order to obtain a new one, although they cannot know why they are thus acting. The other is, their always fixing upon a grub three days old. The bees cannot know why they do this either, but we can understand the end fulfilled by it; for if we consider the length of time between the laying of the egg and the appearance of the perfect insect in the different varieties of the occupants of the hive, we see that the bees by this procedure save several days, and repair their loss and obtain a new monarch in ten days.

But the instincts that are manifested by the bees upon ordinary occasions in the economy of the hive, are as wonderful as in the above exceptional case. Not the least curious among them are those that lead them to construct their habitations. There are two, and sometimes three kinds of working bees to be observed in a hive—a black sort, that appear to be either superannuated or diseased, and which are mercilessly put to death by the others—and nurse bees and wax-makers—the last-mentioned having the power of secreting the peculiar substance that we call wax. Besides this secretion from their own system, bees gather resinous matter from trees, which, when kneaded up, is called *propolis*. With these two substances they construct their cells. When they begin to build, they divide themselves into bands; one of these produces the material, another lays the foundation of a cell, another completes it, sorts the angles, and scrapes off superfluous wax, while one band is employed in bringing food to the labourers. The wax is used for forming the walls of the cells, and the propolis for filling up any chinks. The latter, too, is used for another purpose, which seems very like the result of reasoning, although the act is undoubtedly instinctive. If, as sometimes happens, a snail creep into the hive, the bees immediately sting it to death. The body of the snail is far too heavy for the bees to drag out; and yet, unless precaution be taken, it would putrefy, and make a stench in the hive. To prevent this, they thoroughly embalm it with propolis; and, which is even more remarkable, should a snail with a shell intrude into the hive, it withdraws its body within its shell at the first sting, and the bees, as if they knew that the shell would not corrupt, in such a case spread no propolis over the shell, but merely fasten up the orifice.

As every one knows, a number of cells are arranged together, so as to form a honeycomb. These cells are hexagonal, are applied regularly to each other's side, and are arranged in two strata, placed end to end. "They are all arranged vertically, at a small distance from one another, so that the cells composing them are placed in a horizontal position, and have their openings in opposite directions; not the best position, one would have thought, for retaining a fluid like honey, yet the bees find no inconvenience on that score. The distance of the combs from each other is about half an inch, that is sufficient to allow two bees busied upon the opposite cells to pass each other with facility. Besides these vacancies, which form the highroads of their community, the combs are here and there pierced with holes, which serve as positions for easy communication from one to the other, without losing time by going round."*

The manner in which the cells of the honeycomb are constructed, has long been held up as one of the triumphs of instinct. They are so shaped, as to possess the greatest stability with the least possible expenditure of wax; and in particular, and as subordinate to this purpose, the base of each cell is not an exact plane, but is composed of three pieces, so as to form a pyramidal concavity; and it is now ascertained that the angle fixed upon in this base, is exactly that which requires the least possible quantity of wax. For a long time it was thought that these angles were such as consumed *nearly* the least amount of wax; but Lord Brougham, who investigated the subject mathematically, found that it is absolutely the least, and that the instinct of the bee had all along been right, and the reasoning of the calculators wrong.

The instincts of the bee lead them to construct three

* Kirby and Spence.

different kinds of cells. Those destined for the reception of eggs that are going to be males, are much larger than those intended for workers.* The cells for storing up honey seem to be generally built upon the same scale as the preceding; but when an unusually large quantity of honey is brought in, and either time or labour is wanting to construct fresh cells, these are elongated by the bees adding a rim to them. But the cells destined for the abodes of the larvæ of the queen bees differ widely from the rest. They, for several of them are usually constructed, are much larger than the rest, are of a pear shape, are composed of a different kind of wax, and at least a hundred times as much wax as would make an ordinary cell is employed for the purpose. Instead, too, of being horizontally situated, they are placed vertically, the mouth always being downwards.

Notwithstanding these cells differ according to the purpose for which they are intended, and that the combs are made with such apparent skill, and by such apparently incapable creatures, it is unquestionably ascertained that the bees do not act even in concert with one another when constructing them. To use a happy expression, the instincts of bees in making their habitations are not simultaneous, but successive. One bee does so

* The cells intended for the larvæ of workers are $2\frac{2}{5}$ lines in diameter, those for the drones $3\frac{1}{3}$.

much, and when it stops, another takes up its labours, and continues them exactly in the right method; and this gives us (if indeed such were wanting, for this is clearly the case in all instinctive movements) a very good illustration of the difference between movements conducted under obedience to instinct, and those conducted under obedience to reason. In the former, there is an irresistible impulse to go through a certain series of motions after a certain fashion, without knowing why they are performed, or what their result will be. In the latter, the actions depend upon previous mental judgments, are performed or not at will, and the end of them is early anticipated and defined.

The instinctive movements of bees, in relation to one another and to their posterity, are almost incredible; but the evidence of such is unquestionable. Foremost amongst them are the proceedings of the queen-mother. Two queens cannot exist in the same hive, and if a couple of them chance to do so, either from a stranger queen coming in, or a young one being hatched, a battle is immediately fought, in which one is sure to perish. In the former case, *i. e.*, when a stranger queen is introduced into a hive that already contains one, an extraordinary scene takes place. A circle of bees instinctively crowd around the invader, not, however, to attack her—for a worker never assaults a queen—but to respectfully prevent her escape, in order that a combat may take place between her and their reigning monarch. The lawful possessor then advances towards the part of the comb where the invader has established herself, the attendant workers clear a space for the encounter, and, without interfering, wait the result. A fearful encounter then ensues, in which one is stung to death, the survivor mounting the throne. Although the workers of a *de facto* monarch will not fight for her defence, yet, if they perceive a strange queen *attempting* to enter the hive, they will surround her, and hold her until she is starved to death; but such is their respect for royalty that they never attempt to sting her.

If the hive lose their queen, strange proceedings take place as the young queen assumes the perfect or imago state. The first one that becomes thus developed almost immediately proceeds to the royal cells, and darts upon the first that she espies. She gnaws a hole in it, through which she inserts her sting, and thereby destroys her embryo rivals. A number of workers accompany her, but do not venture to offer any opposition to her violence; and indeed, after the murder is committed, they enlarge the breach and extract the dead body.

It sometimes happens that two young queens attain perfection at the same time, and in such a case they afford indication of another and very peculiar isntinct.

At first the instinct of fighting prevails, and they dart upon one another with a fury that seems to threaten death to both, and head is opposed to head and sting to sting. But the moment that they come into this position, a sudden panic seizes them, and both fly. They soon return, and the same scene is repeated over and over again, until one young queen in the advance seizes the other by the wing, and then inflicts a mortal wound. By this instinct the two do not perish, and thus the hive is prevented from wanting a queen. All this is performed before they are perhaps five minutes old.

The workers, however, do often prevent the queen from attacking and destroying the royal grubs; but this is only before she has come out of her cell and assumed authority. They keep her confined until she is perfectly able to lead a swarm; and, even when they do let her out, they hinder her from destroying her immature royal sister, a proceeding she is much bent upon. She then becomes violently agitated, and inclined to lead a swarm, the members of which follow her. This proceeding only takes place in full hives; and when the hive is thin in numbers, and it is not desirable to send out new colonies, the workers let the queens destroy one another, as before mentioned.

If the queen die, or be removed from a hive, the population do not appear to discern their loss for about an hour. At the expiration of this time a degree of restlessness begins to manifest itself; the bees run to and fro, and those that first begin to do so, strike the others with their antennæ, and apparently communicate the news and disorder. All soon becomes in a very confused state, work is neglected, and the bees continually pass in and out of the hive. The tumult lasts for some hours, after which the bees become quiet, and proceed to fill some of the cells with jelly, and, as before mentioned, rear up neuter larvæ into queens. If, however, the queen be restored to them, their joy is excessive, and manifested.

Another remarkable fact connected with the instincts of the bees is, that the queen sometimes, apparently from disease, becomes incapable of laying eggs that will turn out workers, all the eggs that she does lay hatching into drones. When this is the case she loses the propensity to attack other queens: in this manner the community is not suffered to die out for want of new labourers; and yet her subjects in no degree diminish their respect to her.

The drones are, in ordinary cases, put to death by the workers when they are about two months old. This they do by stinging them; but in the case just mentioned, where the queen lays male eggs only, their instincts teach the workers to let the drones live—and they do not attack them.

As soon as a working bee has attained its perfect or imago state, it seeks for the door of the hive, and instantly sets out, quite capable of fulfilling all its destinies. The hum made by its wings ceases at the first flower it arrives at, into which it enters, and, rubbing its tongue between the petals and stamens, sweeps out all the nectar, which it deposits in its honey-bag. When, having passed from flower to flower, this honey bag is full, it takes from the anther the pollen necessary to make the bread for the pupæ, and it also gathers propolis. It will have flown, perhaps, a mile before it has got laden. It then returns uniformly in a straight line to its hive. Arrived there, it imparts to its comrades, who have been engaged at home, what nutriment they require, and stores up the rest for after use. It then rests for a few minutes, and again departs on its food-collecting errand. In like manner it arrives into being, perfectly able to perform all its other instinctive actions without requiring the slightest education.

Perhaps not among the least surprising of these, are the contrivances of the bees for ventilating the hive. A bee-hive, as may easily be fancied, is apt to get both heated and corrupted by foul air. In order to obtain a supply of fresh and pure air, a number of the workers, often about twenty, station themselves in a file upon the floor. They hold very firm to the ground, and "by means of their marginal hooks, unite each pair of wings into one plane, slightly concave, thus acting upon the air by a surface nearly as large as possible, and forming for them a pair of very ample fans, which in their vibrations describe an angle of 60°." They vibrate these fans with such rapidity, that the wings are scarcely visible. By this operation, a very perceptible current of air is driven into the hive, which of course displaces the corrupt air.

The warlike undertakings of bees are amusing. Dreadful deeds are sometimes to be witnessed in a hive, and probably depend upon one of the workers having become old and not so active as before, and another one trying to kill him. These encounters occasionally end in the death of both combatants; sometimes one slays the other, and sometimes, after fighting for an hour or more, they give up by mutual consent. Occasionally general battles take place between the occupants of two hives. A hive may attempt to plunder the honey of another, and, when this is the case, the bees composing it at first act with caution, and a few of them linger about the door of the hive intended to be pillaged. After a little the whole robbers come in a body, and a fearful battle ensues. If the invaders can succeed in killing the queen, the attacked join with them, assist in plundering their former house, and then depart home with the robbers.

Occasionally four or five bees unite together, and attack either a straggling hive bee or a humble bee. Their object is merely to rob him of his honey. They hold him by the legs and pinch him until he unfolds his tongue, which is sucked in succession by his assailants, who then suffer him to depart in peace.

On the other hand, bees are themselves exposed to many assailants. The common wasp often attacks their hives on a pilfering expedition, and, owing to his size and courage, is a formidable thief: one wasp being able to fight three bees. On some occasions the wasps drive the bees out bodily, take possession of their hive, and, of course, eat all their honey. A still more formidable opponent is found in the larvæ of *Tinea mellonella*, and other species of moths, who spend the early part of their lives in the hives, where they consume large quantities of food. They spin a silken tube around them, through which the stings of the bees cannot penetrate. The bees, however, take great pains to keep the moths out of their hives, and thus prevent the possibility of their laying eggs in them.

They put sentinels at night, who, on the approach of the moth, utter a low hum which brings assistance, and the moth is stung to death. The death-hawk moth, which is almost as large as a common bat, sometimes makes its way into hives, where it commits great havoc. To defend themselves against it, the bees barricade the entrance of their hives with a strong wall made of wax and propolis. This wall is built behind the gateway, which it completely stops up, and is only pierced with a hole that will admit one or two workers. This erection is only put up in extreme emergencies, but is a striking example of an instinct.

CHAPTER IV.

THE INSTINCTS OF FISHES AND REPTILES.

OWING to reptiles being (from their cold and slimy feel) an object of disgust to most people, and owing to their lives being in part, and those of fishes altogether, passed in a different element from that which we inhabit, our knowledge of their habits and instincts is very confined. Nevertheless, the movements that they make are very complex, and serve very important ends, and they seem to be exclusively or nearly so the result of instinct, and not of experience and reason.

The instincts shewn by fishes in their migrations, for instance, are very wonderful. There is the cod-fish, so important, particularly in a dried state, as an article of food, and the fishing for which gives employment to thousands of sailors. Every winter, or at the beginning of spring, this fish, which inhabits the depths of the ocean, makes for the shore; always directing its course northwards. The mackerel, at the approach of winter, seeks out landlocked bays in the Arctic, Antarctic, and Mediterranean seas, in the muddy bottoms of which it plunges its head and the upper part of its body, and then passes the winter in a state of hybernation. In the spring the mackerels emerge from their torpid state, and then they direct their course invariably south. The herring, too, inhabits the arctic seas, and instinctively makes immense migrations southward, being irresistibly compelled to depart three times in the year; once when the ice begins to melt in spring, again in summer, and the last time in September. The object of these migrations is to deposit their eggs in places where a more genial warmth will hatch them. Another class of fishes, of which we may take the salmon as an example, spend a certain portion of the year in the ocean, and then migrate for a period to the fresh water of rivers, sometimes penetrating to a distance from the sea of three thousand miles. The salmon is a very widely distributed fish, having been found in almost every sea save the Mediterranean. In temperate latitudes it leaves the sea in spring, and proceeds with regularity and circumspection to enter the rivers. One of the largest of the band that ascends any particular river, generally a female, takes the lead, and appears to direct the enterprise. She is followed by two of the same sex, and these by other pairs of females, each pair being at the distance of about six feet. After these come the males in pairs, and in like order. It is a familiar fact, when they arrive at a cataract they place their tail in their mouth, and let it suddenly go out with violence, and in this manner are able to spring several feet out of the water. The pertinacity with which they repeat their leaps until they surmount the obstacle, is, as is the case with all instinctive movements,* very great. The object, or the main object of the migration of the salmon, is to deposit their spawn in the shallows of fresh water streams.

To bury themselves in the mud can scarcely be called a migration, yet doing so is an instance of an instinct; and pond fishes, as carp and tench, thus act when the heat and drought of summer threaten to dry up the water. Other pond fish are, however, upon such occasions led by their instinct to desert their native pools, and seek others with more water. Eels are a familiar instance of this; but in other countries still more remarkable examples are to be found. Thus, there is a fish called by the Indians the flat-headed hassarr, which lives in small pools that are very liable to be dried up during summer. When this danger is imminent in any particular pond, the fish unanimously desert their home, spring on the land, and, by means of their pectoral

* Thus, if an ant seize a dead insect which it cannot carry off, it does not leave its hold, but pulls until it dies of starvation.

fins and their tail, wriggle themselves along until they arrive at a pond containing water. It is believed that they have some means of conveying a supply of water with them, with which they keep their gills moist, and are thereby enabled to breathe. Another fish that inhabits Carolina, also possesses this migratory instinct, and was experimented upon by Bosc. He found that they uniformly directed themselves towards the nearest water, although they could not possibly see it. Still more extraordinary are the land expeditions of a species of perch, which not only comes on shore, but ascends palm-trees in search of food. The gill-covers of this fish are studded with spikes, and it contrives to climb the tree by sticking these into the bark alternately with the spines of its fins, the one set supporting it while it is advancing with the other. This perch has a contrivance by means of which it can keep its gills damp.

It was formerly thought that fishes made very little or no provision for the habitation, &c., of their progeny; but it is now known that several species of them are led by their instinct to construct nests, in which they deposit their eggs. A species of sticklebat, that is common on the coast of Berwickshire, has been observed by Sir David Milne, Mr. Duncan, and the Rev. M. Turnbull, decidedly to do so. The nests of these fishes are to be found in spring and summer, in rocky pools between high and low tide-mark; and are noticed to be particularly common about Eymouth and Coldingham. They are about eight inches long, of a pear shape, and are formed by matting together the more common sea-weeds. These pieces of sea-weeds are firmly tied together by means of a thread, run through, around, and among them, in every possible direction. This thread appears to be secreted by the animal. In the centre of this nest the eggs are laid, and the parent mounts guard upon it to protect it from the attacks of animals; and so intent is it upon the safety of the nest, that it will allow itself to be taken out of the water. In the Thames, too, sticklebats have been noticed to build nests, using there as materials, bits of wood and sticks, and pieces of straw. Another kind of fishes' nest is constructed of coralline, pieces of which have clearly been conveyed from a considerable distance.*

Other singular instincts have been observed in certain fishes, with regard to the manner in which they obtain their food. There is the fishing frog, for example, or the sea devil, as it is sometimes called, a very ugly inhabitant of European seas. "This fish," says Lacèpéde, "having neither defensive arms in its integument, nor force in its limbs, nor celerity in swimming, is, in spite of its bulk," (it is sometimes six or seven feet long),

* Aristotle was quite aware of this habit of fishes.

"constrained to have resource to stratagem to procure its subsistence, and to confine its chase to ambuscade, for which its confirmation in other respects adopts it. It plunges itself into the mud, covers itself with sea-weed, conceals itself among the stones, and lets no part of it be perceived but the extremity of the filaments that fringe its body, which it agitates in different directions, so as to make them appear like worms, or other baits. The fishes, attracted by this apparent prey, approach, and are absorbed by a single movement of the fishing frog, and swallowed by his enormous throat, where they are retained by the numerous teeth with which it is secured." Another fish, the fly-shooter, adopts a still more extraordinary mode of providing its food. This food consists of small insects, and these it shoots, as it were, by ejecting a small drop of water from its mouth, which hits them, and makes them fall within its range.

Some fishes have the power of giving off from themselves electricity, and in this manner of killing or stunning their prey. The one of these that has been most particularly studied, is the torpedo. This fish was known by Aristotle to possess a benumbing action upon all who touched it. This is owing to an electrical charge which proceeds from a special apparatus that is provided to the animal for the purpose. The fish probably lies concealed in the mud, and, when other fishes approach it, it instinctively discharges it electricity, and then takes possession of them in their benumbed condition. A duck that was placed in a vessel of sea-water in which was a torpedo, was found at the end of three hours to be quite dead. Another probable use of the electrical apparatus is, to defend its possessor when attacked by sharks or other large fishes.

Among the reptiles, there is one family that does not excite the same disgust that other reptiles do, and several members of which are used as food. These are the turtles or tortoises; and, although the habits and manners of them have been very little observed, some rather curious examples of instincts have been noticed in them. Thus the thalassian, or sea-turtle, although she lives at sea, is taught by her instinct to seek out the land, on which to deposit her eggs. To do this, she has often to travel more than fifty leagues, which she does, accompanied by her consort. She is a very unwieldy creature on the land, moving with great difficulty and slowness. She instinctively, however, crawls at any effort to above high water-mark, when she carefully scoops out a hole, lays her eggs in it, and then carefully covers them up with sand. The very moment, too, that the young turtles are hatched, they instinctively make for the sea.

These turtles are very much preyed upon by fishes, birds, crocodiles, and man. The last-mentioned sometimes makes use of the natural instincts of a fish to catch them, this being the only instance in which a fish is used for such a purpose. The inhabitants of China and the Mozambique employ in this way a species of remora. This fish has a ring fastened in his tail, to which a strong cord is attached. When the fisherman perceives a tortoise floating on the sea, he slips one of these remora into the water, who instantly makes for the turtle, of whom he takes a firm grip. The two are then hauled into the boat by means of the string. The fish is then returned to a tub kept filled with water for his habitation in the boat.

There is a reptile, a species of salamander, that places each of its eggs in a leaf of *persicaria*, which it protects by doubling the leaf over it. This egg, too, is surrounded by a gluey matter, which assists in securing it to its envelope. The salamander is the animal that, from the days of Aristotle, has been reputed to have the property of putting out flame into which it may be thrown. To a certain extent, this is really true. The salamander has the power of secreting from its skin a white and very acrid fluid, which it instinctively ejects when it desires to destroy its prey, or apparently when irritated, and this can put out flame. Kirby was aware of a remarkable example of this. Three ladies, living in a very damp country-house, had their cellar very much frequented by frogs, and also by some black newts or salamanders. One day some of the frogs were caught and put into a pail. While the ladies were looking at the frogs, a salamander that was also in the pail, was noticed running amongst the frogs and touching them, and the moment it did so touch them, the frogs died. Not unnaturally, the black salamander was from that day regarded as fearfully venomous, and one of them being found one night afterwards in the kitchen, was caught with a pair of tongs and dropped into the fire, which was burning pretty brightly. Instead of being instantly consumed, the reptile slipped through the glowing coals, and escaped apparently unhurt under the fireplace. It was probably protected in its fiery ordeal by this juice.*

Serpents swallow their prey whole, and instinctively, before swallowing it, crush it with their voluminous folds, and lubricate it excessively with saliva. By obeying these instincts, a boa-constrictor can swallow animals bigger than itself.

There is a species of chameleon that can, by variously inflating its lungs, change its colour from green to dark-brown; and when lurking for its prey, or seeking security from its pursuer, it is believed that its instincts

* This anecdote is given on the authority of Kirby.—T. L. K.

teach it to modify its colour, according as it is by the side of a tree or of a rock.

The last indication of instinct that we will mention as to be noticed among reptiles, is that of the crocodile, which, when sore pressed with hunger, swallows stones to relieve the uneasy sensation.

CHAPTER V.

THE INSTINCTS OF BIRDS.

THE indications of instincts in birds that will be noticed in this chapter, have reference to their migrations, the construction of their nests, and the habits of some of them that live in communities.

We may take as the type of a migrating bird, the swallow. It makes its appearance here in spring, constructs its nest, and hatches its young ones. In the autumn, it and also those young ones that are hatched in this country, are led by an irresistible instinct to fly all the way to Africa. No decrease of temperature or diminution of food appears to have any influence in determining this migration.* On the contrary, the desire to depart, and the route taken, must be entirely ascribed to two blind instincts. The young swallow born in this country, accustomed to our scenery, our insects, our animals, our very habitations, for its own

* The swallow is pretty indifferent to cold.

nest has been constructed against them, obeying an uncontrollable instinct of which it cannot anticipate the result, leaves all that is familiar, and crosses a vast ocean and leagues of land until it reach some African wild, with new trees, animals, insects, and perhaps men. And in a few months this same instinct makes it leave all these, retraverse the leagues of land, recross the ocean, and again approach the scene of its nativity.

We have in this country a number of birds that make partial migrations, but which do not leave the island. They merely shift their quarters from one part to another. Thus the duntin inhabits, during the breeding season, the moors of Dumfries-shire and other Scottish moors; but when the young are fledged, these birds come to the sea-shore, from whence they gradually extend over all the coasts of the island, returning next year to the Scottish moors to breed. In a similar manner, the curlew and the golden plover live in winter on the coasts, and in summer repair to inland lakes and moors. The linnet, in winter, approaches the habitations of man; the dipper, in summer, ascends the streams to their sources; and the lapwing, when winter comes on, goes north. A curious instance of this partial migration has been observed amongst the crows of Dumfries-shire; they breed in great numbers at Carruchan, in that county, but when their young are fledged, they leave that locality. During the autumn and winter, however, they frequently pay a passing visit to their nurseries.

A number of birds inhabit this country during the summer only, and disappear in the autumn. With the early spring comes the wheat-ear, the whinchat, and the ring-ouzel, and, among these vernal birds of passage, the cock-birds arrive about a fortnight before the hens. A little later appear the swift, cuckoo, nightingale, &c., in all about twenty in number. White, in his delightful history of Selborne, noticed that the first visiter in that village was the wryneck, which usually appeared about the middle of March, and that the last of the summer birds of passage was the flycatcher, which generally came on the twelfth of May. He also observed that by the end of September all had disappeared.

As, however, these depart, their place is taken by the winter birds of passage, *i. e.*, by those who arrive here at the end of autumn, spend the winter with us, and depart on the approach of spring. The most abundant of these are the redwing, the fieldfare, the woodcock, the two snipes, the wood-pigeon, (so hostile to the farmer, and doing more harm to the turnips than the pheasant does to the white crops,) the widgeon, the teal, and the wild-duck and goose.

That each of these species should have its appointed season for coming and departing to the country, and that this season should be strictly observed by each succeeding generation, are very striking instances of instincts. They are not owing to any want of food or alteration of temperature; for they take place before the supply of food falls off, and before the weather becomes much colder, or warmer. Indeed, when there is abundance of food and a high temperature, a summer bird of passage still departs at the end of summer. The stork, for example, leaves Bagdad, where the winter is extremely mild, just at the same time that it does the fens of Holland; and, if confined in a cage, although it remains quiet for a period, yet when the appointed hour comes, it dashes itself against the bars of its cage until it beats itself to death in its struggles to obey its instincts. Birds migrate because He who made them knew, that He had so ordered matters that there generally *would* be, *by and by*, a deficiency of food and a change of temperature, and He implanted in their matter this strong but blind instinct to depart ere such supervened.

The nidification of birds affords many examples of movements that are purely instinctive, inasmuch as the young hen (the hen generally takes the principal charge in nest-building) of each species builds her nest after the right fashion, the first time as well as the last. We may begin our indications of these nest-binding instincts by considering the habits of some of the birds that make burrows in the ground. The peterel family do this. One of these, seldom seen in Europe, but familiar to every one from description, as being an object of superstitious dread to mariners—the stormy peterel, or Mother Carey's chickens—and remarkable for the bold and fearless manner in which it hovers over the waves in the severest storm, uttering a wild cry of—*weet, weet.* It was probably the wildness of this cry, coming amongst the confusion of a storm, that led sailors to conclude that the bird was in some manner connected with the prince of darkness. Among other opinions held regarding them are, that no man knows where they come or whither they go, and that the female carries her egg underneath her wing, and there hatches it. This last is of course impossible, and the truth is, that they take possession of cavities in the rock, or dig out burrows in the shore. "They make holes," says Wasser, speaking of Juan Fernandez, "in the ground, like rabbits;" and father Lobat states, that "the great sulphur mountain in Guadaloupe is all bored like a rabbit warren with the holes that these imps excavate."

Until lately a bird of the peterel tribe—the puffin—was very common in the Isle of Man, and is still found in Wales and other parts of the western coasts of Britain. This bird makes extensive subterranean residences. Contrary to the usual custom, the male undertakes the greater part of the labour. He commences by scraping a hole in the sand, near the shore. When he has made a little excavation, he throws himself on his back, digs with his very broad bill, and with his webbed flat foot casts out the rubbish. In this way he succeeds in making a burrow, with several windings and turnings, and about ten feet deep, where his mate can hatch and bring up her young brood in comparative safety. It is said to sometimes save itself trouble, by taking possession of the burrows of a rabbit.

Another bird that inhabits our island—the beautiful kingfisher—excavates itself a home in the ground. It selects as the scene of its operations the bank of a river. Then it excavates about three feet deep, the direction of the hole being diagonally upwards, and the inside is much wider than the opening, in order probably to give the bird room to turn.

Another class of birds are called, from the manner in which they construct their nests, mason birds. The nuthatch, or *pic maçon* of the French, is one of these. It fixes upon a hole in a tree for its habitation, but it puts up a barricade of plaster at the opening, merely leaving a hole large enough for its own ingress and egress, and thus keeps out intruders. If this wall be pulled down, it is immediately rebuilt. The house martin, too, is a familiar example of a mason builder. Mr. White's account of its proceeding in this respect has become classical. "About the middle of May," he says, "if the weather be fine, the martin begins to think in earnest about providing a mansion for its family. The crust or shell of this nest seems to be formed of such dirt or loam as comes most readily to hand, and is tempered and wrought together with little bits of broken straws, to render it tough and tenacious. As this bird often builds against a perpendicular wall, without any projecting ledge underneath, it requires its utmost efforts to get the first foundation firmly fixed, so that it may safely carry the superstructure. On this occasion, the bird not only clings with its claws, but partly supports itself by strongly inclining its tail against the wall, making that a fulcrum, and, thus steadied, it works and plasters the materials into the face of the brick or stone. But then, that this work may not, while it is soft and green, pull itself down by its own weight, the provident architect has prudence and forbearance enough not to advance her work too fast; but by building only in the morning, and by dedicating the rest of the day to food and amusement, gives it sufficient time to dry and harden. About half an inch seems a sufficient layer for a day. Thus careful workmen, when they build mud walls (informed at first perhaps by these little birds), raise but a moderate layer at a time, and then desist, lest the work should become top-heavy, and ruined by its own weight. By this method, in about ten or twelve days is formed an hemispheric nest, with a small aperture towards the top, strong, compact, and warm, and perfectly fitted for all the purposes for which it was intended."

Some birds work in wood, and may be termed carpenters. The nuthatch, before mentioned, on account of his qualifications as a mason, is believed to enlarge the hole in the tree when that is necessary. Both the tomtit and the woodpecker, with their sharp beaks, excavate altogether a hole in a tree, and, moreover, they carefully carry away the chips, so as not to give any unnecessary indication of their whereabout. Wilson relates of an American woodpecker, that the excavation it makes in a tree is sometimes five feet in depth, and that it is winding, so as to keep out the rain and wind.

Ill calculated as the structure of the bird seems to be for either mining or working in wood, it seems still less so for sewing. There are nevertheless some birds—none, however, inhabiting this country—who are led by their instincts to construct their nests in this last-mentioned manner. The orchard starling is an example of this. It usually suspends its nest from the twigs of an apple tree, and uses for its material a tough species of grass, pieces of which are sewed through and through. Wilson detatched one of the stalks of this, and found it thirteen inches long, and that it went in and out like a thread thirty-four times. The tailor bird of the East Indies, is a still more remarkable instance of this instinctive sewing: Forbes watched it constructing its nest, and he observed it to select a plant with large leaves, next gather cotton, spin the cotton into a thread by means of its bill and feet, and then sew the leaves together, using its beak as a needle, or rather, awl.

Other birds construct their nests in a manner analogous to weaving; others are led by their instincts to cover their nests with a dome, and still farther peculiarities might be cited. Passing over these, however, we may notice some strange instincts which lead particular species of birds to dispense with building a nest altogether, and to use one built by another bird or mammal. Most of the hawks and owls take possession of the nests of crows, ravens, squirrels, &c. Sparrows, too, are very apt to take by force the nests of swallows and other birds; but this does not seem to be the result of instinct, but to be an acquired habit, a piece of roguery, the result of reasoning, for the sparrow can make upon occasion a very good nest for itself. But the most remarkable bird in this respect is the cuckoo. This never constructs a nest of its own, but lays its egg in that of another bird, where it is hatched. The instinct of the parent cuckoo always leads it to select the nest of an insect-feeding bird, and it also prefers a small nest. If it neglected the former, its young when hatched would starve, as the cuckoo lives on animal food; and the latter is one of the best indications of an instinct that can be found. The young cuckoo, as soon as it is hatched, is taught by its instinct to pitch out its foster brothers and sisters, in order that it may get all the meat to itself. To effect this, it creeps under the other little fledglings, clambers backwards, and ejects it from the nest by a jerk; and the pertinacity with which it repeats this process until it effects its object is very great. But if it were in a large nest it could not succeed in its purpose, whereas in a small one it can hoist it over the side. It is quite incredible that the mother cuckoo can foresee this at all; and her selecting the nest of a little hedge sparrow, or even of a still less wren, in which to deposit her egg, must be altogether instinctive. Another very curious fact with regards to the young cuckoo is, that while newly hatched birds have in general their backs convex, that of the young cuckoo has a depression in the middle, which forms a lodgement for the other young birds. If the cuckoo is hatched before the other eggs are, it takes these eggs and throws them over.

Owing to the activity of flight and the shy nature of most birds, we know little of the instinctive actions that serve a common purpose of those that live together in societies. And indeed it has been affirmed, that when birds do live together, no instinctive actions are performed for a common end or a common safety. But some such unquestionably are, and probably a great many more than we have ever observed exist. The crane and the wild-goose would seem to elect a leader, and almost all gregarious birds appoint sentinels. Every body must have seen the sentinels of crows, and noticed their extreme watchfulness. So also do sparrows, and sparrow sentinels keep a very strict watch, especially for cats, and on the approach of one of their feline enemies at once give the alarm. Sparrows, too, frequently hold assemblies, or sparrow-courts as they are called, and appear in them to be scolding and perhaps beating one of their number; and it has been conjectured that they are punishing a delinquent sentry. So, also, there are crow-courts held, and probably for a similar purpose. The internal economy of a colony of rooks is certainly subject to a regular police. "I have often," wrote Goldsmith, "amused myself with observing their plan of policy, from my window in the temple, that looks upon a grove where they have made a colony in the midst of the city. At the commencement of spring, the rookery, which, during the continuance of winter, seems to have been deserted, or only guarded by about five or six, like old soldiers in a garrison, now begin to be once more frequented, and in a short time all the hurry and bustle of business is fairly commenced. Where these numbers resided during the winter it is not easy to say, perhaps in the trees of hedge-rows, to be nearer their food. In spring, however, they cultivate their native trees; and in the place where they were themselves hatched, they prepare to raise a future progeny. They keep together in pairs, and prepare for making their nests and laying. The old inhabitants of the place are all already provided, the nest which served them for years before will, with a little trimming and dressing, serve them very well again. The difficulty of nesting lies upon the young ones who have no nest, and who, therefore, must get up one as well as they can. But not only are the materials wanting, but also the place in which to fix it. Every part of a tree will not do for the purpose, as some branches may not be sufficiently forked, others may not be sufficiently strong, and still others may be too much exposed to the rocking of the wind. The male and female, upon this occasion, are for some days seen examining all the trees of a grove very attentively; and when they have fixed upon a branch that seems fit for their purpose, they continue to sit upon it, and observe it very sedulously for two or three days longer. The place being then determined upon, they begin to gather the materials for their nest, such as sticks and fibrous roots, which they regularly dispose in the most substantial manner. But here a new and unexpected obstacle arises. It often happens that the young couple have made choice of a place too near the mansion of an older pair, who do not choose to be incommoded by such troublesome neighbours; a quarrel, therefore, instantly ensues, in which the old ones are always victorious. The young couple, thus expelled, are obliged again to go through their fatigues—deliberating, examining, and choosing; and, having taken care to keep their due distance, the nest begins again, and their industry deserves commendations. But their activity is often too great in the beginning; they soon grow weary of bringing the materials of their nests from distant places, and they very early perceive that sticks may be provided nearer home, with less honesty indeed, but some degree of address. Away they go, therefore, to pilfer as fast as they can, and, whenever they see a nest unguarded, they take care to rob it of the very choicest sticks of which it is composed. But these thefts never go unpunished, and probably, upon complaint being made, there is a general punishment inflicted. I have seen eight or ten rooks come upon such occasions, and, setting upon the new nest of the young couple, all at once tear it to pieces in a moment.

At length, however, the young pair find the necessity of going more regularly to work. While one flies to fetch the materials, the other sits upon the tree to guard it; and thus in the space of three or four days, with a skirmish now and then between, the pair have filled up a commodious nest, composed of sticks without, and of fibrous roots and long grass within. From the instant the female begins to lay, all hostilities are at an end; not one of the whole grove, that a little before treated her so rudely, will now venture to molest her, so that she brings forth her brood with perfect tranquillity. Such is the severity with which even native rooks are treated by each other; but if a foreign rook should attempt to make himself a denizen of their society, he would meet with no favour, the whole grove would at once be up in arms against him, and expel him without mercy."

CHAPTER VI.

THE INSTINCTS OF MAMMALS.

WE may commence the account of the indications of instinct that occur in mammals, and which are much less remarkable than those which may be witnessed in the lower animals, by some notice of the habits of one of the lowest of them, and one that manifests little or no signs of intelligence. This is the common mole of our fields; an animal that leads a subterranean life, and scarcely possesses the faculty of vision; indeed, it is probable that its very minute specks of eyes only suffice to inform it that it has come into contact with the light of the day, and is therefore in the midst of danger from which it cannot defend itself.

This insignificant animal, "the little gentleman in black velvet" of the Jacobites, is led by its instinct to construct a very elaborate underground dwelling. Underneath a hillock, in some secure place, it makes its headquarters or fortress. This is roofed by a compact cement, which the animal has beaten and spread as plaster. Two galleries are formed in it, one at the bottom, and one higher up, which communicate together by means of five tunnels or passages. From this fortress, which is used as a dormitory, a number of excavations proceed, each somewhat larger than is necessary to allow a mole to proceed, but not of such extent as to permit two to pass. These roads constitute the animal's hunting-grounds, in which he seeks for worms; and he is continually extending them, the indefatigable miner throwing to the surface the earth that he displaces, and thus forming molehills. In making all these tunnels the mole is led by its instincts to select a depth which varies according to the nature of the soil and the surface. Sometimes they are not more than four inches down from the surface; but if a road or a stream have to be undermined, they sometimes extend to the depth of nearly two feet. It has also been noticed that, when food is scarce, a number of branch tunnels are made, and that the depth of these is regulated by the consistency of the soil, being deepest in heavy and humid ones, where the worms burrow low; indeed, in very light gravely soils, it comes almost to the surface, and the tunnel becomes nearly a trench.

The mole is a thirsty creature, and accordingly it is led by its instincts to invariably provide for a due supply of fluid. Generally it contrives to be near a stream; but if, probably when it is driven from such convenient localities by a stronger mole (for moles are very pugnacious animals, and do not endure rivals,) it is compelled to erect its fortress in a dry place unprovided with a stream, it sinks deep wells. These are perpendicular shafts, and may be often observed quite full of the water that has gathered in them.

Le Court, to whom we are indebted for most of our knowledge of the habits of the moles, made an experiment which demonstrated the very considerable rapidity with which the mole progresses in its tunnels. He took one day advantage of a mole being out hunting at the extremity of its domain, and he placed along the course of the high-road or main tunnel that led from where the animal was engaged towards the fortress, several little flags of coloured paper, the staffs of which were single straws which he stuck upright through the centre of the tunnel. Near the end of the road he inserted a horn, having its mouthpiece projecting out of the earth. When his arrangements were all completed he blew a blast upon his horn, upon hearing which the terrified mole was immediately impelled by its instinct to make for its fortress; and of the rapidity with which this was done, some idea could be formed by observing how fast in succession the flags fell, from the animal in its flight displacing the straws. The observers thought that it ran about as fast as a horse can trot.

There is the *Mus messorius*, or small mouse, the least of all British quadrupeds (White found that two of them weighed only as much as a copper halfpenny,) which shows curious indications of building instincts. Its nest for its young is suspended on a corn-plant, a thistle, or some other small vegetable. One of these nests was found by Gilbert White. "One of these nests," he wrote, "I procured this autumn, most artificially platted, and composed of blades of wheat perfectly round, and about the size of a cricket-ball, with the aperture so ingeniously closed that there was no discovering to what part it belonged. It was so compact and well filled that it would roll across the table without being discomposed, though it contained eight little mice that were naked and blind. As the nest was perfectly full, how could the dam come at her litter respectively, so as to administer a teat to each? Perhaps she opens different places for that purpose, adjusting them again when the business is over; but she could not possibly be contained herself in the ball with the young ones, which, moreover, would be daily increasing in size. This wonderful procreant cradle, an elegant instance of the efforts of instinct, was found in a wheat-field, suspended on the head of a thistle."

This little mouse, too, in winter, if not carried by the harvesters into a stack, makes burrows in the ground, which it lines comfortably with grass, and in which it keeps itself warm during the cold weather.

A much larger animal belonging to the mouse family, the hamster, is common in the north of Europe, where it commits great ravages upon the farmer. It is impelled by its instinct to construct both subterranean dwellings and subterranean barns. It first burrows down obliquely to form an entrance; at the end of this the male constructs one perpendicular shaft, and the female several. At the terminations of these latter, several vaults are excavated, which serve for their own dwellings, for the reception of their young, and for store-rooms; and it is stated that for every different kind of corn a different vault is constructed. In a complete establishment the vaults will sometimes go down to a depth of between four and five feet, and the whole collectively will have a diameter of eight or ten feet. The apartments intended for residence are well lined with grass. When the hamster is out foraging, after having satisfied his appetite, he fills his cheek-pouches with corn until they become enormously distended. In this state he repairs to his granaries, and, after having carefully separated the chaff, hoards it up. As the winter's cold increases, he stops up the entrance to his premises, and prepares for hybernation, during the intervals of which he subsists upon the food that he has instinctively laid up. The peasants hunt out these burrows of the hamsters, out of which they commonly obtain about two bushels of corn.

As is well known, rats, in like manner, store up food against a time of scarcity. Squirrels, too, afford us examples of instinctive storing of food and constructing residences. Our common European squirrel constructs its abode of moss and dried leaves, which it packs between the fork of two branches of a tree, and in a hole near it stores up nuts for its winter use. An American ground squirrel makes a burrow in the ground, at the root of a tree, where it lays up a great quantity of winter food; and when the cold becomes severe it ensconces itself in it, having previously taken the precaution of making more than one outlet. The common hedgehog of this country also constructs a house for its winter residence; but this animal is not known to store up food.

Another mammal that constructs a habitation is the badger. It excavates a subterranean house, which enters by a passage, that soon divides into several chambers, but that eventually terminates in an apartment, well lined with hay. The beaver, also, affords very striking indications of instinct in his building arrangements; but these have been noticed in the *Natural History of Creation.* But it must be admitted that almost all the instinctive movements of mammals are far less extraordinary than those of beings lower in the scale; and also that, in investigating them, it is much less easy to decide how much is purely instinctive, how much decidedly intellectual, and how much the result of original instincts, added to and improved by acts of reasoning upon experience.

CHAPTER VII.

THE REASONING POWERS OF THE HIGHER ANIMALS.

No one who has watched the decidedly instinctive actions of the higher animals, can have failed to have noticed with how slight a degree of intensity they are manifested when compared with those of animals lower in the scale. There is the bee, for example, an insignificant insect that is led by its instinct to store up a supply of food; and we have seen with what an ardour and determination it persists in obeying that instinct. Nothing save death can arrest it in laboriously hoarding up honey every summer day. Then there is the hamster, an animal much higher in the scale, which also uniformly and persistently puts by food for future use. The dog, a very high animal, has likewise this propensity to gather food and store it for an after day's consumpt; and his instinct teaches him to bury bones and meat in the ground. But he only occasionally obeys that instinct, and the slightest accident deters him from his purpose. Nay, he may be made to understand that his master disapproves of the custom, in which case he will probably entirely discontinue the practice.

When, as in this last-mentioned case, the dog desists from concealing food in the ground because he finds his master dislikes the habit, he clearly does not act from an instinct, but from a process of reasoning that passes through his mind. An exceptional case from any thing that could occur to him in a state of nature happens, and he meditates upon it, and finally decides upon a line of conduct. It is not an irresistible impulse that he obeys, the result of which he knows not of, nor cares about; on the contrary, he restrains the strong desire that he has to conceal the superfluous meat, and he does so because he judges that if he hide it he may be punished, if he do not that he may be caressed or praised, and that a due supply of food will always be given to him. Accordingly, in all the higher animals, indications of reasoning upon facts that have been experienced, and decisions evidently adopted for particular cases, and often modified in each individual case, are to be plentifully witnessed.

These begin to manifest themselves pretty low down in the scale, although at first it is not easy to draw the line of demarcation very exactly as to where the purely instinctive movements become mixed up with actions performed under the guidance of reason. None of the latter probably exist in any beings lower than insects; and, even among insects, only two or three such have been observed, and even these comparatively simple and insignificant ones. One of the most remarkable of them was observed by Colonel Sykes, in the case of some black ants in India. This gentleman's dessert, which consisted of fruit, cake, and preserves, was always allowed to remain in a verandah that opened off his dining-room. The ants found this out, and attacked the dessert. In order to keep them off, the legs of the table were immersed in pails of water. At first this proved effectual; but the dessert was so tempting, that the ants at length braved the water, and plunging in, managed to scramble to one of the legs and ascend the table. Every morning the dessert table was found covered by hundreds of them. The legs of the table were then painted just above the water, with a circle of turpentine, which for some days appeared to completely defend the dessert from the attacks of the ants. However, in a little they were again found in the mornings as thick as ever, and plundering at the sweets; and it was at last discovered that the ants had hit upon the plan of creeping up the wall, proceeding to the ceiling over the table, and then letting go their hold they tumbled among the viands that they were so hungry to eat. This last expedient must certainly have been the result of a reasoning process.

The drones of the wasp, too (wasp drones, as before mentioned, are the scavengers of a wasp nest,) assist one another in removing any dead wasps from the nest; and, if the corpse is too heavy for them, they have often been noticed to sever it in two, and remove each part separately. Something analagous to this has been observed with regard to ants. Lyon experimented upon these insects in Barbadoes, and thus reports:—"We sometimes kill a cockroach and throw him on the ground, and mark what they (the ants) will do with him; his body is bigger than a hundred of them can carry, and yet they will find the means to take hold of him and lift him up, and, heaving him above ground, away they carry him, and some go bye as ready assistants if any be weary, and some are the officers that lead and show the way to the hole into which he must pass; and if the van carriers perceive that the body of the cockroach lies across, and will not pass through the hole or arch through which they mean to carry him, order is given, and the body turned endwise; and this is done a foot before they come to the hole, and that without any stop or stay; and this is observable, that they never pull contrariwise."

It is, however, in the highest animals, as elephants, horses, and dogs, that we can behold pretty complex actions which are clearly the result of reasoning, and performed altogether in subjection to the animal's will.

Perhaps the property of the higher animals being able to understand to a certain extent the spoken language of man, and also of communicating to one another ideas, or at any rate facts, and acting in consequence of that communication, not as the ants do, in one unvaried instinctive fashion, but according to the peculiarities of the case, afford us many conclusive proofs of the reasoning powers of the higher animals. Part of the former of these are undoubtedly owing to the animal coming to understand the expression of his master's face; but it is certain that some of the higher animals absolutely have acquired a certain understanding of language. Thus, if we speak French to a dog, he can come after a time to tell our meaning, and to obey us. If we then begin speaking English to him, he can understand nothing for a while, and requires to be educated over again until he has acquired his new language.

This power of the higher animals to understand by means of experience and reasoning, is certainly very remarkable. The tame elephant at the Jardin du Roi, immediately on hearing the words, *en avance*, without the slightest elevation of voice or gesture, made the desired movement. The manner in which our horses comprehend and are obedient to what is said to them, is matter of notoriety. Perhaps the best instance of this may be noticed among Scottish farm-horses. It is the custom in Scotland to plough, &c., with a pair of horses, which are yoked together, and which are directed in their proceedings (which are a great deal more complicated than the uninitiated would suppose) almost entirely by the spoken orders of the man who holds the stilts of the plough, no boy leading them, as is the case in England. Not only do they perfectly understand the order to stop, to move slower or faster; but when the man cries *hi*, they turn round to the right side, and when *hup*, to the left. In fact, so well do the horses understand farming, and so willing are they to do what is right, that a distinguished agricultural writer* has declared his belief, that in the rare case when the horses and the man quarrel in the field, the horses will be found to be right, and the man wrong.

It would seem, too,† that the domesticated animals have an artificial language, acquired by experience, and used in accordance to reason. The wolf, or the fox, or the wild-dog, if caught in a trap, or even if put to a painful and violent end, never cry out. Will Crane, the huntsman to one of the Lords Fitzwilliam, during the whole course of his great fox-hunting experience, never heard but one fox cry out when being worried by the

* Mr. Stephens.

† As mentioned in the *Natural History of Creation*, even the highest animals only possess this power to a small degree.

hounds. This strongly contrasts with the cry of a domesticated dog, for example, even when slightly struck. But the higher animals possess several sounds which they appear to be able to interpret accurately enough. These have been particularly attended to by M. de la Malle, who acquired such a perfection in the language of the higher animals, that he often succeeded in deceiving them. Indeed he did sometimes to his own cost; for seeing his own dog, who was much attached to him, approaching, he uttered the cry of defiance, upon which the animal flew upon him and bit him in the leg. The dog immediately discovered his mistake, and threw himself howling upon the ground, beseechingly looking for pardon. At other times he was not so accurate in his imitations, and the animals were not deceived. Upon these occasions, their looks sometimes expressed their contempt at his failure, but at others they received it with a grave expression of irony, as if they understood and appreciated the joke.

This same gentleman was acquainted with the Count de Fontenay, who, in concert with the Marquis des Feugerets, was engaged in some experiments relative to the breeding of Merino sheep. The count had a particularly intelligent pointer. One day he was anxious to send a letter to Feugerets, but he had no messenger at hand. It occurred to him that perhaps his dog might do, and accordingly he tied the letter to the collar of the pointer, and said, "Carry that to Feugerets." The dog did as he was desired, and, when he arrived at his destination, would permit no one to touch the letter except the marquis. Subsequently he was often employed in this manner. "I have seen this dog," says La Malle, "for four or five years acting as messenger between the two chateaux with remarkable quickness and fidelity. When the dog delivers the letter he goes to the kitchen to be fed; as soon as he has had his meat, he sits down before the Marquis de Feugerets' study window, and barks at intervals, to shew that he is ready to take back the answer. On the letter being attached to the collar, he sets off and then brings it to the count."

Indeed, we have instances of dogs understanding and obeying spoken language—in sheep dogs and in sporting dogs—which are too familiar to require mentioning, and which indicate a certain amount of reasoning. M. Edwards knew a dog that was in the habit of seeking and bringing back gloves; and if by accident the word *gants* was mentioned in his hearing in the course of conversation, he would immediately set out in search of some. Another French dog was very fond of gingerbread, and, whenever the name of that substance was spoken, would get up in an excited state and run to the cupboard where his favourite dainty was kept.

Not only do the higher animals understand, to a certain extent, what is going on, but they dwell upon them, so as to have their characters and dispositions changed or modified. "The dog which becomes so dainty when brought up in a lady's chamber, is ferocious with the butcher, submissive in the poor man's cabin, or thieving and cringing with the beggar. When standing at the nobleman's lodge, he even adopts the tone and manner of the great man's porter. M. Edwards tells us that he has often seen dogs, educated by weak females, excessively timid, and that this timidity was transferred to their offspring. A terrier born in the house of M. De la Malle, and treated like a spoiled child by a kind-hearted woman who amused herself with speaking to it all day, had its sensibility brought at six months' old to such a state, that when its mistress caressed her cat, or pretended to scold the little animal, its large eyes would fill with tears, and it would end by crying like an infant."

Although wandering from the subject before us, we may state that the converse is the case, and that uncivilized and ill-educated men really have their characters somewhat modified by the animals among whom they dwell. Dr. Virey, perhaps, has pushed this farther than any body. "Behold," he says, "those men who pass their lives among animals, as cowherds, shepherds, swineherds, grooms, and poachers, they always acquire the nature of the brutes with which they are brought in contact, and they contract analogous manners, morals, and even odours. It is thus that man becomes heavy and rude with the ox, filthy and a glutton with the pig, simple with the sheep, courageous, and an adept hunter with the dog. In like manner, the Arab is sober with his camel, the Tartar rough and blunt as his horses, the Laplander timid as his reindeer, the mountaineer active as the goat, the African impudent as his ape, the Indian sombre as his elephant, because it is man's fate to take the nature of his animals when he cannot form their nature to his."

One animal sometimes acquires the habits of one of another species, and this implies observation, and that trains of thought regarding the things observed, have passed through its mind. One of the most remarkable instances of this was observed by La Malle. This gentleman had a kitten which had attained the age of six months, when his live stock was increased by the presence of a terrier pup, Fox, that was only two months old. The dog and the cat were brought up together, and Fox for two years had no association with other dogs, but received all his education from the three daughters of the porter, and from the cat. The two animals were continually together, and acquired a great affection for one another; the cat however, as the senior, taking the lead. Soon Fox began to bound like a cat, and to roll a mouse or a ball with his fore-paws after the feline fashion. He also licked his paw and rubbed it over his ear as he saw the cat do; nevertheless, owing to his native instinct, if a strange cat came into the garden he chased it away. M. de la Malle brought a strange dog into the house, who manifested the utmost contempt and indignation for all Fox's habits. M. Andouin, too, had a dog which acquired all the habits of a cat.

Both dogs and cats have often been known to have perceived the result of ringing bells, and knocking door-knockers, and to have done such for similar purposes. M. de la Malle had a dog which he brought from his country house (where he had no knockers on his doors) to Paris. On the day of his arrival this animal went out of the house, but, feeling apparently fatigued, had the desire to return. It happened, however, that the door was shut, and it endeavoured, but in vain, to attract attention within by barking. At length a stranger calling, raised the knocker and gained admittance. The dog noticed what had been done, and came in along with him. That same afternoon he went in and out half a dozen of times, gaining ingress upon each occasion, by using the knocker of the door.

Two very good examples of this kind on the part of cats are recorded. One occurred under the personal knowledge of Archbishop Whately. "This cat," he says, "lived many years in my mother's family, and its feats of sagacity were witnessed by her, my sisters, and myself. It was known, not merely once or twice, but habitually, to ring the parlour-bell whenever it wished the door to be opened. Some alarm was excited on the first occasion that it turned bell-ringer. The family had retired to rest, and in the middle of the night the parlour bell was rung violently; the sleepers were startled from their repose, and proceeded down-stairs with poker and tongs, to intercept, as they thought, the predatory movements of some burglar; but they were equally surprised to find that the bell had been rung by pussy, who frequently repeated the act whenever she wished to get out of the parlour." Mr. Crouch was acquainted with a cat that could open a lock. "There was," writes that gentleman, "within my knowledge, in the house of my parentage, a small cupboard in which were kept milk, butter, and other requisites for the tea table, and the door was confined with a lock, which from age and frequent use could easily be made to open. To save trouble, the key was always kept in the lock, in which it revolved on a very slight impulse. It was often a subject of remark, that the door of this cupboard was found wide open, and the milk or butter greatly diminished without any imaginable reason, and notwithstanding the persuasion that the door had certainly been regularly locked; but it was accident that led to the detection of the offender. On watching carefully, the cat was seen to seat herself on the table, and by repeated pulling on the side of the bow of the key, it was at last made to turn, when a slight pull of the door caused it to move on its hinges. It had proved a fortunate discovery for puss for a long time before she was taken in the fact."

Then the "learned" dogs, horses, and pigs, afford very convincing proofs that these animals are capable of a certain amount of reasoning. There is no great difficulty in teaching dogs to open and shut doors, ring bells, and the like, when ordered. They may also, by perseverance, be taught to do much more complex actions. Thus, a dog belonging to Mr. Wilkie, could, when commanded, feign very accurately all the agonies of death. He would, on such occasions, roll over on one side, stretch himself at length, move his hind-legs with a convulsive motion as if in extreme pain, and eventually fall on his back with his legs stretched out, and remain apparently a corpse, until his master permitted him to resuscitate. Every one has seen dogs, and even pigs, that can understand the meaning of some small signal from the showman, and pick up particular cards, letters, &c. The last-mentioned animal, the pig, is capable of a considerable amount of reasoning. A pig has even been taught to point game. Pigs often become very clever in opening doors and gates; and of all the animals of the farm, the pig is the only one that is led by reasoning to hold a piece of solid food, as a turnip, fast with one foot, while it takes bites out of it with its mouth. A dog's holding a bone in like manner with its fore-feet, is not an instinctive habit, but one acquired by reasoning; and any one watching a young dog beginning to eat bones, will perceive that he is quite ignorant how to steady them.

Dogs of different kinds club or combine their talents for hunting, and proceed upon an arranged plan, which is unquestionably the result of observation and reason. "I had at one time," says M. de la Malle, "two sporting dogs, the one an excellent pointer with a very smooth skin, and of remarkable beauty and intelligence; the other was a spaniel with long and thick hair, but which had not been taught to point, but only coursed in the woods like a harrier. My chateau is situated on a level spot of ground, opposite to copse wood filled with hares and rabbits. When sitting at my window, I have observed these two dogs, which were at large in the yard, approach and make signs to each other, and first glancing at me, as if to see if I offered any obstacle to their wishes, step away very gently, then quicken their pace when they were at a little distance from my sight, and finally dart off at full speed when they thought I could neither see them nor order them back. Surprised at this mysterious manœuvre, I followed them, and witnessed a singular sight. The pointer, who seemed to be the leader of the enterprise, had sent the spaniel out to beat the bushes, and give tongue at the opposite extremity of the bush-wood. As to himself, he made with slow steps the circuit of the wood by following it along the border, and I observed him stop before a passage much frequented by rabbits, and there point. I continued at a distance to observe how the intrigue was going to end. At length I heard the spaniel, which had started a hare, drive it with much tongue towards the place where its companion was lying in ambush, and the moment that the hare came out of the passage to gain the fields, the latter darted upon it and brought it to me with an air of triumph. I have seen these two dogs repeat this same manœuvre more than a hundred times; and this conformity has convinced me that it was not accidental, but the result of a concerted agreement and combined plan of operations concerted beforehand."

There was a dog that lived in a strict monastery where the monks dined alone, and who, instead of asking for their meals, obtained them by knocking at the buttery door, the cook answering by opening the door and pushing the allowance through. The dog observed this proceeding, and accordingly knocked at the door, and laid in wait until the meat was placed outside, and the door shut, when he ran off with it. This he repeated a number of times.

If we course a hare with an old greyhound and a young one, we have examples of both instinct and reason. The young one instinctively pursues his game, following every turn and winding, and the old one, under the influence of reasoning and experience, knows that the hare will double, and accordingly does not exactly follow her, but goes across.

It may be here observed, however, that any practice of an animal acquired by reasoning, is very easily put out and supplanted by an instinct. For instance, when two strange rams meet they instinctively fight. If, however, two are brought up together from being young, they seem to become convinced of the propriety of being on good terms, and live amicably enough. When, nevertheless, they are sheared, the difference of their appearance causes their instincts to come out in their primitive force, and they fight desperately, and sometimes until one is killed. We return, however, to the narration of some acts decidedly performed under the influence of reason.

It has been noticed in South America, that when hunting the deer there with newly imported dogs, the dog, when he approaches his game, flies at it in front, and very often gets his neck broken by the violence of the shock. But the native dogs carefully avoid this instinctive impulse, and have learned the danger of it, and they invariably remove to one side and attack the stag in flank.

Something similar has been noticed with elephants. Thus it is recorded on good authority, that in Cochin China a party of seventy elephants, mounted by their guides, were set off to hunt tigers. A tiger being found, one of the more advanced elephants was driven to attack it. The wild beast remained crouched until the elephant was going to strike it with his tusks, when it gave a sudden spring, alighted upon the elephant's neck, and severely wounded him. All the other elephants immediately so arranged their trunks, that if the tiger attempted to repeat his plan of operations upon them they could foil him.

Lord Brougham's translation of an old Spanish account of the beggar's dog, is pleasing in itself, and curious as a very happy imitation of old English. "The blind man's dog," he translates, "will take him to the place where he may but hope to get his alms, and bring him thither through the crowd by the shortest and the safest way; he will take him out of the city some miles to the great church of St. Paul's, as you go to Ostia.* When in the street he cometh to a place where several ways meet, and with the sharpness of ear that the blind have, guided by some sound of a fountain, he gives the string a jerk by either hand, straightway will the poor dog turn and guide him to the very church where he knows his master would beg. In the street, too, knoweth he the charitably disposed houses that be therein, and will lead thither the beggar man, who stopping at one, saith his paternoster, then down lieth the dog till he hear the last word of the beadsman, when straight he riseth and away to another house. I have seen myself, to my great joy mingled with admiration, when a piece of money was thrown down from some window, the dog would run and pick it up, and fetch it to the master's hat; nor when bread is flung down will he touch it, be he ever so hungry, but bring it to his master, and wait till he may have his share given him. A friend of mine was wont to come to my dwelling with a great mastiff, which he left by the door on entering; but he, seeing that his master had entered after drawing the string of the bell, would need do likewise, and so made those within open the door, as though some one should have rung thereat."

The manner in which tame elephants assist in cap-

* The Spaniard is describing the blind beggars' dogs at Rome.

turing wild ones, affords us an instance of reasoning in an animal. The elephant-hunters, attended by two or sometimes four domesticated elephants, pursue their intended victim cautiously. The tame ones affect to be grazing, and as if, like him, they were in a state of nature; while the hunters, well provided with strong ropes, conceal themselves close by. The elephants gradually approach the wild one, and endeavour to establish an intimacy. If they succeed in attracting his attention, the hunters contrive to tie strong ropes to his legs, and, if practicable, it is said that the decoy elephants actually lend a hand, or rather a trunk, in this operation. If a large tree be near, the other end of the ropes are at once bound to it, and the decoys leave; and if no tree be near he is allowed to walk away, trailing the cables after him, until he approach one, to which he is fastened. When he discovers that he is secured he is most furious, but he is allowed to remain without food until sufficiently tamed, when he is taken to the station of the hunters, under the guard of his treacherous friends.

The following very curious anecdote relative to two elephants, exhibits perhaps the most remarkable reasoning powers ever observed in animals. It is related by Griffiths, "At the siege," writes that gentleman, "of Bhurtpore, in the year 1805, an affair occurred between two elephants, which displays at once the character and mental capability, the passions, cunning, and resources, of these curious animals. The British army, with its countless host of followers and attendants, and thousands of cattle, had been for a long time before the city, when, on the approach of the hot season and of the hot dry winds, the supply of water in the neighbourhood of the camps necessary for the supply of so many beings began to fail, the ponds or tanks had dried up, and no more water was left than the immense wells of the country could furnish. The multitude of men and cattle that were unceasingly at the wells, particularly the largest, occasioned no little struggle for the priority in procuring the supply for which each were there to seek, and the consequent confusion on the spot was frequently very considerable. On one occasion two elephant-drivers, each with his elephant, the one remarkably large and strong, and the other comparatively small and weak, were at the well together; the small elephant had been provided by his master with a bucket for the occasion, which he carried on the end of his proboscis, but the larger animal, being destitute of this necessary vessel, either spontaneously, or by the desire of his keeper, seized the bucket, and easily arrested it from his less powerful fellow-servant; the latter was too sensible of his inferiority openly to resent the insult, though it is obvious that he felt it; but great squabbling and abuse ensued between the keepers. At length the weaker animal, watching the opportunity when the other was standing with his side to the well, retired backwards a few paces in a very quiet and unsuspicious manner, and then, rushing forward with all his might, drove his head against the side of the other, and fairly pushed him into the well.

"It may easily be imagined that great inconvenience was immediately experienced, and serious apprehensions quickly followed that the water in the well, on which the existence of so many seemed to depend, might be spoiled, or at least injured, by the unwieldy brute that was precipitated into it; and as the surface of the water was nearly twenty feet below the common level, there did not appear to be any means that could be adopted to get the animal out by main force, at least without injuring him; there were many feet of water below the elephant, who floated with ease on the surface, and, experiencing considerable pleasure from his cool retreat, evinced but little inclination even to exert what means he might possess in himself of escape.

"A vast number of fascines had been employed by the army in conducting the siege, and at length it occurred to the elephant-keeper that a sufficient number of these (which may be compared to bundles of wood) might be lowered into the well to make a pile, if the animal could be instructed as to the necessary means of laying them in regular succession under his feet. Permission having been obtained from the engineer officers to use the fascines, which were at the time put away in several piles of very considerable height, the keeper had to teach the elephant the lesson, which, by means of that extraordinary ascendancy these men attain over the elephants, joined with the intellectual resources of the animal itself, he was soon enabled to do, and the elephant began quickly to place each fascine as it was lowered to him successively under him, until in a little time he was enabled to stand upon them; by this time, however, the cunning brute, enjoying the pleasure of his situation after the heat and partial privation of water to which he had been lately exposed (they are observed in their natural state to frequent rivers and to swim very often,) was unwilling to work any longer, and all the threats of his keeper could not induce him to place another fascine. The man then opposed cunning to cunning, and began to caress and praise the elephant; and what he could not effect by threats he was enabled to do by the repeated promise of plenty of rack.* Incited by

* It is common to prevail upon elephants to execute a hard piece of work by the promise of arrack, cake, &c., and the animals appear to understand the promise perfectly.

this the animal again went to work, raised himself considerably higher, until, by a partial removal of the masonry round the top of the well, he was enabled to step out; the whole affair occupied about fourteen hours."

Tales, almost equally wonderful, are told of the sagacity of dogs. For instance, before smoke and spring-jacks became common, it was the custom to turn the spit by means of a large hollow wheel in which a dog was placed, and which, by constantly trying to advance, it turned. Arago, the lamented astronomer, was detained by a storm at a country inn, and ordered a chicken for his dinner. Arago was warming himself by the kitchen fire, and saw the innkeeper put the fowl on the spit and attempt to seize a turnspit dog lying in the kitchen. The brute, however, refused to enter the wheel, got under a table, and shewed fight. On Arago asking what could be the meaning of such conduct, the host replied that the dog had some excuse, that it was not his turn but his comrade's, who did not happen to be in the kitchen. Accordingly, the other turnspit was sent for, and he entered the spit very willingly, and turned away. When the fowl was half roasted Arago took him out, and the other dog, no longer smarting under the sense of injustice, now took his turn without any opposition, and completed the roasting of the fowl.

In like manner dogs may be taught to steal. During the last century sheep-stealing was a very common crime in the south of Scotland, the thieves being always very much assisted by their dogs, which were educated for the purpose. Towards the close of it there was one man who went about, accompanied by his dog, pretending to buy sheep, and, while handling them, pointed out to the animal which he desired to be stolen. At night the dog went to the flock, singled out the particular sheep, and conducted them to its master by bypaths and unfrequented routes. Eventually these were discovered, and both were hanged. Sometimes dogs steal sheep on their own account; and Sir Thomas Wild knew of one that had the cunning to slip its collar at night when he wished to depart, and to slip it back on his return. Lastly, but the other day, the papers contained an account of a novel mode of robbery, in which a dog ran about frightening the people of the house, while its human confederates robbed it.

This is not the place to enter into the consideration of the nature of these mental acts of animals, or to draw any influence from them. We may be content with remarking that the result of those reasoning powers of the higher brutes is, after all, only physical movement.

CHAPTER VIII.

THE INSTINCTIVE BELIEFS OF MAN.

"THE man who meditates," says Rousseau, "is a depraved animal." And if we regard man as an animal, the saying is unquestionably true; for with meditation and its result—civilization, come disease and debility, and often premature death: in fact, a diminution of animal activity and perfection. But the man who does not meditate is a depraved spirit; for the truth is, that man is not an animal. The sagacious elephant and the meanest moss have a common connection with matter, and a common vitality, and so, also, have the elephant and man a mutual life; but the difference that exists between the two last, is far greater than between the intelligent animal and the weed. Man comes into this world naked, and he clothes himself; without an instrument of offence or defence, and he constructs weapons, by means of which he can subdue the wildest, the strongest, and the most furious of brutes; ignorant, and he discovers the secrets of the heavens, and reveals antiquity. But, perhaps the most striking distinction of all is, that man is not under the control of instinct. With the exception of what are, perhaps, acquired habits of throwing the hands forward when falling, or winking the eye when a substance approaches that organ, the adult man has not a single instinct.

We have seen that mental acts take place in the higher animals, and that the actions of many of them are, to a considerable extent, guided by reason. When we come to man, we find *all* his actions placed under the control of reason. Man, it is true, has corporeal relations: the matter that forms his structure is the same as that which forms the rock on which he treads, and is, indeed, derived from it; and like it too, when brought under the influence of gravitation, it obeys the attractions of that power. It has not, however, been immediately derived from the soil, but its substance has previously been passed through vegetables, which have prepared and introduced this matter, as it were, into his frame, and, in common with these vegetables, man enjoys or he suffers, as the case may be, the endowments of vitality. Like the plants, he springs into being, acquires matter from without, exhibits certain functions, and performs certain motions; and at last dies, and his identity as a physical structure, like the identity of a dandelion or a groundsel, is lost. He is surrounded by still higher vitalized beings than even exogenous plants, many of whom he compels into his service. Of these animals, some only differ from plants, in that their motions are performed under the influence of an instinct that seems to be attended with a vague consciousness of external impressions; but the higher of them perform definite actions clearly under the direction of a sentient principle that has observed what was passing around, and owing to meditation upon such inferred deductions. We have also seen that there was a time when matter was under the influence of the laws of gravitation only, but that even then there were different modifications of it, and that the globule of platinum tended more rapidly to the common centre than its bulk of hydrogen; that then came the rule of chemistry; but that, under its sovereignty also, various elements had very varying attractions for one another, and that next vitality came on the scene; and we do not wonder to find in its progeny very varying powers, from those of the instinctive mushroom or coral, to those of the still instinctive, but also reasoning dog, or elephant. When we come to man, we find something more than the corporeal structure, the instinctive motion, and the reasoning that exists in mammals. We do not find pure reason that has, and can have, no doubt, or fear, or dread; but we find, and find distinctly, a new element—spirituality. Instinct, says the apothegm, is ignorant that it knows, and reason knows that it is ignorant; but spirituality does more—it hopes. Instinct acts by material impulses, reason from material evidence; but spirituality proceeds upon the "faith, which is the evidence of things unseen, the substance of things hoped for."

Man is, indeed, devoid of instincts; and his reason, if indeed it be of the same nature as that of the higher beasts, is as superior in its results as the instinct of the bee is to the instinctive turning of the plant to light. But besides his corporeal connexion, and his exalted power of reasoning upon external objects, he has something additional. When external objects are presented to his senses, he does not instinctively act in some particular manner as the beasts do; but he observes, and reflects, and acts in accordance to the decision of his mind. But although his physical actions are under the control of his intellect, some of his mental operations are of a nature analogous to the corporeal instincts of animals. As when the first ray of light discloses to the young water-bird or the young crocodile the water, each of these makes for that element; so when certain propositions—propositions, too, that have no connexion with matter—are made to man, his mind or his spiritual part at once believes them, and adopts them as part of its own being.

There have been whole tribes, and there are at this moment in our country, many individuals who have never been told that a great, a good, and a spiritual Being exists, who made this world, and who called mankind into existence, and still watches and cares for his destiny. But whenever one has come from a distance to these first-mentioned savage tribes, and proclaimed that there was a superior Creator: that moment all who heard that saying believed it firmly and undoubtedly. In like manner, when one goes among our own poor, ignorant outcasts, and proclaims this, it is at once unhesitatingly received. Degraded as both are among the ranks of men, still, unlike the brutes, they have no physical instincts, but they possess, instead, this instinctive tendency to believe in this great truth of the existence of a Deity whenever it is proposed to them. And although, in high states of civilisation, individuals may be found possessing warped and inert spiritualities, (just as highly pampered hounds lose their instincts,) who profess to be superior to this spiritual law of their nature; yet even with them, or with nearly all of them, when the hour of danger and strong dread of death come, nature reasserts her sway; and the mind, although the idea has been carefully banished for years, again instinctively believes, and believes with rejoicing,—just as an animal exults in its material instincts—in an almighty and ruling Being.

To repeat this in other words: no animal either loves or fears, or at all believes in a power that is invisible to its senses; nor indeed does any operation pass through its mind that does not tend to some physical movement in that animal. Man has not only the power of forming, from his observations and reflections, abstract ideas that have no reference to physical movement; but he immediately and instinctively believes in the great abstract idea of the existence of a Deity whenever it is proposed to him; and after he has done so, let him endeavour to banish it from his mind as much as he will, yet if accidentally put into a state of nature, and removed from artificial trammels, he again falls back upon the old belief.

There is another, and perhaps still more remarkable, property of the soul of man. No animal has any idea of futurity, not even of one to-morrow. Those that store up food for the winter, or even for another day, clearly do so under the influence of instinct, and not of reason; and even very few animals do thus instinctively act. The hunger, the thirst, or the enjoyment of the passing hour, are all that even the most intelligent of the animals care for; and to him the present is nearly all, the past little, and the future nothing. The want of fear that we sometimes admire in animals, is perhaps the absence of hope. Not so with man. With him memories, however dear and beloved, actualities, however real and absorbing—all are as nothing as compared with his anticipations. Of all created beings connected with matter, at least of all of which we are cognizant, he alone spurns what has been, disregards what is, but toils and struggles for what is to be. He alone has the idea of another day, another week, another year. But this is not all.

There are nations or tribes, the members of which by their reason perceive that all created beings die: that the poppy, that so suddenly develops its gorgeous corolla, almost as suddenly returns to the soil from whence it so mysteriously sprang; that the dog that has so faithfully served them, soon becomes old, infirm, and at last perishes; and that those who live in the same huts as their members or associates, inevitably return to the dust. Such know, also, that the time will come when they too will have their last hunt, their last fight, their last look at the earth on which they tread, and the heavens under whose canopy they walk. Such may, and such do know no more than this. Nay, even in our own land, there are many, very many, who, although they excel the animals in this, that they can conceive the idea of to-morrow, and who know, although they banish the thought from their mind, that they must die, yet look upon death merely as an inevitable necessity, and whose notion of futurity extends not beyond that last breath which will free them from a world of crime, and care, and sorrow.

But if to any of these tribes, or to these poor inhabitants of our country, any one declare, that there is an existence after this—a world of spiritual being after this world of mixture with matter, that moment it is instinctively or intuitively believed. There is no reasoning required, no proofs demanded, no inquiry made, no desire of explanation; the instant that the announcement reaches the mind, that same instant it is received. And although, in highly civilized states of society, individuals may be found who doubt it in their ordinary moments, yet even they, when they are softened by affliction, or the approach of death, return to their natural mental (not physical) instincts, and believe, even more firmly than they did before, that they will soon be in another state and being. True it is, that in matters of detail the prominent features of the future life vary in different states of civilisation and habit, just as the physical scenery of different countries varies. The futurity of the wild Indian is a vast hunting-ground, where he will be guided by the counsel of his ancestors; that of our own Scandinavian forefathers was a perpetual banquet; that of the oriental Musselman is scented with odour, cooled by flowing streams, and tended by beauty; that of the intellectual man is a higher sphere, where doubts will be cleared up, and the actions of the mind be unrestrained by the contact of matter; and that of civilized woman, a place where dear ties that have been broken will be renewed, and where will flourish an everlasting rule of kindness, of mercy, and of love. But, whatever be the station or position of the human mind, the tidings of another world are never heard without immediate and instinctive belief; and when the idea has once possessed the mind, it is as fixed and permanent as the industry of the bee, or the clinging to life of the wild beast.

This, then, is the argument. Ages ago it pleased an all-powerful Being to call into existence this matter that is cognizable by our senses. What endowments he at first conferred upon it, it is impossible to discover; but at one period he made it subject to the laws of gravitation, to which laws a great portion of it is still liable. Subsequently, he bestowed upon the different elements of it those extraordinary chemical affinities which, after a study of nature for two thousand years, man is now beginning to discern, and which chemical affinities still regulate the greater part of the unions that yet occur. After this, it would seem to have been part of His will to make various portions of matter unite so as to form organized beings, subject to the laws of vitality and instinct. When we come to the higher of these we behold the operation of a new element—reason, which is supplementary to instinct in producing and causing motion. Then, leaving the animals, we come to a new being, man, connected in some mysterious manner with matter, but who is not under the control of instinct but of reason, and who produces, by means of that reason, not only physical movements, but mental abstractions; and who, moreover, instinctively believes, when told, in God and another state of being. And as we see in merely vitalized beings, that the instinctive desire to attain an end invariably concludes in that end being attained, so also, the instinctive beliefs of man will unquestionably be realised. That this will be so, may be learned from another and a higher source, but still it is the legitimate deduction from the study of that physical science which is so often thought to oppose revelation, and is from time to time set up to oppose it. And thus it is that from apparent darkness proceeds light, that faith springs out of doubt, and that, to use the words of the old Hebrew warrior, "out of the eater there came forth meat."

THE END.

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ELECTRICITY

AND

THE ELECTRIC TELEGRAPH:

TOGETHER WITH THE

CHEMISTRY OF THE STARS;

AN ARGUMENT TOUCHING THE STARS AND THEIR INHABITANTS.

BY

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AND

THE ELECTRIC TELEGRAPH.

Our readers are all familiar with that beautiful production of Oriental romance, the tale of Aladdin and the Wonderful Lamp. He needed but to rub it to summon an almost omnipotent Genie, who fulfilled his wildest desires; and whosoever rubbed the Lamp had its Genie equally under his control. A deeper truth than its author probably intended, or than most of his readers have discovered, is shadowed forth in Aladdin's story. Some six hundred years before the birth of our Saviour, the keen-sighted, inquisitive Greeks had unconsciously realised the dream of the eastern legend. It was not by rubbing a lamp (although a lamp or any other piece of metal would have done quite well), but by rubbing a piece of amber, that they evoked an Invisible, and, as they believed, Living agent, which in our hands has done far more wonderful things than the genie of Aladdin's Lamp did, or could have done, for its possessors. The Orientals would have named this agent *The Genie of the Amber;* and such is the exact signification of the term we employ at the present day; for the word *electricity*, derived from the Greek name of amber, ἤλεκτρον (electron), denotes, when applied to it as a branch of knowledge, the Amber Science, and when applied to the agent of which it treats, the Amber Force or Amber Power.

It was known to mankind, however, many thousand years before it received a name, or was developed by rubbing amber; and if we are to consider him the founder of electrical science who first observed an electrical phenomenon, then the honour must be assigned to Adam, who earliest, doubtless, of men witnessed a thunder-storm, and might have named the agency which produced it the Lightning Force.

There were other natural electrical phenomena, also, less striking than the thunder-storm, but still sufficiently remarkable to awake and occupy the attention of mankind, during the ages that intervened between the occurrence of the first thunder-storm that had a human eye-witness and these days of the Electric Telegraph. The spectacle of such phenomena has in some cases been recorded, but more frequently no record was made. Thus the ancient Greek and Roman naturalists and physicians, such as Aristotle, Pliny, and Galen, knew that there occurred, on the Mediterranean shores, a flat fish like a boy's kite, or a skate with all its angles rounded, called a *torpedo*, which had the power of thrilling and temporarily benumbing the fisherman who trod upon it with his naked feet, as it lay half hidden in the sand. The dwellers on the banks of the Orinoko have, from time immemorial, had similar but even more vivid experiences of the power of the Gymnotus, or Electrical Eel, which abounds in the tributaries of that great river, to cramp the limbs of the incautious swimmer in these streams. In opposite quarters of the globe, accordingly, electricity must have been simultaneously recognised by the Italian fisherman and the South American Indian as a benumbing, convulsing Torpedo or Gymnotus Force.

Electrical meteors, likewise, including the Aurora Borealis, must have been familiar to the men of all countries and ages. The Roman historians, such as Livy and Cæsar, tell how the spearheads of a whole legion under march were sometimes seen in dark fogs to be each tipped with flame; and the ancient sailors of the Mediterranean worshipped, as Castor and Pollux, the similar stars of fire, which were often seen by them on the mastheads of their vessels. They are equally worshipped by the modern Italian mariners, who name them the fires of St. Elmo. Longfellow, in his *Golden Legend*, makes a Mediterranean sailor say:—

> "Last night I saw Saint Elmo's stars,
> With their glimmering lanterns all at play,
> On the tops of the masts, and the tips of the spars,
> And I knew we should have foul weather to-day."

In the Monkish Chronicles of the Middle Ages are descriptions of individuals, who at certain periods appeared, when lying in bed in darkness, to be floating or swimming in waves of fire. These descriptions are greatly exaggerated, as was natural in a wonder-loving, superstitious, credulous epoch; but they referred to a truth sufficiently remarkable, even when stripped of all exaggeration. The bodies of living men and of certain of the lower animals may frequently, by rubbing them, be made to evolve sparks and flashes, so that, for the time, they are literally living electrical machines. The incidental friction attending the pulling off of a tight-fitting stocking, or other article of dress worn next the skin, has often unexpectedly developed electricity, to the surprise and terror of the party who was at once the electrifier and the electrified. The mediæval chroniclers, indeed, may well be excused if their pictures of such startling occurrences are somewhat overdrawn.

The main condition needed for such electrical developments on the surface of the body appears to be great dryness of the skin; and hence they are seen best in frosty weather, when the amount of water-vapour in the atmosphere is at a minimum, and in the persons of those who, from natural habit of body, long residence in tropical climates, or other causes, have dry, harsh, unglistening cuticles, and who perspire little. In such, electricity may at any time be developed in cold weather, by placing them on an insulating support, such as a block of gutta percha, a sheet of Indian rubber, a stool mounted on glass legs, or a board laid upon glass bottles, and rubbing the body and limbs with dry silk or flannel. Even without the formal insulating arrangement electricity will be procured, provided damp be avoided.

These conditions are so readily realised in the colder seasons of the year in northern latitudes, that they must have been more or less familiar to mankind from the earliest periods. A recent case is on record as occurring in the person of an American lady, in whom, at certain periods, the mere friction of her dress was sufficient to develope electricity, so that when she approached her hand to a door-handle, a bell-pull, a candle-stick, or any other metallic article, a spark passed before she touched it. To her it was only a matter of temporary annoyance, and to those about her of amusement or interest. In the middle ages she would probably have been held to be possessed of an evil spirit, tormenting her before her time.

The most electrical (superficially) of the lower animals is the cat, which pays for its fastidious cleanliness, its careful dressing of its fur, its dislike of damp, and love for basking in the sun or before the fire, by a greater susceptibility to electrical excitement than most other creatures. There are few cats in good condition, which, if coaxed to sit on a dry stool (especially one with glass legs), may not be rendered electrical in frosty weather by stroking them. It is proverbial that they hate to be stroked the *wrong way*, or from the tail to the head, and one, perhaps the chief, cause of the dislike of these sensitive and luxurious creatures to the reversed stroking is the greater amount of electrical excitement which it occasions. The traditional connection of cats with witches and evil spirits, which figures so largely in the German legends, is probably in part connected with the observation of the mysterious sparks which, at times, they flashed out when stroked, and the impatience of caresses which attended those fiery manifestations. Many a poor cat, doubtless, paid with his life for his unwilling and unwelcome feats as an electrician; and when, at a later period, the practical Dutch philosophers recognised that in the nature of the animal's fur lay the secret of its electrical susceptibility, they killed hosts of cats for their skins, and gave the latter the first place among the exciters of electricity. If the humane dream should prove true, in which Goldsmith indulges in the "Citizen of the World," that the torturers of animals on this earth will, after death, run the gauntlet in worlds each of which is occupied by a single class of the animals they have wronged, then the electricians may anticipate, with peculiar dread, their treatment from the spirits in the cat-world, and, next to them, from those in the heaven of the frogs. A frog's body is the most sensitive of all indices of electrical action; and many a harmless croaker has been a reluctant and uncommemorated martyr in the cause of science. But this is a digression.

Besides the electrical phenomena we have noticed as certain to have been matters of observation, more or less widely, for ages, we must add, as closely related to them, and to the special subject of our paper, the discovery of the natural magnet. This mineral, one of the oxides of iron, to which our English ancestors gave the expressive name of Loadstone, *i. e.* leading or guiding-stone, in reference to its services to the mariner in conducting him across the pathless ocean, has been known to mankind from a period lost in a fabulous antiquity. The word magnet is of Greek origin; but the Chinese were acquainted with it centuries earlier than the Greeks, and constructed compass-needles, in which, unlike our compass-makers, they marked the south pole as the more important end of the needle.

The phenomena we have noticed constituted the entire stock of electrical knowledge possessed by mankind from the commencement of the historic era down to the beginning of the 17th century. These phenomena, however, were not known to proceed from a common source, or to be related as unlike effects flowing from a single cause. The amber-force was not suspected to be identical with the lightning-force; or both to be the same in essence with the thrilling power of the Torpedo, and the illuminating agency of the atmospheric meteors. Neither did any one as yet know that electricity and magnetism are sister-forces as inseparably associated as the shadow is with the illuminating body throwing it; so that the one cannot be developed without developing the other. Nor, so far as history tells, did any one improve upon the observation made first by Theophrastus, 600 years B.C., that rubbed amber attracts light bodies, and succeed in constructing a machine, by means of which electricity could be produced artificially on a large scale. So far as we know, no one even attempted such a construction. It is only within the last 250 years, and chiefly within the last 50, that we have learned at the hands of men recently dead, or still living, the common source of the phenomena referred to as so long known to mankind; and have been taught how to produce and to regulate electricity at will. A few references will demonstrate this.

The entire annals of the ancient world do not supply the names of a dozen persons who can be styled electricians; and even these only observed or recorded isolated phenomena. The educated and uneducated portions of mankind stood nearly on the same level in reference to them. The Italian fishermen knew more concerning the powers of the Torpedo than Aristotle or Galen, who merely repeated what the fishermen told them; and the Roman legionaries were more familiar with the meteoric stars which occasionally tipped their javelins than Cæsar, or Livy, or Pliny, who chronicled their appearance.

No doubt, for men of genius like those we have named, a phenomenon had a much deeper significance than it had for unlettered fishermen or barbarian soldiers; but, after all, it taught the former, so far at least as they have instructed us, little more than it did the latter; and the fisherman and soldier, as the more experienced observers, must be counted the best electricians of an epoch in which no electrician was more than an observer.

Electricity, as a science, may be considered as dating from the year 1600, when Dr. Gilbert, a native of Colchester, published in London, a Latin treatise on the magnet. It discusses electricity as well as magnetism, explains certain of their fundamental laws, and announces certain conclusions in a truly sagacious and philosophical spirit. Curiously enough, this treatise, which we look back upon as far before its age, and destined to a lasting place among works on science, was selected by Lord Bacon as an example of inconclusive and vicious reasoning: so much more easy is it to give advice than to take it, or even to see that it has already been taken.

The disparagement of Gilbert's inquiry prevented it attracting the attention it otherwise might have received; so that more than half a century passed before electricity was taken from its cradle. In 1670, however, the famous burgomaster of Magdeburgh, Otto Guericke, who is memorable in scientific annals as the deviser of the first air-pump, made a new claim on the reverence of posterity by his construction of the first electrical machine. It was a globe of sulphur, made to whirl on a vertical axis, whilst it was rubbed by the hand. Otto Guericke cast the sulphur in a mould of glass; and it was afterwards discovered that the hollow glass sphere did better than the core of solid brimstone, to set free which the glass was broken; but, compared with the fragments of yellow amber which Theophrastus rubbed, the sulphur globe was a wonderful electrical machine.

The centenary of Dr. Gilbert's observations marked a retrogression in electrical science. The value of large machines was not appreciated, and the commencement of the 18th century was unhappily signalised by a return on the part of observers, headed by Hauksbee, an English experimentalist of repute, to the glass tubes which were the electrical instruments in vogue before Otto Guericke's time.

Yet with these tubes good work was done; and by the year 1730 the great discovery had been made that all solid bodies may be divided into two classes, — viz., *electrics*, such as glass and amber, which, if held in the hand and rubbed, evolve electricity; and *non-electrics*, such as the metals which, in the same circumstances, evolve none. This was the discovery of Stephen Gray, an Englishman; and about the same time Dufaye, in France, made the observation that there are two kinds, as he expressed it, of electricity, the one of which he named *vitreous*, the other *resinous*.

In 1745 the Germans returned to the use of large machines, like Otto Guericke's, but made of glass. An immense extension of electrical science followed this step. In truth, when we read the descriptions of the earliest machines, we cannot but wonder that so much was done with them. They recall the "three-man beetle" with which Falstaff ironically wished he might be filliped. Like it they were three-man machines. One person stood on the floor, holding in one hand a large glass tube, and rubbing it with a piece of silk held in the other. A second party stood near him, mounted on a glass-legged stool, and holding towards the rubbed tube one end of a metallic rod terminating at either extremity in a ball, whilst opposite its other end stood a third party on the floor, who received sparks from the ball nearest him, and experimented on the electricity accumulated on it.

After the replacement of this and other cumbrous and inefficient arrangements by revolving glass cylinders, spheres, and plates, the rate of progression, which before may be said to have been arithmetical, became geometrical. We can only, therefore, glance at the important dates after 1745. In 1746 Holland was a great seat of electrical inquiry; and a new and most valuable weapon of research was placed in the hands of all by the Dutch electricians who devised the Leyden jar. The same year is memorable as that in which the great Italian Volta began his electrical studies; and the next year, 1747, saw Benjamin Franklin follow his example. In 1752 he showed the identity of lightning and electricity. In 1775, Walsh, Hunter, and Cavendish proved, by experiments on the living torpedo, dissections of its dead body, and imitations with machines of its benumbing powers, that it possessed a very powerful and peculiar electrical apparatus, which, during life, it could will into action when it pleased.

In 1777 Volta showed that an electric spark could be most conveniently applied to kindle gases; and within six years the application of the spark, in the way proposed, had led, in the hands of the English chemists, to the great discovery that water is not an element, but a compound of two very unlike gases.

The year 1790 is an *annus mirabilis* in Electrical Annals. In the course of it a Bolognese lady caught a cold, and was recommended to take frog soup as a cure for it. Her husband's name was Galvani, Professor of Anatomy at Bologna. The lady followed the advice given her, and proceeded to procure and dress some frogs. It should seem either that she did this in her husband's studio or laboratory, or that he prosecuted physiological researches in his wife's kitchen; at all events, his assistants were working an electrical machine in the same apartment, and close to the spot, where the lower limbs of the frogs (the only edible parts) were being prepared for culinary use. Galvani, who was looking on, was startled by observing that whenever the machine gave out a spark the limbs of the frogs were convulsed, and struggled as if still parts of a living body. He mistook in part the nature of this singular phenomenon, and was long thought to have mistaken it altogether; but his merits are better appreciated now, and his countryman Matteucci has in our own day vindicated the justice of many of Galvani's forgotten or despised views concerning the existence of electrical currents in the bodies of all animals. He is referred to here, however, solely because he has given its name to that development of electricity which is most to concern us in what follows. The word GALVANISM is as firmly rooted in our language, and as widely spread, as that of CALVINISM, which in sound, though not in sense, it so closely resembles.

The 19th century, which has far excelled all previous centuries in the success with which it has cultivated physical science, was not to commence without a remarkable electrical achievement. In 1800, Volta, who was Professor of Natural Philosophy, first at Como, afterwards at Pavia, devised the remarkable machine which has since deservedly borne his name, and is known as the Voltaic circle, pile, or battery. In the same year, its immense power to effect chemical decomposition was discovered, and by means of its agency even water was decomposed, and first in England. The hour had plainly come for a great advance in chemistry; and the man who should make it was forthcoming also. Davy commenced his electrical researches in 1800, and, besides much else, he had directly or indirectly given to the world twelve new metals before the end of 1807.

The whole civilised world was now astir with electrical excitement. Napoleon offered a prize for the greatest galvanic discovery; and hostile enactments were suspended, that the victorious English Davy might proceed to Paris to receive the prize for which all Europe had contended.

Throughout this period men's minds had been haunted by the conviction that some close, though veiled alliance subsisted between electricity and magnetism. It was given to Oersted, the Dane, to discover the clue to this, and to announce the observation of the influence of an electrical current over the position of a compass-needle, which led in a wonderfully brief time to the invention of the Electric Telegraph. This was in 1819. In 1821 Seebeck of Berlin discovered that by the unequal heating of associated metals of unlike character electricity is developed. This thermo-electricity has supplied us with an exquisitely delicate thermometer—far surpassing all the ordinary measurers of the intensity of heat, and has likewise furnished the probable explanation of the magnetism of the earth. Our revolving globe, heated unequally by the sun, has, according to this view, currents of electricity determined in it, in directions corresponding more or less closely to its parallels of latitude; and, as a consequence of this, possesses north and south magnetic poles, which may be developed in an artificial globe similarly traversed by electrical currents.

About the same time, Ampère and Arago, in France, discovered the power of an electrical current to develope magnetism; which, along with Oersted's observations, laid the foundation of electro-magnetism, the science which stands in closest relation to the Electric Telegraph.

In 1821, also, Faraday, the greatest living electrician, began his original labours. In 1830, he demonstrated the practicability of evolving electricity from magnets, and was the chief founder of the branch of the science named Magneto-Electricity, which is fast rivalling galvanism in its applications to the useful arts.

From 1830, onwards, Faraday proceeded in his career of discovery; and to him, more than to any other single observer, we owe the demonstration of the essential identity in nature and power of all the so-called different kinds of electricity. He furnished the true explanation of its decomposing power over chemical compounds, which Sir Humphry Davy, with all his genius, had in several respects misinterpreted; and, besides much else, he discovered that as a loadstone renders magnetic all the iron in its neighbourhood, so a current of electricity, proceeding from a battery along one wire, developes a momentary current along another and passive wire stretched near it. To this observation medical men, and their suffering patients, are indebted for the most efficacious methods of applying electricity to the cure of disease.

To this period belongs the date of greatest practical interest in reference to the telegraph. In 1837, the inexhaustibly ingenious Wheatstone, and Cooke, a man in whom the practicality of the English character showed itself in its fullest, freest development, took out their patent for an electric telegraph; and to them, as the earliest practical telegraphists, belongs the honour which attaches to that difficult step in all enterprises, *le premier pas*, but of which, in their case, it may be emphatically added, *qui coute.*

From 1837, onward to 1851, it may suffice to refer to Faraday, who has distanced all his electrical competitors. In 1845 he startled the scientific world by his announcement of the subjection of light to magnetic influence. From that period onwards to 1850, he has kept constantly adding to his remarkable observations on a *new magnetic condition of matter* ; from which we have learned that the reproach we complacently cast upon our forefathers, for fancying that amber only was electrical, will be retorted on us by our descendants for thinking that iron only was magnetic. The proof of this may be said to have reached its climax when, in the autumn of 1850, Faraday showed that the very air is magnetic, and that soap-bells, or glass-bubbles, filled with its more important gas, oxygen, will move towards a powerful magnet, as a piece of iron does. Whilst we write, a paper is in the press, which will speedily appear, containing Faraday's latest magnetic discoveries.

From this account it will be seen, that men have learned more concerning electricity in the last half-century than they did in all the centuries together which preceded it : and that though some nations have contributed more than others to its extension, no single people has monopolised its discoveries or applications. Knowledge is not a fixed sun in the heavens, revolving only on its own axis, but a planetary torch which passes from land to land, now blazing brightest on one shore, and then on another. The Greeks begin empirical electricity; the Romans continue it. The Chinese begin magnetism: the English Gilbert sketches the outline of magnetism and electricity as sciences: the German Otto Guericke makes the first electrical machine: the French Dufaye discovers the two electricities: the Dutch Muschenbröck devises the Leyden jar: the Italian Volta constructs the pile: the American Franklin shows the identity of lightning and electricity: the Danish Oersted discovers electro-magnetism. A single name has been selected in each nation, but each can boast of several. Germany, Italy, France, and England have produced the greatest number of famous electricians; and the science, as it now exists, is a monument to the genius and labour of a multitude of gifted men, belonging to different countries, races, and times.

We are now to look a little more particularly into the nature of electricity, and the mode of applying it in working a telegraph.

A difficulty, at first sight very formidable, attends all explanations of electrical phenomena. The question is asked, What is electricity? And to this no categorical answer can yet be returned. The question, however, may be set aside, as not requiring to be answered before the effects of electricity are considered. Of the nature of heat and of light, as well as of magnetism, we are in truth still quite ignorant: but we do not hesitate to discuss the changes which matter undergoes when illuminated, heated, or magnetised, without waiting till our theories of heat, light, and magnetism are perfect. We can do the same, therefore, with electricity, in explaining the telegraph, or any other electrical contrivance,—provided we adopt some provisional theory as to its nature, which shall supply us with suitable terms for describing the phenomena, although it may be quite inadequate to account for them.

Two views, setting aside minor modifications, are entertained concerning the nature of electricity,—very analogous to those now held concerning the nature of heat, light, and magnetism. According to the one view, electricity is a state, condition, or power of matter; according to the other view, electricity is a peculiar substance, or form or kind of matter. The latter is the more easily apprehended hypothesis; and supplies the nomenclature almost universally adopted in describing electrical phenomena, even by those who prefer, as more probable, the opposite belief. Electricity, then, may be assumed to be a highly attenuated substance,—analogous to an elastic fluid, such as hydrogen gas, but infinitely lighter; in truth, not sensibly heavy at all. In bodies not exhibiting electrical phenomena this imponderable entity is supposed to exist in a latent or insensible condition, hidden as it were in their substance or pores. Bodies, on the other hand, which manifest electrical phenomena, have the imponderable fluid set free at their surfaces, in an active, sensible, or non-latent condition: so that it envelopes them, as a fog does a mountain-top; or flows over them, as smoke does over the mast of a ship; or flows through them, as a current of warm water streams through a mass of cold. Electricity, as thus defined, is as invisible as common air; but when its intensity is high, it is cognisable by all the senses. It addresses the eye by its spark or lightning-flash; the ear by its snap or thunder; the nostrils by a peculiar indescribable odour which it develops; the tongue by an equally peculiar taste which it occasions; and the organs of touch by its characteristic shock. The unknown something, condition, or kind of matter which is the cause of those and many other phenomena, is electricity. We shall, for the present, write of it as a kind of matter, *i. e.* as something over and above, or superadded, to the body, whatever that be, which exhibits electrical phenomena; so that a telegraph-wire will be referred to, as conveying a current of substantial electricity, as a gas-pipe conveys gas, or a water-pipe water. Before, however, we can consider how this wonderful agent is made to convey intelligence, we require to notice certain relations of electricity which we proceed to discuss.

The phraseology of scientific treatises, in reference to electrical phenomena, is very apt to mislead and perplex those who consult them for information concerning special points. Such terms continually occur as, statical electricity, dynamical electricity, positive electricity, negative electricity, electricity of tension, electricity of quantity, friction electricity, voltaic electricity, animal electricity, magneto-electricity, thermo-electricity—till the distracted reader, who finds one electricity perplexing enough, loses count and heart, and closes the treatise in despair. But this formidable list of electricities, which might readily have been lengthened, fortunately admits of being reduced to *two kinds* of electricity, and *two modifications* of each kind. The kinds are *Positive* and *Negative* electricity. The modifications are electricity *of Tension*, and electricity *of Quantity*. Statical and dynamical refer respectively to free electricity, as either at rest or in motion; and the five other titles merely point to certain important sources of electricity,—which, however, is essentially the same, whatever be its source. The titles, positive and negative, apply to a much deeper and more fundamental peculiarity of electricity than the terms tension and quantity; but the latter are more important in reference to its practical applications; inasmuch as they are variable; whilst the twofold positive and negative relation of this agent is constant—and, so far as we at present know, inseparable from the very existence and manifestation of all electricity. We shall discuss this duplex character of electrical force presently; but it will be better appreciated after the difference between electricity of tension and electricity of quantity has been shortly explained.

The phrases in question, which, philologically considered, are inaccurate and inelegant enough, are used to denote the difference which is found to exist between the quantity of electricity which any source of it, such as a voltaic battery, furnishes, and the intensity of the electricity so furnished. The distinction is one of the same kind as that which is familiarly recognised in the case of light and heat. In the phosphorescence of the sea, for example, which often spreads continuously over thousands of miles, we have an illustration of light very feeble in intensity, but enormous in quantity; a white-hot platinum wire, on the other hand, gives out a very small quantity of light, but that of high intensity; while the sun radiates light at a maximum, as regards both intensity and quantity. A similar variation exists in the case of electricity; but we have no electrical sun, *i.e.* no source, natural or artificial, of electricity alike great in quantity and in intensity.

We measure *the quantity* of electricity in many ways; but most conveniently by the amount of any chemical compound which it can decompose. A machine or battery, for example, which, when arranged so as to decompose water, evolves from it four cubic inches of oxygen and hydrogen in one minute, is furnishing twice the quantity of electricity supplied by an apparatus which evolves only two cubic inches of the gases in the same time. The *intensity* of electricity is less easily measured; but is well enough indicated by the ease with which it can travel through bad conductors; by its power to overcome energetic chemical affinity, such as that which binds together the elements of water; by the length of space across which it can pass through dry air (as in the case of the lightning flash striking a tree from a great distance); by the attractions and repulsions it produces in light bodies; and by the severity of the shock it occasions to living animals. Tried by those tests, and by others, we find that the electricity of the friction-machine, of an insulated steam-boiler, or of a thunder-cloud, has extraordinary intensity—while its quantity is excessively small. We speak very much within bounds when we state, that the whole electricity of a destructive thunder-storm would not suffice for the electro-gilding of a single pin,—so insignificant is its amount. A small copper wire, dipped into an acid along with a wire of zinc, would evolve more electricity in a few seconds than the largest friction electrical machine, kept constantly revolving, would furnish in many weeks. No shock, on the other hand, would be occasioned by the electricity from the immersed wires; nor would it produce a spark or decompose water—so low is its intensity. A double-cell voltaic battery, again, produces electricity of such intensity that its shock would kill a large animal; and it can force its way along very bad conductors—at the same time its quantity is so enormous, that torrents of oxygen and hydrogen rise from the water it is made to decompose.

Out of the distinctions thus explained, have arisen the phrases, electricity of Tension, and electricity of Quantity. Interpreted literally, those terms have no meaning. We cannot recognise the existence of any electricity, unless it possess such intensity as to produce some effect cognisable by our senses; neither can any intensity be conceived as separated from a quantity of electricity which possesses that intensity. The terms in use are thus very awkward. In ordinary language we should use intense electricity for the one, and leave the other undefined, or only call it abundant electricity. But those questionable terms are now universally employed; and are rendered necessary by the circumstance already adverted to, that we have no artificial method of producing enormous quantities of electricity at a high intensity. As produced by us, therefore, it must always take a character from the preponderance of its intensity, or the preponderance of its quantity.

Tension is merely a synonyme for intensity, which originated in the hypothesis of electricity being an elastic fluid, which might be regarded as existing in a thunder-cloud, or on the conductor of a friction-machine in a state of condensation or compression, like high-pressure steam struggling to escape from a boiler, or air seeking to force its way out of the chamber of an air-gun. The word tension, we believe, has been preferred to intensity, simply on account of its brevity, and its convenience in forming a double noun with electricity. Electricity of intensity then, or tension-electricity, is electricity characterised by the greatness of its intensity — or whose intensity is greater than its quantity. Electricity of quantity, on the other hand, has its quantity greater than its intensity. The intensity diminishes as the quantity increases; but the ratio which the one bears to the other, differs through a very wide scale, so that a knowledge of the degree of the one does not often enable us to predicate the amount of the other. Practically, we have no difficulty in reducing both to a minimum, or in exalting the one whilst we reduce the other; but we cannot at once greatly exalt both intensity and quantity. The discovery of a method of effecting this, will make a new era in the science, and admit of the most important applications to the useful arts. Meanwhile we may compare electricity of tension, as we have done already, to high-pressure steam issuing in small jets under great pressure; and electricity of quantity to the thousands of cubic feet of invisible vapour which arise softly every moment from the surface of the sea. Or the former may be likened to a brawling, gushing mountain brook, rushing with great force but little volume of water; and the latter to the slow rolling Amazon or Mississippi, silently moving onwards to the ocean. Or the first to a swift, sudden hailstorm or avalanche, and the second to the inexhaustible glacier, constantly melting, but as constantly increasing. Or the one to an instantaneous gust or white squall, passing off in a moment, and the other to the unceasing trade wind, for ever sweeping gently over the bosom of the waters.

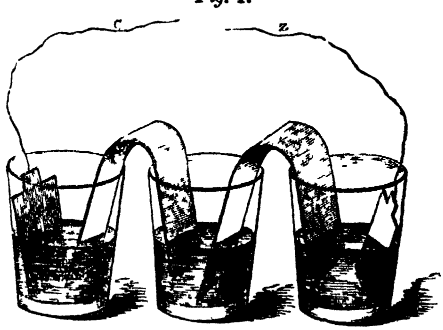
It depends upon the purpose to which electricity is to be applied, whether it should be chosen great in quantity, or great in intensity. If the chemist desires to analyse a gaseous mixture by detonation, he will use the friction-machine, to supply a momentary spark of great intensity. But the electro-plater, who has constantly to decompose a compound of gold or silver, employs the magneto-electric machine, or a small voltaic battery, — which furnishes great quantities of electricity of considerable intensity. The electric light requires both quantity and intensity to be very great. For the electric clock the intensity may be at a minimum, and the quantity need only be moderate. The electric telegraph demands great quantity, but the intensity need not be very high.

This much premised, we may now consider its application to the construction of the telegraph. An electric telegraph consists essentially of three things. First, a voltaic battery or other apparatus to evolve, when required, electricity. Secondly, an arrangement of metallic wires or other good conductors, to convey the electricity to the distant places with which telegraphic communication is to be carried on, and to bring it back to the machine from which it set off. Thirdly, the application of the electricity so conveyed, to produce at the distant station some striking phenomenon, which, according to a preconcerted arrangement, shall represent a letter of the alphabet, a numeral, a word, a sentence, a paragraph, or the like. A source or fountain of electricity; conductors to carry it; and a dial plate on which it shall cause an index to exhibit signals, are thus the essential elements of an electric telegraph.

Our present object is to discuss chiefly what is electrical in the telegraph, — without much reference to the mechanical devices or subsidiary arrangements which it involves. Our first concern, then, is with the source of electricity; and, as our space is limited, we shall confine ourselves to the voltaic battery, the apparatus chiefly in use along the telegraph lines. A voltaic battery, in its simplest form, consists of two dissimilar solids, — generally metals, —arranged side by side, without touching each other, in a liquid which dissolves only one of them. One of the solids is almost invariably a plate of zinc, rubbed over with quicksilver, or, as it is called, amalgamated. The other is copper, iron, silver, gold, or platinum; the last being preferred for very powerful batteries, and admitting of being replaced by coke. For telegraph-batteries, amalgamated zinc and copper, or zinc and silver, are generally employed; and the liquid in which they are dipped is diluted sulphuric acid— which dissolves the zinc, but does not affect the copper or silver. Let us suppose copper and zinc to be the metals selected. We have it in our power to take all the copper we propose to employ, in one large sheet, and all the zinc in another; or we may cut down each sheet into many small ones. *The quantity* of electricity evolved by a voltaic battery is chiefly determined by the size of the plates made use of; but if we take a single sheet of zinc, however large, and a single sheet of copper, we find *the intensity* of the electricity they evolve exceedingly feeble. If, on the other hand, we cut down each of the large plates into several smaller ones, and arrange these so that the copper and zinc shall be placed alternately, in a way to be presently described, we find the quantity of the electricity much diminished, but its intensity greatly increased. Unless the intensity be considerable (although it need not be very great) the electricity cannot force its way along a great length of conductors; and, if its quantity be not great, its effect will be but momentary. Plates, however, a few inches square, supply a sufficiency of electricity for a long telegraph line; and from twelve to sixty pairs of such plates are as many as are required. The exact number needed will be determined by the distance which the electricity is to travel. By varying the number and size of the plates, as well as the strength of the acid in which they are dipped, the quantity and intensity of the electricity may be modified through very wide limits.

A voltaic battery, strictly speaking, consists of associated pairs of dissimilar solids, such as zinc and copper. A single pair, or *simple* voltaic circle, like a single cannon in an artillery battery, is but an elementary portion of a voltaic *battery*, which is constructed by arranging several pairs together. The simplest voltaic battery, then, will consist of at least two pairs, *i. e.* of four plates, two of zinc and two of copper. In arranging these, two glass beakers or drinking tumblers are taken, and placed side by side, half full of diluted sulphuric acid. A wire is then soldered to one of the zinc plates, and a corresponding wire to one of the copper plates, and one of these plates is placed in each of the tumblers. The second zinc plate is thereafter soldered by one edge to the second copper plate, so as to form one continuous surface of metal. The compound plate thus produced is then bent over, so that the soldered edges form the summit of an arch, which resembles a saddle, with one flap consisting of copper and the other of zinc. This metallic saddle is placed astride of the approximated edges of the tumblers, so that the zinc flap dips into the vessel in which the first copper plate with the wire is immersed, and the copper flap into the tumbler containing the zinc plate with its wire (*Fig.* 1.).* If we wish to enlarge the

Fig. 1.



* *Fig.* 1. A voltaic circle or battery of three pairs, consisting of three plates of copper and three of zinc, placed in as many tumblers containing dilute sulphuric acid. The coppers are shaded, the zincs unshaded. c, wire

battery, we take additional tumblers, and such copper-zinc arches as have been described, connecting the vessels, half filled with dilute acid, by the metallic bridges which dip on either side into the liquid; taking care also that all the zinc semicircles or saddle-flaps shall be turned in one direction, and all the copper ones in the opposite, so that zinc and copper succeed each other alternately, from the first tumbler at one end of the range to the last at the other. In actual practice, porcelain, or wooden, or gutta percha cells or troughs are generally substituted for glass vessels, and the pieces of zinc and copper are not soldered together, but only connected by moveable wires and binding screws. But these mechanical adjustments are only for greater economy and convenience; and the battery remains, in principle, identical with the arrangement described.

Such, then, in its most skeleton and simple form, is the apparatus which is to furnish the *primum mobile* of our telegraph. Although each zinc and copper pair contributes to the power of the battery, the whole electricity generated by it manifests itself only at the detached zinc plate at the one end of the battery, and the detached copper plate at the other. A battery thus resembles a compass-needle or bar-magnet, which appears to manifest its inherent magnetism only at its opposite poles; although, in reality, it is magnetic throughout its entire length. In the practical application of such a battery, accordingly, no account is taken of any portion of it but the terminal zinc and copper plates, to each of which a wire is attached. To these plates all the intermediate ones convey the electricity which they respectively set free; so that we may, after all, properly enough conceive the battery as consisting of a single plate of zinc and one of copper. Such an embryo battery—or, rather,

from the free copper at the one end of the battery. z, wire from the free zinc at the opposite end. The copper-wire is also called the *positive pole*: the zinc-wire the *negative pole*.

voltaic pair—might, indeed, be used for working the telegraph, where the distance was very short; and it is within possibility that a single voltaic pair of strongly contrasted solids, immersed in a rapid solvent of one of them, will yet be found sufficient for working the longest existing or conceivable telegraph line. As it is, the intermediate pairs of the voltaic batteries in actual use are introduced only to give the requisite intensity to the electricity generated. They may be ignored in our further discussion; and our telegraph-battery will resolve itself into a piece of copper and a piece of zinc, immersed, without touching each other, in the same vessel of acidulated water.

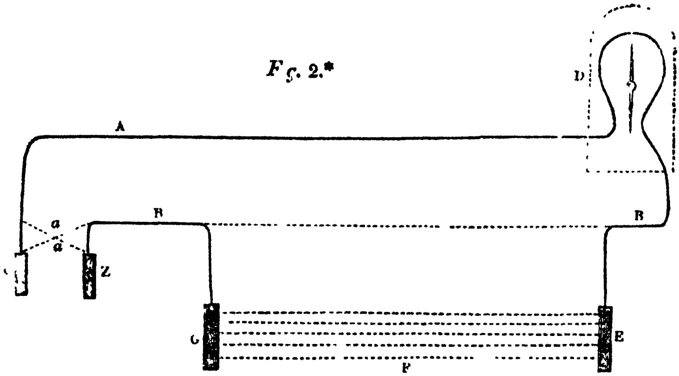
It may assist some readers towards a better understanding of the reason, why only the two terminal plates of the largest battery are referred to, if we offer the following comparison. In every human being there is resident a living or vital force or power, so far analogous to the electrical force developed by a voltaic arrangement. Let us imagine persons of opposite sexes selected, to represent the unlike metals; a girl standing for the fair, white zinc; a boy for the dusky, red copper. Any equal number of girls and boys may be supposed taken, for example, twelve of both, and arranged alternately in a straight line, beginning with a girl at the one (for example, the right) end, and terminating with a boy at the other. To represent the arrangement of the zinc and copper plates in a battery, let the twenty-four individuals in the row join hands with each other, so as to form a continuous straight chain. The result will be, that of all the forty-eight hands possessed by them, only *two* will be free, namely the *right* hand of the *first* girl, and the *left* hand of the *last* boy. If we further imagine, that the effect of such clasping of hands were, that the living force of all the girls passed along the line, and became concentrated in the one free right arm of the first girl; and that conversely, the vitality of all the boys passed in the opposite direction, and became located and available in the one free left arm of the last boy; we may realise what a voltaic battery is, as distinguished from a voltaic pair. In the battery, although the alternations amount to thousands, or millions, there is but one free copper, and one free zinc, like the one free right arm and the one free left arm, which alone would be available if all the pairs of men and women in the world were to arrange themselves alternately, according to their sex, and to join hands. By placing men and women together in this way, we cannot invest a single male arm with the masculine energy of all the men, and a single female arm with the feminine energy of all the women; but by arranging pieces of copper and zinc alternately, we *can* concentrate in the last copper the electrical power of all the coppers, and in the last zinc the electrical power of all the zincs. In particular, we thus increase the *intensity* of the electricity, which we have always more difficulty in elevating, than we have in increasing its quantity. The latter, in truth, is superabundant, as obtained from even a single voltaic pair.

Our readers, then, will think of the free zinc as if it were the one disposable female arm, and strong as the arm of a giantess; and of the free copper as if it were the one disposable male arm, and powerful as a giant's; being careful, at the same time, to regard the giantess and the giant as possessed of *exactly* equal power. If we further suppose the opposite ends of a long wire to be grasped by each giant hand, and assume that the force passing along the wire will move an index to the right or to the left, according as the male or the female hand grasps the one or the other end of the wire, we shall realise the idea of the telegraph arrangement so far as the battery and conductors are concerned.

For the sake of simplicity and clearness in our further description, we shall suppose the battery described to be situated in London; and that our object is to send messages to Edinburgh, without communicating with any intermediate place. An iron wire, plated with zinc to keep it from rusting, is connected with the *copper* plate of the battery, and then stretched all the way from London to Edinburgh, along wooden posts, erected some sixty yards apart. In order that the electricity, which is to travel along this wire, may not go elsewhere than to the northern metropolis, the zinc is *insulated, i. e.* prevented from coming in contact with metallic conductors, moist wood, or other surfaces which would transfer the electricity along the posts to other wires that are generally stretched upon them, or to the earth. The insulation is effected by passing the wire through rings or short tubes of glazed porcelain, attached to the posts, so that the electricity has no choice but to move along the wire. At Edinburgh the wire is placed in connexion with the signal-apparatus, to be afterwards described; and then is brought back to London through separate porcelain tubes along the posts as before, and finally terminates at the detached *zinc* plate of the battery. In the arrangement described, which is the earliest and most easily understood form of telegraph, it will be observed that the zinc and copper plates of the battery at London are connected by one unbroken metallic wire, which extends to Edinburgh, bends back there, and returns to London (as shown in *Fig.* 2., page 28.).

The wire, however, does not return to the latter city, in order to provide a channel for messages being sent from Edinburgh to London, as well as from London to Edinburgh. Without this returning double wire (as we shall call it), or an equivalent arrangement of conductors, it is impossible to telegraph from either town to the other, even if it were thought sufficient or desirable to send messages only from one of them. It will appear from this that there must be something peculiar in the way in which electricity travels along the telegraph-wire. We have compared it to the transmission of a fluid; but the wires cannot convey it as pipes do gas or water, otherwise there would be no occasion for the return-wire. A tube extending from London to Edinburgh, and filled with air or water, might be

Fig. 2.*



* *Fig.* 2. Diagram of telegraph supposed to have a single message-sending and receiving station.

C, last copper, and Z, last zinc of battery at sending station.

A, upper wire suspended on posts, on the aërial (English and American) telegraph lines, and insulated by being passed through porcelain rings; buried in the ground on the subterranean (Continental) telegraph lines, and insulated by being covered with gutta percha.

D, long loop of covered wire, continuous with A, and coiled many times round the magnetic needles of the signal-index (shown in profile in *Fig.* 3. p. 39.) at the receiving station.

B, lower or return-wire, a continuation of the upper one, which in the *theoretically* simplest telegraph returns, as shown by the dotted line, to the last free zinc of the battery. In actual practice the return-wire is cut short after bending back from the signal-index at the receiving station, and is made to terminate in a plate of metal E, which, in the land telegraph, is buried in the earth, and in the aqueous or marine telegraph is plunged beneath low water-mark in the channel to be crossed.

F, interposed mass of earth or water, separating giving and receiving station.

G, second buried or submerged plate sunk near the sending station, and communicating by a wire with the battery.

By means of a moveable handle not represented in the diagram, A can be connected with the copper of the battery, and B with the zinc (as indicated by the vertical *unbroken* lines proceeding from C and Z) when the index-needle at D moves to one side; or B can be connected with the copper, and A with the zinc (as shown by the *dotted* lines *a a*), when the index moves to the opposite side: or the wires may be disconnected from either end of the battery, and the index stands vertically, pointing to neither side.

employed to telegraph from the Metropolis to the Northern Capital, as an air-tube is actually employed at the railway tunnels near termini; and but one tube would be needed, if messages were sent only from London. It is very different with electricity; it must not only travel to Edinburgh, but it must come back to London—otherwise nothing can be recorded at Edinburgh; so that the communication must be as complete between Edinburgh and London, although the latter only is to send messages, as between London and Edinburgh.

The explanation of this peculiarity, if we avoid the niceties of electrical theory, may be said to be found in the fact, that no electricity leaves the battery till its terminal zinc and copper plates are *connected* by a wire or other electrical conductor. It is not as if one wire were sufficient at least to carry the electricity from London to Edinburgh. Our electrical messenger is like a government courier—who does not start till he is satisfied that there are relays of horses to make certain his homeward, as well as his outward journey. If there be not a return-wire, or equivalent arrangement, the electricity never sets off from London! or, rather, there is in truth no electricity to set off in any direction, till the zinc and copper at that starting place are connected. Till a communication is effected between them, the battery is equivalent only to a loaded gun. The completion of the connection is like the fall of the trigger which fires the charge. In a moment the battery discharges its electricity, which, with inconceivable rapidity, passes, by the shortest route it can find, from the copper plate, at the one end of the battery, to the zinc plate at the other. No shorter route, however, is provided for it than the insulated wires, so that in the case supposed, although the plates to be connected are only a few inches apart, the electricity which leaves one of them must travel from London to Edinburgh and back again before it can arrive at the other! Our newest telegraph in this respect is like Noah's most ancient one. His raven "*went* *to and fro*," and his dove "*returned*" to the Ark with the olive-leaf in her mouth.

If we look, however, a little more closely into what happens, we shall find something still more curious than we have yet indicated, in the movements of the electricity produced by the battery. We have hitherto represented matters, as if only one current of electricity swept along the wires; but in reality, if we are to speak of currents at all, we must acknowledge at every moment two, moving in opposite directions. Electricity, like magnetism, always displays itself as a two-fold force. A bar-magnet or compass-needle has magnetism at each pole or extremity. The magnetism of its north pole has the same powers and intensity as the magnetism of its south pole, if we test these by their action on a third body, such as a piece of non-magnetic iron. But if we try two bar-magnets against each other, we find that the south pole of the one attracts the north, but repels the south pole of the other, and *vice versâ*; and if a north and south pole be placed together, instead of the magnetism being doubled in intensity, it is reduced to zero—or what we may call the northern magnetism neutralises the southern magnetism, and all indications of free magnetic force cease.

Electricity exhibits exactly similar phenomena. In the very act of becoming free, as when it is evolved from a voltaic battery, it separates into two forces—identical in nature, but opposite in the direction of their manifestation—whose intensities and powers are equal, and which, like the northern and southern magnetisms when they meet, instead of yielding a double electrical force, neutralise and annihilate the powers of each other. To the two electricities the names have been given of *positive* and *negative* respectively,—an unfortunate nomenclature, as it almost unavoidably conveys the impression that the one is more positive or potent than the other; whereas the negative electricity has as positive an existence and as substantial powers as the opposite electricity—and neither, in fact, can be produced without the development of the other. The terms in question, like the older ones *vitreous* and *resinous*, are to be regarded, in short, as quite arbitrary, and might be replaced by any other words or signs:—though we leave medical men to explain the account which a wilfully ambiguous critic has given of *their* electrical acquirements: viz. that their knowledge of electricity is chiefly of the negative kind!

The twofold magnetism in a bar-magnet has been likened to a double-headed arrow at rest, pointing in two opposite directions, like a wind-vane. The twofold electricity liberated from a battery may be likened to a similar double-headed arrow,—not at rest, however, but rapidly elongating itself in opposite directions, so as to separate its two heads or points, further and further from one another. The one arrow-head represents positive, the other negative, electricity. Though they separate, they are never disunited. At first they move away from each other; but their paths are equivalent to semicircles of the same radius, and are in the same plane, so that they ultimately meet—and in the act of meeting, each arrow-head destroys the other, and a harmless non-electric circle is completed. The Egyptian hieroglyphical serpent, devouring its tail, might be accepted as the symbol of the closed electric circuit.

If we apply what has now been said to the telegraph, the necessity for the two wires will appear in a new light. When the plates of the battery, consisting of amalgamated zinc and copper, are merely placed apart from each other in dilute sulphuric acid, no change of any kind occurs. But if they are connected, as by attaching the zinc to the one end of the double telegraph wire, and the copper to the other end, the zinc immediately begins to dissolve in the acid; and simultaneously with this solution of the metal, and the evolution of hydrogen from the water, electricity in its twofold form is developed. At the middle point in the liquid between the two immersed plates we may suppose the electricity to come into existence,—likening it as before to a double-headed arrow. Elongating themselves in directly opposite directions through the liquid, the one arrow-head speedily reaches the copper-plate on the one side, and the other arrow-head the zinc on the other. The arrow at the copper is positive electricity. If we speak of it as before, we shall say that a current of positive electricity flows from the copper along the telegraph wire to Edinburgh, and then returns to the zinc plate, where it may be regarded as stopping;—at the same time that a current of negative electricity travels from the zinc plate along the same telegraph-wire, in an opposite direction to that taken by the positive current, and may be considered as ending at the copper plate.

According to this view, the narrowest telegraph-wire may be compared to a railway with two sets of rails, along which trains (of positive and negative electricity) travel in opposite directions, in obedience to a statute which requires that there shall always be two opposite trains moving at the same time along the rails. We must further regard the wire, whilst conveying electricity, as traversed, not by solitary engines or a few carriages, but by trains occupying the entire length of the railway,—fresh carriages constantly setting off at the one end, and being detached at the other.

The necessity, however, for the double wire, is best seen when we revert to the notion of electricity travelling like a flying arrow. The route of the arrow is the wire, and the latter must be double, because the arrow itself is not an English cloth-yard shaft, which flies only in one direction: but such a two-forked thunder-bolt as the Greek sculptors placed in the clenched hand of Jupiter Tonans, which shoots east and west, or north and south at the same time, and the one bolt of which will not fly in one direction unless the other is equally free to move in the opposite direction.

What evidence, it may here be asked, is there to show that any thing substantial moves along the telegraph-wires? To this, as already implied, there is but one answer. No actual proof can be given of the passage of anything material. The flowing currents and the flying arrows are both purely imaginary: the one is an hypothesis, the other an illustration. But there is yet another mode of explaining the apparent passage of this invisible agent. It is, to be sure, quite as hypothetical as the other two; but it is, on the whole, more likely to be true, and it is therefore now preferred by most men of science. Our discussion would, consequently, be incomplete if we did not refer to it.

According to this view, the metallic conductor, such as the telegraph-wire which connects the terminal plates of the voltaic battery, is not a highway along which electricity travels. The wire exhibits electrical phenomena throughout its entire length, only because its connexion with the zinc and copper wetted by the acid, produces, for the time, a new arrangement of its own particles or molecules, which invests the wire with new properties,—those, namely, which we call electrical. Nor is there any thing extreme or anomalous in this assumption. The whole of physical science bears testimony to the fact that we cannot alter the arrangement of the component parts of a mass, without inducing a corresponding change in the qualities of the mass which those atoms build up. Soot and wood charcoal, coke and black lead, owe their different properties merely to a different arrangement of identical particles of carbon; and a further modification of these invests them with the utterly diverse and characteristic attributes of the diamond. But the electrical differences between two wires, one acting as an electrical conductor and the other not, are not greater than the optical differences between a lump of coke and a diamond crystal,—or between carbonate of lime, uncrystallised in chalk, and crystallised in pellucid Iceland spar. We can set no limits, indeed, to the extent to which modification of molecular arrangement will affect the properties of a mass.

Nor is it any objection to such a view, that a metallic wire is a rigid solid, the component particles of which are so locked together as not to admit of motion upon each other, or change of relative position. The opinion once entertained that only liquids and gases permit the mobility requisite for alteration in molecular arrangement, is now universally abandoned. And indeed the expansion and contraction of a mass of metal under the influence of heat and cold is a sufficient refutation of it. The Britannia tubular iron bridge creeps, like a huge snake, backward and forward several inches during the twenty-four hours of a midsummer day. The massive glacier changes, from an aggregate of minute crystals of packed snow, into a mountain of clear ice. Every school-boy is familiar with the same phenomenon as developed during the formation of a slide on a surface of snow. In copper mines, an iron hammer, dropped into a pool saturated with cupreous salts, is found, after the lapse of years, converted into a hammer of copper:—the whole of the iron has been extracted, and its place supplied, to the very centre, by copper,—without the form or the bulk of the solid having altered during the process of transmutation. During the production of steel from iron, in like manner, the latter is embedded in charcoal powder and the whole made red hot. The charcoal then penetrates into the solid iron, and impregnates its entire mass.

These examples (and many more might be added) apply to alterations in the structure of solid masses, much greater than we need assume to occur in an electrical conductor. So that we need not hesitate to admit, as possible, molecular changes of a more simple character. The change that probably happens in the telegraph-wire is believed to resemble what we can pretty confidently affirm to take place in magnetised iron, where the characteristic phenomena are more readily observed, and are more familiar than in the case of electrical conductors. A bar-magnet, or compass-needle, appears at first sight to possess magnetic powers only at each end, or pole. On closer examination, however, it is found to possess the opposite northern and southern magnetisms, in alternate succession, throughout its entire length. We may compare it to one of the lines or stripes of a chess board, or tesselated pavement, made up of *alternate* coloured pieces. The colours, however, must be only two,—for example, blue and yellow; the first square, or tessera, being of the one colour, and the last of the other. A piece of non-magnetic iron becomes temporarily magnetic if brought into the neighbourhood of a permanent magnet, such as a loadstone: and, while thus magnetic, the iron exhibits the same alternation of oppositely magnetic particles which the compass-needle does. We may liken non-magnetic iron to an aggregate of compound green particles. It becomes magnetic in consequence of each of these separating into a blue and a yellow particle,—which follow each other alternately in rows. When the iron ceases to be magnetic, in consequence of the withdrawal of the loadstone, the result is as if the blue and yellow particles united again, and the whole became uniformly green. In like manner, the wire which connects the zinc and copper of a voltaic battery is believed, in consequence of its junction with these metals whilst they are affected by the acid, to have induced in it, throughout its entire length, a succession of alternate electro-positive and electro-negative points, or particles possessed of positive and negative electricity respectively. The arrangement is of exactly the same kind as that of the magnetic bar—only it is an alternation, not of the opposite magnetisms, but of the opposite electricities. They remain separate so long as the constraining force of the battery is exerted upon them; but, the instant the wire is disconnected from it, the separate electricities unite, and all electrical phenomena cease. We may liken the telegraph-wire, when disconnected from the battery, to a thread on which purple beads are strung together, as on a necklace. When the wire is connected with the battery, each purple bead separates into a red (positively electric) and blue (negatively electric) one. The red and blue beads now succeed each other alternately along the line, beginning with a red bead at the last copper of the battery, and ending with a blue one at the last zinc; and they remain separate, whilst, in the language of another theory, electricity is passing; but they coalesce again into the compound purple spheres, so soon as the connexion with the battery is interrupted.

According to this view, there is no travelling of electricity charged with messages from one station to another. The message telegraphed from London to Edinburgh is not wafted by electricity which speeds from the former, inscribes its hieroglyphics at the latter as it rushes past, and fleets back to London; but the telegraph-wire, with inconceivable rapidity, merely arranges its own constituent particles, from end to end, in alternate electro-positive and electro-negative molecules; and the index on the Edinburgh dial-plate is affected only by the small portion of the wire which surrounds the gnomon. It is as if a row of men were placed side by side from Edinburgh to London, with signal-flags in their hands. The flag shown as a signal at Edinburgh has not been passed along the line. No man has stirred further than to observe the flag shown him by his neighbour on the one side, and to show a corresponding flag to his neighbour on the other. The flag displayed at Edinburgh was there from the first, though unfurled, and remains there concealed, till the next message is telegraphed from man to man.

The reader can select whichever of the explanations now given he prefers, or can devise theories for himself, or dispense with any. But the ultimate and only important *fact* in reference to the telegraph is, that, by the marvellously simple device of dissolving a few pieces of metal connected with a long wire, we can develope instantaneously, a thousand miles off, a force which will speak for us, write for us, print for us, and, so far as the conveyance of our thoughts is concerned, annihilate space and time. This annihilation is not of course complete, but in reference to practice it may be called so. Shakspeare's Juliet refers to—

> "The lightning which doth cease to be,
> Ere one can say it lightens."

The exact velocity of electricity along a copper wire, according to Wheatstone, is 288,000 miles in a second. It is calculated, accordingly, that we could telegraph to our antipodes in rather less than the five hundredth part of one second of time! In actual trial, however, on the long American telegraph lines, the velocity has appeared to be only 18,700 miles in a second; which after all is swift enough.

The most impatient of correspondents may be satisfied with this velocity; and we may now inquire in what way electricity is made to produce signals. In discussing this we shall recur to the provisional theory adopted at the outset, that electricity flows in currents; and, in conformity with the universal practice of expositors of electrical phenomena, write as if there were but a single current of positive electricity flowing along a telegraph-wire. The other and opposite negative current may conveniently be disregarded, as in navigation a compass-needle is referred to as if it had but one pole, pointing to the north.

Having secured the means of transmitting at will a current of electricity with great velocity, it remains to determine what phenomenon we shall cause it to produce at the distant station.

The phenomena most easily produced by electricity are *magnetic* ones; and these, accordingly, are generally preferred as the sources of signals. The electric telegraph, indeed, remained an unrealised idea in the minds of ingenious men, till the famous Danish philosopher Oersted discovered, that a current of electricity, even though of very small intensity, if passing near a compass-needle poised on a pivot, will cause the needle to change its position, and point in a new direction. Let the telegraph-wire, for example, whilst connected with a battery, be placed so that the needle of a mariner's compass shall be directly below or above and parallel to the wire, and the needle, no longer "true to the pole," will whirl round and stand east and west, instead of as before north and south. It depends upon the direction in which the current of electricity is sent, which pole of the compass-needle points east or west. Let the telegraph-wire, stretching from London to Edinburgh and back again, be considered as consisting of an upper and a lower wire. If the end of the upper wire be connected with the copper extremity of the battery, whilst the end of the lower wire is connected with the zinc, the current of positive electricity (the only one of which we now take cognisance) will flow along the upper wire to Edinburgh, and return by the lower one to London. If the upper wire be now attached to the zinc, and the lower to the copper, the current will travel north by the lower wire, and come south by the upper. Now, without entering into details for which we have not room, and which are not essential to the comprehension of the telegraph, it may suffice to say, that the pole of the compass-needle, which points east if the electrical current passing near it be sent in one direction, points west if it be sent in the opposite one: while, if the passage of electricity be discontinued, the needle resumes its original position. We have it thus in our power to cause a compass-needle to move to either side at will; and we can bring it in a moment to rest. These effects are produced still more strikingly if the wire, instead of being stretched above or below the compass-needle, be coiled many times round the compass-box or case containing the magnetic needle. The wire, in that case, is covered with thread; which allows its coils to be put close together, without risk of the electricity passing *across* from coil to coil where they touch, as it would do, if the thread, which is a non-conductor, did not insulate the electricity.

It is more convenient that the magnetic needle should originally stand vertically, so as to move from right to left, or *vice versâ* —like the index of a wheel barometer, than that it should revolve in a horizontal plane like a mariner's compass. It is also much more easily moved, if the effect of the earth's magnetism on it be neutralised. This is done by placing *two* magnetic needles on the same axis, with their poles reversed, so that the north pole of the one is opposite the south pole of the other. Such an arrangement, if the needles are of equal power, has no tendency towards one point of the compass more than another; and, by making what are to be the lower ends of the needles somewhat heavier than the opposite extremities, the needles, when not under the influence of electric currents, will at once resume their vertical position.

Fig. 3.

The one of the two needles which is to act as the visible index appears in front of a dial plate; the other, surrounded by the coil of covered wire, which is continuous with one of the telegraph-wires, is placed behind the dial. (*Fig.* 3.*) An arrangement of this kind is provided at Edinburgh, the upper telegraph-wire being drawn out there into a long loop, which consists of

* *Fig.* 3. View in profile of signal-index shown in front in *Fig.* 2. p. 28. The vertical line, to the left of the diagram, indicates the visible magnetic needle which shows on the front of the dial-plate, and, by its movements to the right or to the left, makes the signals. This needle has (we shall suppose) its *north* pole pointing upwards. To the right of it is the dial-plate seen in profile ; and further to the right, or behind it, the second vertical line represents the concealed magnetic needle with its *south* pole upwards, and throughout its entire length surrounded by a coil of covered wire, returning on itself many times, and forming a long loop continuous with the upper or insulated telegraph-wire. Both needles are on the same axis, and move together, and the electricity acts directly on each, so as to deflect them to the right or to the left, according to the direction in which the current is sent along the coil.

soft copper wire covered with thread. This is wound round the concealed magnetic needle, so that a current of electricity moving along the upper wire follows the coiled loop, moves the needles in passing, and returns to London. At London, for a reason to be mentioned immediately, there is a similar loop or coil of covered copper wire surrounding a double magnetic needle, and then rejoining the upper main wire from which it proceeded. From the copper end of the battery, a wire is conducted to one of the strands of this coil, and soldered to it. From the zinc end a wire also is conducted, which is soldered to the lower telegraph-wire. The current, setting off from the London battery, deflects the needles at London and at Edinburgh before it returns to London. That the needles may be deflected to either side at will, a contrivance is supplied for cutting off and letting on, as well as for reversing, the electric current from the battery. It is a little difficult to explain distinctly this important portion of the telegraph. The following description, however, will perhaps make it sufficiently clear. Let the upper end of the double telegraph-wire at London be marked A, and the lower end B. If A be connected to the copper of the battery, and B to its zinc, the current of electricity, setting off from A, and returning to B, moves the index-needle to one side, for example to the left. If the arrangement be now reversed, so that A is connected to the zinc, and B to the copper, the current flows from B to A, and moves the needle to the right. (*Fig.* 2. p. 28.)

In actual practice, however, the wires are not shifted from the zinc to the copper, but are *cut across* between the battery on the one hand, and the telegraph-wires, and coil round the magnetic needles on the other. The gap thus made is left vacant when no message is to be sent. When a signal is to be transmitted, a metallic cylinder is moved by a handle so as *to fill up the gap*, and establish continuity between the wires and the copper and zinc respectively of the battery. This bridge, however, is so contrived, that, when the handle which controls it is moved to the left, it stretches in such a manner as to connect the end A of the telegraph-wire with the copper, and the end B with the zinc, and the needle moves to the left. When the handle is moved to the right, it shifts the cylinder or bridge so as to establish a communication between A and the zinc, and between B and the copper; and the needle moves to the right. When the handle is placed vertically the current is cut off from both wires.

It only remains that an arrangement be made between the parties in Edinburgh and London, as to *the signification* of these deflections of the needle. This having been settled, the message-sender in the Metropolis, seated before his dial, moves the handle which determines the transmission and direction of the electricity along the wires. Every motion of the handle, to the right or to the left, causes the index-needles at London and Edinburgh to move simultaneously to the same sides. We may suppose, for example, that an answer in the negative is to be telegraphed from London to an interrogation from Edinburgh. It has been pre-arranged that one movement of the needle to the left shall signify N, and one to the right O. The respondent accordingly moves his handle to the left; thereby transmits the current of electricity in such a direction as to move the index-needle at Edinburgh to the left also; and so represents N. He then places the handle vertically, so as to cut off the current and permit the needle to resume its vertical position; and, after a brief pause, carries his handle to the right, which moves the Edinburgh needle also to the right,—and indicates O, thus completing the answer.

The signal-dial at London is not essential, if London is not to receive messages; but, as it must be provided with a view to their reception, it is so arranged that the electricity moves its index-needle before it passes on to Edinburgh. The party transmitting a message has thus figured before him deflections of the index-needles identical with those which his correspondent is watching and deciphering, at the same moment, hundreds of miles away.

Only two movements, it will be observed, can be effected: but it is easy to make them represent the whole alphabet, and to telegraph rapidly, although every word be spelled letter by letter. Man, moreover, is by his natural-history definition one of the *bimana*, and by consequence two-handed. Two dials can, therefore, be arranged side by side, with coils and index-needles for each, and handles to be managed by either hand. Four movements are thus made possible; and for most purposes these supply an ample abundance of signals. It does not form part of our present purpose to explain these, —as their employment to represent letters, numerals, words, paragraphs, or the like, is quite arbitrary, and involves nothing electrical. We give a specimen, however, of one of the telegraph alphabets:—

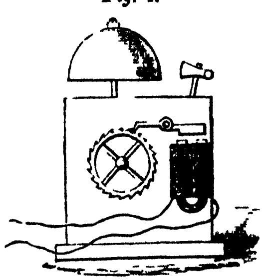
A, one movement to the left	N, one right
B, two left	O, two right
C, three left	P, three right
D, four left	Q, four right
E, one left, one right	R, one right, one left
F, one left, two right	S, two right, one left
G, one left, three right	T, three right, one left
H, two left, one right	U, one right, two left
I, two left, two right	V, two right, two left
J, two left, three right	W, three right, two left
K, three left, one right	X, one right, three left
L, three left, two right	Y, two right, three left
M, four left, one right	Z, one right, four left.

We have provided hitherto only for messages being despatched from London. To secure Edinburgh the same privilege, it is only requisite to deposit a battery there also, and to attach one of the wires from the battery (controlled by the handle for reversing and arresting the current) to the coil round the magnetic needle, and the other wire to the telegraph-wire with which the coil is not connected, as more fully described with reference to the London arrangement. If intermediate stations are to receive messages, then one of the telegraph-wires is cut across opposite the station, and an insulator of porcelain inserted between the divided surfaces. A thin wire covered with thread is then soldered to the main wire on one side of the insulator, led into the station, wound round the magnetic index-needle, led out again and soldered to the main wire on the other side of the insulator. This arrangement is equivalent to a loop on the telegraph-wire; and it must be bent so that the current shall flow in the same direction round the intermediate station-needles as it does round the terminal ones; otherwise, the indices will not be moved to the same side by the same electrical current. A battery at each station, with wires connected in the way already described, enables each to send messages in its turn.

From what has been said, it will be understood that signals telegraphed from any one station to any other will be contemporaneously exhibited at every station. For the whole of the stations are included in one circle of conductors, which carry the electricity round all the indicating apparatus within the circle; and the current cannot move one index without moving all. It is impossible, therefore, if a common alphabet be used along the line, to conceal from the whole of the stations what may be intended only for one. All that can be done, unless a separate series of wires or other conductors is supplied for every station, is to signify what place the message is directed to, so that other stations need not be at the trouble of deciphering the signals.

In addition to the arrangements for producing and interpreting signals, it is plainly necessary that we should have some contrivance for calling the attention of the parties in attendance to the dials, when a message is about to be sent. For this purpose, warning is given by a bell, which a very ingenious application of electricity is made to ring. Electric currents not only deflect permanent magnets, such as the compass-needle, but confer magnetism upon non-magnetic iron. If a copper wire, therefore, be coiled round a rod of malleable iron, and a current of electricity be sent along the wire, the rod becomes a magnet so long as the current passes; and loses magnetism when the current ceases. This magnetising power of electricity is turned to account in the telegraph. An ordinary alarum, or the striking machinery of a common clock, wound up so that the hammer would strike and ring the bell if one of its wheels were not locked, is placed at every station. This wheel is locked by an iron rod, which is balanced on a centre, and so arranged that one end falls into one of the notches between the teeth on the circumference of the wheel. The other extremity of the rod is placed opposite, and close to the ends of a horse-shoe of malleable iron, which is surrounded by a coil of covered copper wire closely twisted round it, and connected by its ends with one of the telegraph-wires. If a current of electricity be sent along the telegraph-wire, it circulates round the horse-shoe, and converts it, for the time, into a powerful magnet; which accordingly pulls towards it the free extremity of the iron rod, and thereby shifts the other end out of the notch in the toothed wheel. The bell immediately begins to ring, as the unlocked wheels revolve by the action of a spring or a weight; but, as soon as the current is stopped, the horse-shoe ceases to be a magnet; the rod is no longer attracted, but falls back into the notch and stops the bell. (*Fig.* 4.*) Under this arrangement, the bells at every

Fig. 4.



* *Fig.* 4. Railway alarum or signal-bell, seen from behind. It is wound up ready to strike, and then locked as shown in the drawing by a steel lever

station would ring simultaneously, although only one'ts are tended to be warned; and the current that rings the'ion would also move the index-needles, though only for a momer On most telegraph lines, however, a separate set of wires is provided for the bells, so that they are rung without affecting the needles. A separate wire, also, is sometimes furnished for every station, so that each bell can be rung independently of the others: but such arrangements necessarily add much to the cost of the entire telegraph.

The magnetising power of electricity is also applied to produce visible as well as audible signals. The following is one of many such arrangements. A horse-shoe, which becomes alternately magnetic and non-magnetic, as an electrical current does or does not circulate round a copper wire coiled about it, alternately lifts and lets fall an iron lever, which, like the beam or piston of a steam-engine, gives a rotatory motion to a wheel; or, as in the cut (*Fig.* 5.), the horse-shoe depresses the lever, and a spring elevates it. This wheel carries an index, which travels over a dial round which the letters of the alphabet are engraved. The current must be alternately interrupted and continued, to keep the wheel revolving. When the current passes along the wire, the index moves from the letter at which it is pointing to the next. The current is then cut off; and, when it is restored, the index moves on to the succeeding letter; or, as in the drawing, the index moves when the current is cut off, and stops when it is let on. A key, like those of the organ or piano,—alternately depressed and allowed to ascend,—furnishes the means of interrupting and renewing the current. This arrangement has been called the step-by-step telegraph; as for each touch of

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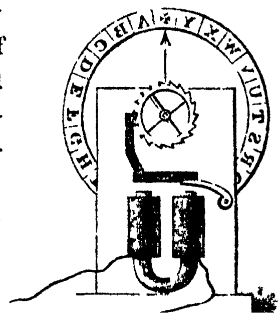
or *detent.* To ring the bell, a current of electricity is sent along the wires which are wound in many coils round the horse-shoe. It becomes a magnet, and pulls towards it the one end of the lever, which lifts the other end or detent out of the notched wheel. The bell is stopped by cutting off the current, which allows the detent to fall back into a notch.

the key the index makes only one step; namely, from the letter it is at, to the next. (*Fig.* 5.*) It has the convenience, too, of using the old familiar alphabet, instead of arbitrary deflections of needles, and is alleged to possess other advantages, which will presently be referred to.

Fig. 5.



A third method of electric signalling is to effect chemical decompositions by the current. One such electro-chemical process is the following. A ribbon of paper, soaked in an acid solution of the yellow prussiate of potash, and pressed upon by two metallic springs, placed side by side,—which are in connexion with the telegraph-wires,—is wound off a roller by a piece of clockwork. When the current circulates, it passes, according to the direction in which it is sent, by the one spring or the other, across the wet ribbon, and decomposes the salt with which it is impregnated, producing blue marks at either of the points where the spring touches the paper. The blue spots or lines thus produced are longer or shorter in proportion to the period during which the current flows, and at the one side or the other of the ribbon, according to the spring by which the electricity passes; and these blue marks or lines may be made to represent letters, according to their length and

* *Fig.* 5. One of the step-by-step telegraphs, represented as if the dial were transparent and seen from behind. The horse shoe becomes a magnet, when the wires are conveying an electric current, and pulls down the lever. When the current is interrupted, the spring at the right hand side raises the horizontal bar, which, by elevating the bent rod, working by its wedge-like end into the notches of the wheel, moves the index represented by a dotted arrow. By attaching a bent rod with a hooked end to the other extremity of the horizontal bar on which the horse-shoe acts, the wheel may be moved when the horizontal bar falls, as well as when it rises.

position on the paper. Their variations in both respects are determined either by the movements of a handle at the station sending messages, by means of which the current from a battery is interrupted, renewed, or reversed at pleasure; or by a mechanical arrangement of great ingenuity.

Lastly, it may be mentioned, on this topic, that, from the first, much attention has been directed to the arrangement of an apparatus which should print as well as signal its messages. Many beautiful contrivances for this purpose have been devised and tried, and some of them are now in use. An arrangement similar to the step-by-step telegraph forms one of the printing machines. The horse-shoe electro-magnet, instead of turning an index, turns a disc or wheel, to the circumference of which an alphabet of inked printing-types is fixed. When the appropriate letter is brought opposite a ribbon of paper, the stroke of a hammer determines an impression; and in this way the message is printed letter by letter. In other printing-telegraphs clock-work is employed to turn the wheel bearing the types, and the electric current is only employed to commence and stop its motions at appropriate intervals, as in the case of the alarum-bell.

In the preceding description we have purposely referred to the simplest and most easily understood form of electric telegraph, where there is a wire reaching from the terminus at the one end of the telegraph-line, to the terminus at the other, and *back again*. In actual practice, however, one half of the wire is dispensed with, and its place supplied—by the earth! A century has elapsed since the very curious discovery was made, that the electricity of a charged Leyden jar or battery will pass instantaneously through a great length of moist earth. Voltaic electricity has more recently been discovered to possess the same power; and advantage has been taken of it in the following way. A wire is led from the last copper plate of a battery placed, let us suppose, at London, along the telegraph posts in the way already described, to Edinburgh, and is there bent backwards towards London. Instead, however, of being carried along the posts a second time, the wire is now cut short and soldered to a large plate of metal, which is buried in the ground at some little depth. A comparatively short wire is also attached to the last zinc of the London battery, and soldered to a metallic plate, which is likewise buried in the ground. (*Fig.* 2. p. 28.) The arrangement is equivalent to a great gap or breach several hundred miles long in the double wire, filled up by moist earth. When the battery is in action, the electricity (positive) flows from the copper along the wire to Edinburgh, descends there to the one earth-plate (as it has been called), passes from it through the earth to the similar plate near the London station, and from it reaches the zinc of the London battery. The circulation of the electricity, in this way, is found to be even more rapid than when the double wire is furnished for its passage.

Good people have perplexed themselves with speculations as to why the electricity never wanders, misses its road, or fails to find its way back. But, as has been implied already, in the case of the double wire, electricity, like a prudent general, always takes care that a retreat be provided for, before it begins its march. Till an unbroken circuit of conductors connect the terminal plates of the battery, no electricity can be set free. It is not essential, however, that those conductors should be metallic; a column or stratum of moist earth will do quite as well as an iron or zinc wire. One half in length of the connecting conductors must be insulated; so that the electricity may be compelled to travel to the farthest point to which messages are to be telegraphed. But the other half of the conductors need not be insulated, and cannot be too large. The quicker the current can pass the better; and it will pass most quickly when conveyed by one or other of the two great electrical conductors which man has at his disposal—the solid mass of the globe, and the ocean with its tributary waters.

The last allusion leads us directly to the marine telegraph.

It requires, however, no detailed description—as it differs from the land telegraph only in having the space between the buried plates occupied by water instead of by earth. Broad estuaries or channels do not permit the insulated wire to be carried across by bridges. The wire, therefore, proceeding from the copper end of the battery, is embedded in gutta percha, or any other waterproof insulator, and sunk in the waters to a depth sufficient to secure it against fishing-nets, ships, anchors, or large sea-animals.

In this way it is conveyed from one shore to the other, and bending backwards after being connected with the index-needles, terminates in a broad plate of metal sunk in the waves, close to the further shore. A second but uninsulated wire proceeds from the zinc end of the battery to a metal plate sunk beneath low-water mark, at the side from which the insulated wire set off. Between the immersed plates on the opposite shores, the mass of water, though ever changing, acts in relation to electricity as if it were an undisturbed gigantic metallic wire. Theoretically, there is no limit to the ocean spaces which electricity may traverse in this way. Already, accordingly, schemes for telegraphing across the Atlantic and the Pacific have been triumphantly expounded to the wonder-loving public.

One of these, whether hopeless or not for immense distances, is so very ingenious, and so likely to succeed across limited spaces, that we cannot pass it unnoticed. It dispenses, except to a very trifling extent, with wires, and carries the current *both ways* through moist earth and water. It is desirable, for example, to telegraph from the right to the left bank of a broad river. From the copper end of a battery on the right bank, a wire is carried to the shore (on the same side) and soldered to a plate buried in the river below water-mark. A wire is also led from the zinc end to a long coil of wire which ends in a metallic plate. This likewise is buried in the river below water-mark on the same right bank, but at a distance from the battery *considerably greater* than the breadth of the river across which signals are to be sent. On the left bank two plates are immersed opposite those on the right bank, and connected by a wire. The electricity on leaving the battery has therefore the choice of two paths. It may either keep entirely on the right bank, passing from the one buried plate on that side to the other, and so back to the battery by the long coiled wire; or it may cross to the left bank through the water, traverse the wire on that side, return across the water to the right bank, and regain the battery by the shorter wire. The Thames has been actually crossed by electric currents in this way; the resistance to their passage by the water between the banks being less than that between the ends of the wires on the right and left bank respectively. The permanent establishment, in September, 1851, of a quadruple telegraph-wire between the French and English coasts, has naturally excited much interest, but it does not involve any electrical novelty. It is generally named the *submarine*, but should rather be called the *transmarine* telegraph; for the triumph is not in having passed *below*, but *across* or *through* the Channel. So early as 1837, Wheatstone demonstrated the practicability of telegraphing under water. The only difficulty then lay in the rarity of good and easily-applied insulators. From the period, however, when the excellence and applicability of gutta percha as an insulator were demonstrated, it became certain that water would not be more difficult to telegraph through than a wet tunnel; and accordingly, in January, 1849, a skilful electrician, Mr. Charles V. Walker (superintendent of telegraphs on the South-Eastern railway) telegraphed for two miles under water (near Folkestone harbour), through that length of copper wire, which had been covered with gutta percha for use in the tunnels. This was strictly a *submarine* telegraph.

The only practical difficulty which attended the laying of a wire from Dover to Calais, or from Folkestone to Boulogne, was the necessity for giving it a strength and solidity which should enable it to resist injury; and the question of strength was only a question of expense, which was solved as soon as the practicability of the scheme was demonstrated to men of capital. It would have been answered much sooner, had not the restrictions which the French government puts on the employment of telegraphs rendered it doubtful whether the scheme would prove remunerative.

In August, 1851, an experimental copper wire, covered with gutta percha, half-an-inch in diameter (including its covering), twenty-five miles long and weighted with lead, was laid between Dover, and Cape Gris Nez on the French coast. It completely answered, so far as transmission of signals was concerned; but in a few days it was cut or broken across. The cable which now stretches at the bottom of the sea, between Dover and Calais, is more than 24 miles long, and weighs about 180 tons. From the account of its construction given in the "Illustrated News" (Sept. 27. 1851), it appears that it consists of four copper wires, through which the electric currents pass, insulated by coverings of gutta percha: these are formed into a strand, and bound round with spun-yarn soaked in tar or tallow, forming a core or centre, round which are led ten iron wires, plated with zinc $\frac{5}{16}$ths of an inch in diameter, each welded into one length of $24\frac{1}{2}$ miles, and weighing about 15 tons. This immense cable, when wound together, formed a coil of 30 feet diameter outside, 15 feet inside, and 5 feet high. It was made in the short space of twenty days.

Each of the copper wires forms, along with the sea which acts as its return wire, a separate channel for sending messages; and the whole arrangement has worked so well, that additional cables, similar in construction, are about to be laid down. Cannons have been simultaneously fired, on either side of the Channel, by the current from a battery some twenty-five miles distant on the opposite coast; but the batteries employed for this purpose must have been much more powerful than those needed for ordinary telegraph use.

It remains to consider some of the imperfections which attend the electric telegraph, and considerably limit its useful applications. When it was first suggested as a substitute for the optical telegraph, which was useless in dark nights and in fogs or snow-storms, it was confidently anticipated that the system of electric signals would be available in all states of the weather. But this expectation has proved fallacious. For hours together the telegraph will not work. This failure is sometimes owing to the insulation of the wires along the poles having for the time been destroyed by moisture. The porcelain insulating tubes, however, are now made of such a shape, and so well protected from rain by sloping covers, that non-insulation from moisture occurs much more rarely than might be expected. There are certain damp fogs, however, or mists, which penetrate every where; and so thoroughly wet the porcelain tubes, that they become conductors of electricity. In those circumstances it travels from the battery no further than the first wet post, down which it passes to the earth, and returns to the battery.

But a much more troublesome cause of inaction, or of irregular action in telegraphs, is the influence of atmospheric electricity upon them. The door left open that the friend may enter, stands open also for the foe. The insulated wires stretched along the telegraph posts for hundreds of miles, in order that a special current of electricity evolved by a battery shall travel only in one direction, cannot, like a private road, be barred against electricity evolved from other sources. Nor is this all. When the electrician wishes to collect atmospheric electricity, he insulates a metallic wire, and suspends it in the air. In other words, he acts exactly as the constructor of the telegraph does, though with a very different object in view. The latter, much against his will, finds that his wires them as a highway. They act, in short, as lightning conductors; and lead the formidable meteor into every station, where it deranges or destroys the coils and magnets, and occasionally menaces buildings, and even life, with destruction.

To guard against these serious evils, lightning-rods, descending to the ground, are fixed at intervals to the telegraph-posts, and at the station-houses. The sharp spikes in which these rods terminate above, being elevated considerably beyond the telegraph-wires, present points of attraction to the electricity of the clouds, so that it is determined to them rather than to the less exalted and unprojecting wires. It is thus transferred from the atmosphere to the earth without affecting the telegraph. The rods in question, however, only protect the wires in their immediate neighbourhood, and that ineffectually.

An additional and more effectual mode of protection is to place a knob of metal on each wire where it crosses the posts. A second and lower knob is then placed close to the first, but without touching it, and connected with a wire led down the post to the ground. If the lightning discharge ran along the wire, it would be cut off at the first knob it reached on the line, on reaching which it would leap across to the lower knob, and descend to the ground; while the current from the battery is found not to have sufficient intensity to overleap the space between the knobs, and hence does not descend the wire, as it would do if the knobs touched.

An additional and very ingenious device against lightning-shocks injuring the station-houses, consists in making one part of the wire which is led off to them from the main line very thin. If a powerful electrical discharge reach this, it melts it; so that the lightning, like an enemy too hasty in pursuit, burns the only bridge by which it could cross to make an attack, and remains on the safe side,—out-generalled by itself.

By one or other, or all of the methods described, sufficient protection can, on the whole, be secured, against the more fami liar and more perilous effects of atmospheric electricity. Electrical disturbances, however, of a kind which do not manifest themselves in discharges of lightning, or involve life or ordinary property in danger, are quite sufficient to derange the operations of the telegraph. During snow and hail-storms, whilst dry fogs are prevailing, when the aurora borealis appears, and in truth during most meteorological changes, much electricity is developed in the atmosphere. It is sometimes directly transferred to the telegraph-wires, but as frequently its action is only indirect. A body in which free electricity is in any way developed determines a similar electrical condition in an insulated mass of metal near it, exactly as a magnet induces magnetism in pieces of iron placed in its neighbourhood. Thus an electrical cloud floating along above the extended wires generates a current of electricity in them; or, to speak more strictly, causes the electricity naturally present in a latent state in the wire, to become free and move along the metal. The currents which thus travel, as well as those which are directly transferred from the atmosphere, have the same effects on the index-needles and signal-bells, as the electricity purposely sent along the wires from the battery. The needles are swung unceasingly to and fro, or remain for hours deflected to one side. The bells ring violently at irregular intervals, or stop only when their weights are run down. Signals cannot be transmitted at all when atmospheric electricity is thus largely developed; and they become more or less confused whenever it is sufficiently powerful to affect the index-needles.

Apart altogether from its practical importance, there is something exciting in the contemplation of these strange atmospheric influences. It must be not a little startling to the drowsy occupant of some solitary telegraph station, to be roused from his midnight slumber by the spectral clanging of his signal-bell, bidding him quail at the wild quiverings of the magnets, swayed plainly by no mortal hands. An imaginative man might then recall the legends which tell of disembodied souls sent back to this earth, to divulge some great secret of the world of spirits, and seeking in vain for means of utterance, which shall be intelligible to those in the body. A philosopher, too, might accept and interpret the legend. For it is sober truth, that the apparently aimless and meaningless movements of the magnetic needles when vibrating at such times, are, after all, the expressive finger-signs of a dumb alphabet, in which nature is explaining to us certain of her mysteries; and already, too, we are learning something of their significance.

Peculiar difficulties have attended the transmission of electric signals through some of the railway tunnels. Those have been traced in some cases to the effect of the moisture trickling down the walls in destroying insulation; and the wires have in consequence been coated, like those of the marine telegraph, with gutta percha. In other cases the index-needles at the stations nearest the tunnels have remained set to one side for considerable periods. This has been referred to the influence on the tunnel wires of electrical or magnetic disturbances in the strata in the neighbourhood of the tunnel. If this view be well-founded, it would be wise to make the telegraph-wires where they pass through the tunnels, of copper, and not of iron, as the non-magnetic character of the former metal makes it less susceptible of electrical excitement. A wire cannot be magnetic and electrical in the same direction at the same time. If a telegraph-wire become magnetic in the direction of its length, like a long compass-needle, it will resist the passage of comparatively feeble electric currents, which would have traversed it had it been non-magnetic. This fact has not, perhaps, been sufficiently considered in the explanations which have been given of the derangements of the telegraph. Iron becomes so readily magnetic, that the telegraph-wires, when made as they generally are of that metal, cannot in certain circumstances escape being magnetised by the earth. Now that railways are projected in India, it may not be amiss also to notice that near the Equator iron rods or wires lying north and south after a time become magnetic. And wherever, in other regions, the wires are extended in the direction of the magnetic dip, the same effect will occur. The cheapness, elasticity, and strength of iron, however, more than counterbalance the inconveniences under notice.

Many of the evils referred to are avoided in the Prussian telegraph, which has also been adopted in Saxony and Austria. In it the wires, which are of copper, are not stretched along posts, but covered with gutta percha and buried at some little depth in the ground. Snow-storms, heavy rains, and fogs do not destroy the insulation of the wires, as they do that of those suspended in the air; nor are the subterranean wires deranged by atmospheric electricity, or subject to the influence of thunder-storms. But it does not appear that they are indifferent to the disturbing effect of the aurora borealis, which often completely suspends the working of the aerial telegraph; and it may be suspected that alterations in the intensity of the earth's magnetism, which we know are constantly occurring, will affect the buried much more than the suspended wires.

In favour of the subterranean telegraph, it is alleged that, though at first more costly, in the end it is much cheaper than the aerial one, as the posts which the latter demands require renewal at intervals, and the suspended wires, in consequence of their exposure to great variations of temperature, and the vibrations determined in them by the impulse of the wind, the passage of railway trains, and the transmission of electric currents, undergo a change in structure, and become so brittle as readily to snap across. On the English railways, however, such brittleness as the Prussian engineers refer to has not been observed to occur in the suspended wires, although it is not to be denied that both in the aerial and subterranean telegraphs the wires slowly undergo a molecular change, which will alter their power to convey electricity; and that the aerial arrangement is exposed to more disturbing agencies than the subterranean one.

On the other hand, it is acknowledged that it is more difficult to secure the insulation of the buried wires, and where this is defective it necessitates the employment of more powerful batteries to force the current along the imperfect conductors. Further; the buried wires are with difficulty reached when deranged, and each wire laid down requires a trench to be prepared for it, whereas in the aerial telegraph one post will carry any number of wires. The encasing of the wires also in gutta percha, determines certain electrical conditions similar to those of a Leyden jar, which do not occur in the suspended wires, and which may interfere with the action of the embedded wires as transmitters of electricity.

The Prussian subterranean telegraph has only been in use since 1848, so that its peculiarities and defects are much less known than the English aerial one, which has been at work since 1838. A further period, accordingly, must elapse before we can decide which is the preferable arrangement. Had gutta percha been as well known in 1838 as it was ten years later, subterranean telegraphs would long ago have been constructed in England, where they were abandoned from the difficulty experienced in finding a suitable and sufficient insulating substance with which to cover the buried wires. A subterranean telegraph, or rather set of telegraph-wires, is about to be laid down in England by a new company, so that before long we shall be able to contrast the working of the two methods at present in vogue. As it is, we cannot but rejoice that different methods of arranging the wires are adopted on the Continent and in England, as we have thus a comparative trial on the largest scale of the two methods, which will double within a given period our experience in the working of telegraphs, besides throwing much light on the electrical disturbances which occur in the atmosphere and within the earth.

We have said nothing regarding the history of the electric telegraph which cannot yet be written otherwise than in the faintest outline. Its earliest scientific originators were Oersted, Ampere, and Wheatstone. Its chief practical constructors have been Wheatstone and Cooke in England, to whose merits we need not again refer; in Scotland, Bain, a man of great inventive skill and ingenuity; in America, Morse, another distinguished mechanical genius; and on the Continent, Siemens of Berlin, the deviser of the Prussian subterranean telegraph. Lastly, we make special mention of Brett and Crampton, who have achieved the construction of the first transmarine telegraph. It must be left to the survivors of those ingenious men, and of the many others who by discoveries in science or practical trials have made the telegraph what it is, to adjust their great but various merits. They are most of them still in life, and few of them past their prime, so that before they become subjects of history, they will have added, as at brief intervals they are doing, to the perfection of the instrument with which their names are connected.

Meanwhile, if our electric telegraph is not perfect, as no tool of man's is, it assuredly is a most wonderful instrument: and it has been brought from small beginnings to its present completeness in a singularly short period of time. To unscientific observers, indeed, the rapidity of its development cannot, we think, but seem miraculous. Like some swift-growing tropical plant, it has spread in a few months its far stretching iron tendrils throughout the length and breadth of the land. It would have done so, however, twenty years ago, had the mechanical conditions for its extension existed: and we must thank the railroads for its early maturity. Till they provided a secure pathway for its progress it could only exist in embryo. It now fringes every railway with its harp-like wires,—apparently as inseparable and as natural an appendage as the graceful parasitical orchideæ which spread along the South American forest trees.

Nursling, however, as the electric telegraph is of this century, almost of this decade, an ingenious pupil of Niebuhr might find in an ancient tradition its birth foretold centuries ago. In the year 1517, as the historians of the Reformation tell us, the Elector Frederick of Saxony had a strange dream. The monk Luther appeared to him, writing upon the door of the palace-chapel at Wittemberg in his dominions. The pen which Luther handled was so long that its feather-end reached to Rome, and shook the Pope's triple crown on his head. The cardinals and princes of the empire ran up hastily to support the tiara, and one after another tried in vain to break the pen. It crackled, however, as if it had been made of iron, and would not break; and whilst they were wondering at its strength, a loud cry arose, "and from the monk's long pen issued a host of other pens."

The Elector's dream, has been fulfilled in our own day. The long pen of iron sprouting forth hosts of pens is in our hands; and every day grows longer. It *has* reached to Rome, and much further; it has shaken popes and kings, and emperors' crowns; and foretold, like the pen which Belshazzar saw, the fall of thrones and the ruin of dynasties. It has written much of wars and revolutions, and garments rolled in blood; and must write much more. But it is the emblem and minister of peace—and the Long Pen shall yet vanquish the Long Sword.

There are other relations, however, than those we have yet referred to, in which the telegraph is daily becoming a more and more important instrument. Hitherto we have referred solely to its application to the practical *reduction* or *annihilation* of TIME; we have now to consider the beautiful way in which it can be made to *measure* it, which has already attained such perfection, that we may soon expect to see every series of telegraph-wires forming part of a gigantic system of clockwork, by means of which, time-pieces, separated from each other by hundreds of miles, may be made to keep exactly equal time, and the clocks of a whole continent move, beat for beat, together. In short, our electric telegraphs will speedily have the additional duty imposed upon them of acting also as essential parts of electric clocks. We proceed to consider how this will be effected.

As electricity generated at one point, can be employed to move magnetic needles at a great distance, so it may be made to move the hands of a clock or time-piece; but to achieve the movements requisite in an accurate timekeeper, will plainly be a much more difficult task than to deflect magnets, which, provided only they point to either side when required, need not do so at equal intervals of time. We must first then inquire, how it is possible to apply electricity to move clock-machinery, and thereafter we shall see to how many important purposes electric clocks can be applied.

An ordinary clock consists essentially of a series of wheels acting on each other, and carrying round, as they revolve, the hands which mark the seconds, minutes, and hours. The wheels are moved by the falling of a weight, or the unwinding of a spring, and the rate at which they revolve is determined by the length of a pendulum made to oscillate by the wheels. In electric, or (as they should rather be called) electro-magnetic clocks, there are neither weights nor springs, so that they never run down, and never require to be wound up. To produce motion, electricity is employed alternately to make and unmake an electro-magnet, or alternately to reverse the poles of a permanent magnet, which, by lifting up and letting fall, or attracting and repelling a lever, moves the wheels.

In Mr. Bain's simple and very beautiful clock, the pendulum itself is the lever moved. The bob of the pendulum is a large brass bobbin like those used for holding thread, on which a long copper wire, covered with silk, is coiled, and connected at either extremity with the zinc and copper of a voltaic pair. In the clock-case, on either side, are permanent bar-magnets, which project with opposite poles from the case, into the hollow axis of the bobbin. When a current of electricity is sent along the wire, the bobbin becomes an electro-magnet; and being attracted by the one permanent magnet, and repelled by the other, moves to the one side, where it would remain if the current continued to circulate. The wires, however, are so arranged, that when the pendulum is thus pulled to one side, it makes a break in one part of the covered wire, and thereby cuts off the current. The bobbin, in con-

Fig. 6.

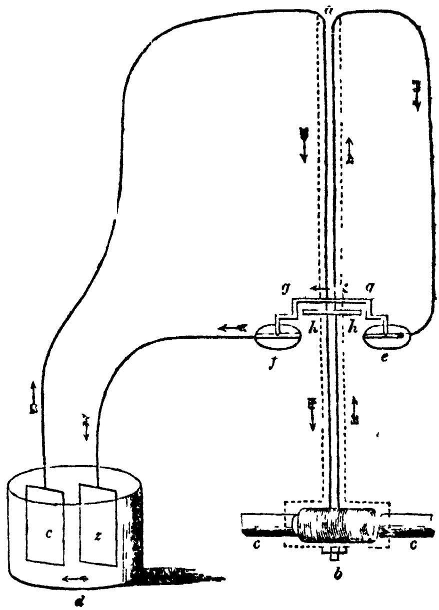


Fig. 6. skeleton diagram of Bain's pendulum.

a, pendulum drawn in dotted outline.

b, bob of pendulum consisting of a hollow cylindrical brass box, containing a lengthened coil of covered copper wire surrounding a bobbin.

c c, two permanent bar-magnets projecting from opposite sides of clock-case into centre of cylindrical pendulum-bob. They are drawn a little shorter than they should be, to show their free extremities, which are oppositely magnetic, the one being a north, the other a south pole.

d, voltaic pair: the arrows show the direction of the current. A wire from the copper is conducted to the top of the pendulum-rod, then down its left hand side to the bob, in which it is coiled many times, and then ascendsequence, ceases to be an electro-magnet, and falls back by its own weight. In so doing, it fills up the break in the covered wire, allows the electricity again to pass, which a second time renders the bobbin magnetic, and determines its motion by the permanent magnets in the clock-case. The pendulum is thus made to oscillate in the one direction by gravity, and in the other by the action of permanent magnets on a temporary magnet; and so long as the current of electricity continues to flow, the pendulum will keep swinging, alternately cutting off and letting on electricity, and making or unmaking the bobbin-coil a magnet, as it oscillates to the left or to the right. The drawing, *Fig.* 6., illustrates its mode of action.

A pendulum, such as this, can readily be made to communicate motion to clock-wheels, of which it is at once the mover and the regulator, and it may be at any distance from the battery which furnishes the electric current. A clock in

ing on the right side to the top of the pendulum-rod, it is brought down within the clock-case and terminates in a disc *e*, made of grooved agate. The black dot in the groove represents a gold stud which forms the termination of the wire from the copper. *f* is a second grooved disc, made,however, entirely of metal, from which a wire proceeds to the zinc. The current thus can only pass, if a metallic bridge stretches from the disc *f* to the gold stud in the disc *e*. This bridge *g g* stands in the grooves on the two discs, the left extremity sliding in the metal, the right extremity in the agate. *h h* is a piece of brass attached to the pendulum-rod, so as to touch the bridge and carry it from side to side. In the diagram the apparatus is not acting. Suppose, however, that the right hand extremity of the bridge touch the gold stud in the agate disc, then the current passes, the coil of wire in the pendulum-bob becomes magnetic, and is carried to the *left* by the action of the bar-magnets. In so doing it slides the bridge off the gold stud, and thereby cuts off the current from itself, and loses magnetism. It returns to the *right* by its own weight, but in so doing it replaces the right end of the bridge on the gold stud, and thus restores the current to the wire and renews its magnetism; and so on *ad infinitum*. Strictly speaking, the edges only of the discs should be shown; they are represented as if seen a little obliquely from above, for the sake of indicating the grooves more distinctly.

London might thus be moved by a battery in Edinburgh, if the telegraph wires were made to convey the current. No particular advantage would result from such an arrangement. If, however, a clock moved by weights, or a spring, and constructed with great nicety so as to keep accurate time, were situated in the astronomical observatory at Edinburgh, it could be made to control one of Mr. Bain's clocks in London in the following way. Let a voltaic pair be placed in the Edinburgh observatory, with wires communicating with those of the telegraph, and let the pendulum in London connected with the telegraph-wires, be constructed in the mode already described, but without any break in the wire, which the oscillations of the *London* pendulum should at intervals fill up. With such an arrangement, the pendulum would make a single vibration, and remain pulled to one side so long as the current passed. It would be easy, however, for a person at Edinburgh to interrupt and renew the current at intervals, and thus make the distant pendulum vibrate at whatever rate he chose; and by arranging one of the wires so that the oscillations of the pendulum of the Edinburgh observatory clock should alternately make a break in it, and fill that up, the London pendulum might be kept oscillating at exactly the same rate as the Edinburgh one, provided the current of electricity did not vary in intensity. Nor would one distant pendulum be all that could thus be kept moving; provided a sufficiently powerful battery were employed at Edinburgh, any number of pendulums might be connected with the telegraph wires at the stations or elsewhere, all of which would keep equal time, and follow the oscillations of the Edinburgh pendulum. In this way a single costly and carefully constructed astronomical clock, worth many pounds, would transfer its own accurate movements to a countless number of pendulums, which, even when connected with clockwork, might have their value estimated in shillings; and wherever we chose to stretch the telegraph-wires throughout the length and breadth of the land, we could set up a clock and read on its face the evidence of the care which the far distant astronomer bestowed on his observatory clock. We are indebted to Wheatstone for the first suggestion of such a scheme, but we have described it in connection with Bain's pendulum, and it will be manifest that the whole clocks of a town could thus be kept moving beat for beat, and keeping equal time, instead of each keeping a lawless time of its own, as is customary with the clocks of most towns at the present period.

In the description just given, we have selected the simplest electro-magnetic clock as the one most easily followed, and have assumed that it is possible to send along a telegraph line a current of electricity of unvarying intensity. Unfortunately, however, it is impossible to do this. Even the so-called constant batteries supply currents too variable in intensity to be applicable to so delicate a matter as the exact measurement of time; and although the battery were perfect, the arrangement would still be at fault. We have already seen how great the disturbing influence of atmospheric electricity is on the currents traversing the telegraph-wires; and the clock would still be more sensitive to such disturbances than the indicating needles of the telegraph dials are. Mr. Bain's beautiful arrangement, accordingly, would not furnish the means of keeping unvarying time. Within the last three years, however, another electro-magnetic clock has been constructed, which is already in use along one of the telegraph lines, and is likely to be extensively employed. It is the device of Mr. Charles Shepherd, and was shown in action at the Great Exhibition, moving the hands on the immense and singular semicircular dial which was constructed on the south front of the arch of the transept. It includes three separate electro-magnetic arrangements with distinct batteries; the first to move the pendulum, the second to move the wheels, and the third to strike the hours. The pendulum is entirely disconnected from the wheels. It is neither moved by them, as in ordinary clocks, nor communicates motion to them, as in Bain's clock. Nevertheless, it controls the motion of the wheels by determining at what intervals the electricity which moves them is cut off and let on to them. The bell stroke is regulated by the wheels, and also by the pendulum, but has a battery for itself. It will not be necessary, however, to refer minutely to the arrangement for striking the hours.

The pendulum is kept in motion by *four* forces, two of which act *directly*, viz. elasticity and gravity; and two *indirectly*, viz. electricity and magnetism. The action of the direct forces is as follows: — A bent spring let loose in one direction throws the pendulum to one side, and the pendulum returns by its own gravity. Whilst it is returning the spring is re-bent, and held back by a detent or catch, which the pendulum itself raises when near the limit of the oscillation which gravity determines, so as to receive from the spring a second impulse to the opposite side. It will thus be understood that some arrangement must be provided for re-bending and holding back the spring, till the pendulum again acquires an impulse from it. This re-bending of the impulse-spring is determined by an electro-magnet, to which a current of electricity is alternately allowed to pass, and then cut off, as the pendulum moves to one side or the other. The pendulum is in permanent connection with one pole of a battery. A wire from the other pole is touched by the pendulum-rod as it moves to the one side so that the current passes, and is separated from it when it swings to the opposite side, so as to cut off the current. When the current is on, it throws into action the electro-magnet, which pulls down an armature or keeper, and this acting on a compound lever, locks back or re-bends the impulse spring, so that it is caught by the catch or detent. When the current is off, the electro-magnet becomes inactive, and a counter-balancing weight and spring raises the armature from the electro-magnet, so as to be ready to act again, and re-bend the spring when the current is restored. The electro-magnetic arrangement is thus solely employed to re-bend the spring, and it does not matter how much the electricity, or the magnetism which it induces, vary in intensity, provided that it is sufficient to re-bend the spring at every alternate oscillation. The release of the spring is effected by the direct mechanical contact of a small arm or point projecting from the pendulum-rod. The diagrams, *Figs.* 7. and 8., will illustrate the action of the clock.

Fig. 7.

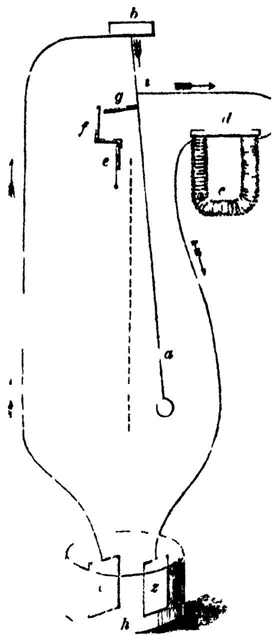


Fig. 7. Skeleton Diagram of Shepherd's Pendulum.

The peculiar advantage of the arrangement just described is that

' *a*, pendulum which has completed oscillation to right, and is about to return by its own weight.

b, portion of brass framework of clock from which pendulum is suspended.

c, horse-shoe electro-magnet, which, by attracting keeper or armature *d*, moves the levers (not represented in the drawing), which lock back the impulse spring *e*.

e, impulse-spring held back by catch or detent *f*.

g, projecting point on pendulum-rod, which, when pendulum swings to the left, throws the detent to the same side, and allows the impulse-spring to fall to the right, and carry the pendulum in the same direction.

h, voltaic pair. The current, as indicated by the arrows, flows from the zinc to the copper up to the clock-frame, then down the pendulum rod to the point *i*, from which, when the pendulum is at the extreme right (as in the diagram), it passes to the second wire round the electro-magnet and no increase in the intensity of the electrical currents employed in moving the machinery affects the rate at which it moves. The only mode in which the electricity can be rendered ineffective is by reduction of its intensity, which by due management of the batteries may, without difficulty, be prevented occurring; or by obstacles to its passage along the wires, which, we have already seen, may be occasioned by atmospheric or terrestrial disturbances. But the influence of these on Shepherd's clock will be much less than on Bain's, or on the ordinary indicating needles of the telegraph box, inasmuch as in the first arrangement the electrical currents do not act *directly* on the moving parts, as they do

Fig. 8.

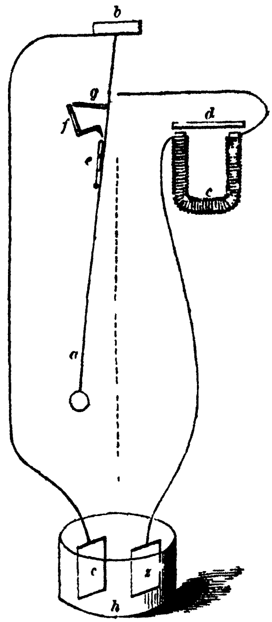


Fig. 8. Skeleton Diagram of Shepherd's Pendulum.

back to the zinc. The current, it will thus appear, only flows, and the electro-magnet is only in action, when the pendulum is at the extreme right. The dotted line represents the vertical position of the pendulum when at rest.

Fig. 8.—*a*, pendulum which has completed oscillation to left, and is about to pass to the right from impulse of spring.

b, clock-frame to which pendulum is attached.

c, electro-magnet *not* in action.

d, keeper or armature raised by levers and counter-balancing spring and weight (not shown in drawing).

e, impulse-spring set free, and pushing pendulum-rod to the right.

f, detent pushed to the left so as to liberate *e*.

g, projecting point on pendulum which acts upon detent *f*, and releases impulse-spring *e*.

h, voltaic pair. The current not passing. The dotted line represents the vertical position of the pendulum when at rest.

in the second two arrangements, so that if the clock goes at all it will keep accurate time.

A large Shepherd's clock is now in construction at Greenwich Observatory. By means of the submarine telegraph wires it will communicate with Paris and with the entire continent; by means of the various railway lines it will communicate with all the great towns of this country; and we may thus receive Greenwich time literally from Greenwich, and set our watches by the dial at a railway terminus with as much confidence as if we were gazing on the face of one of the exquisitely constructed clocks which the Astronomer Royal regulates with so much care.

How this is to be effected will be understood by the following account communicated to the "Times" newspaper by Mr. Charles V. Walker, the accomplished telegraph engineer on the South-Eastern line.

"Wires are to be laid underground from the Royal Observatory to the Lewisham station by the electric telegraph company. From the London station wires will diverge to Westminster, to the Royal Exchange, and to the central telegraph station at Lothbury.

"The objects the promoters have at present in view are —

"1. To transmit Greenwich time and corrected time to and from the clock at the New Houses of Parliament and the Royal Exchange.

"2. To transmit Greenwich time throughout the kingdom by the various lines of electric telegraph.

"3. To compare the transits of stars at Greenwich with the same at Paris.

"The transmission of time-signals will be automatic. Shepherd's electric clocks will be placed in the Royal Observatory in conjunction with an automatic apparatus to be appended to the clocks at the various stations. With respect to the signal to the New Houses of Parliament, a certain time will be agreed upon, and the adjustment at Greenwich will be made accordingly. There will be a permanent electric circuit maintained between Westminster and Greenwich, broken only at the clock at Greenwich and in three places: one of these breaks is completed every minute, one every hour, and one every twenty-four hours, at the time agreed upon; and as these three contacts will occur simultaneously only once a-day, at the precise hour, minute, and second determined upon, the signal which then passes will be the true time required, and it will be made accurate to the 1-20th of a second. In the first instance this signal will be made manifest at Westminster by the motion of a needle. The pendulum there will be furnished with two oscillating bars, one for 'too fast,' and the other for 'too slow,' and either this or that may be made to act on the pendulum by the clock inspector as the case may require, and for a certain short time. At the end of half an hour the Westminster clock will automatically send its time to Greenwich to be observed and recorded.

"To distribute time throughout the kingdom, the clock at the London terminus of the South-Eastern railway will be provided with special wheels and studs. A certain hour will be determined on for transmitting time to Dover for example; and about fifty or sixty seconds before this time the London clock will disconnect the Dover telegraph wire from the telegraph instrument at London, and will place it in connexion with the wire that leads to Greenwich. Precisely at the last second of the minute, the Greenwich clock will place this same wire in connexion with the voltaic batteries of the Royal Observatory, and a signal will be visible at Dover and at all other stations on the same wire. The Greenwich contact will be instantaneous, but that at London will remain a few seconds longer, always allowing a margin for the variation of the ordinary clocks. As the Greenwich wire is taken off the Dover wire, it will be placed in contact, automatically, with the Lothbury wire, where a clock may be fitted with contacts corresponding to such lines of railway, and such towns or stations as may require time-signals."

It remains only to notice the beautiful applications of electro-telegraphic arrangements to astronomical observations, which were first put in practice by the American professors, and are now about to be employed by the British and French astronomers. These are the mechanical registering of the instants at which astronomical phenomena occur, and the transmission of time-signals from one station to another. It will conduce to perspicuity if the subject is considered under three divisions; namely, 1. The application of electro-magnetic apparatus, *without the intervention* of the telegraph wires, to the observation of astronomical phenomena at a single observatory. 2. The application of electro-magnetic apparatus, *with the assistance* of the telegraph-wires, to the transmission of time-signals, or records of the occurrence of astronomical phenomena from one station to another. 3. The application of the combined apparatus to the determination of differences in longitude.

Observations of the times at which astronomical phenomena occur are necessarily difficult, for the astronomer must at the same time do two apparently incompatible things; namely, observe the motion of a star, and that of the hands of a clock. As he cánnot gaze at both, he turns his *eyes* from the clock to the telescope a few seconds before the transit (as it is technically called) of the star occurs, and then transferring to the *ear* the charge of the clock, counts its beats till the transit happens, when he notes the time. Such an association, however, of the eye and ear as is thus required, is at best imperfect, and throws a great strain on the attention of the observer, so that the results are less accurate than they might be. By the ingenious devices of the American astronomers, especially Bond and Locke, an electro-magnetic apparatus was so arranged, that when the current of a battery passed along a wire and called into action an electro-magnet, the latter pressed down a steel point or pen on a ribbon of paper, and made a permanent mark on it. A piece of ordinary clock-work was made slowly to unwind the ribbon of paper from a cylinder or roller, so that different points upon its surface were successively presented to what we may call the electro-magnetic *pen*. By arrangements the same in principle as those adopted in Bain's and Shepherd's clocks, the pendulum of an astronomical clock is made to let on the current to the *pen* once every second, so that at each second a mark is made on the paper ribbon. In this way the clock permanently marks its own beats, and the observer, turning a deaf ear to its clicking, can gaze with undivided attention on the motion of the star across the field of his telescope. Let us suppose, for simplicity's sake, that this passage or transit of the star occurs exactly at a second as indicated by the clock-beat, then this second will be marked upon the unwinding ribbon; and if it have been previously divided into spaces corresponding to hours and minutes along its length; or if any one second-mark on the ribbon be noted from the clock, for example, exactly at the stroke of an hour, so that we may reckon along the ribbon from this, then by mere inspection we shall observe and may mark the instant of the occurrence of the transit. To do this, we may suppose the astronomer to withdraw his eye from the telescope the moment the transit occurs, and to put a pencil mark opposite the last impression which the electro-magnetic pen has made. It soon occurred to the observers, however, that this record might also be made by electricity. For this purpose it was only necessary to have a second electro-magnetic apparatus moving a pen, and so arranged that the observer could at will, by touching a finger-key, call the apparatus into action by allowing a current to flow from a battery. If we suppose this additional pen placed at the side of the one already described, so that it mark the same ribbon, then the object in view will be secured. To prevent confusion, let the one arrangement be styled the *clock-pen*, and the other the *star-pen*. The former is making a mark every second near the *right* edge of the ribbon, while the *left* edge is free to receive the marks of the latter. The moment the transit of the star occurs, the observer, *without withdrawing his eye*, touches a finger-key, and instantly the star-pen makes its mark, side by side with one of the marks of the clock-pen; the transit, for simplicity's sake, being supposed never to occur at the interval between two seconds. If, however, it should occur at such intervals, it is easy, by dividing the space between two second marks into equal portions, to register the transit to the tenth or other fraction of a second. By such arrangements, it will be seen that rapidly succeeding phenomena, such as those which characterise an eclipse, may be unerringly noted, without the observer ever needing to shift his eye from his instrument, or to do more than merely touch a key with his finger.

We are now to inquire, in the second place, how such observations can not only be accurately, permanently, and instantaneously recorded at the spot where they are made, but with equal accuracy, permanence, and rapidity, at a distant station. Let us imagine, for example, that the Astronomer Royal at Greenwich engages to communicate to the Director of the Observatory at Paris the instant when the total phase of a solar eclipse is observed to occur at the former locality. It would be quite sufficient for this purpose that the ordinary apparatus of the telegraph, described in the early part of this paper, was employed; so that by means of the wires stretching from Greenwich to Paris, the English astronomer could at will produce a signal such as the deflection of a magnetic needle at Paris. The apparatus just described, however, would be still better. Let the Parisian Observatory be provided with such a time-ribbon and clock-pen as we have already described, under the control of the local director. In addition, let the star-pen be so arranged, in connection with the telegraph wires, that it can be actuated by a current sent along them, and let any marks be agreed upon to represent intervals of time, and it will be easy for the English observer to mark upon the Paris ribbon the *time* when an event occurs at Greenwich, by touching a finger-key which transmits a current. The mark may be made on the same or on a different ribbon from that impressed by the Parisian clock-pen, and it will constitute a *time-signal*, as it is called. Such time-signals may be made in many ways, and for many purposes. The most manifest one is the rating of clocks and chronometers; but a not less interesting one is the determination of longitude. To render intelligible this part of our subject, we must enter into some brief detail in reference to the mode in which longitude is ascertained. We are indebted to an astronomical friend for the following account of the matter:—The determination of the longitude of a station by astronomical observations, is founded on principles which will be apparent from the following illustration. To take a simple case, suppose a spectator situated on the equator, and that a particular star is directly over his head, so as to be seen through a telescope fixed vertically. Immediately, owing to the earth's rotation, the telescope will turn away from the star, which will no longer be seen in the middle of the field of view, and will in a short time move out of it altogether. The spectator must then wait until the earth has made a complete revolution, or until twenty-four hours of sidereal time have elapsed, before he can again see the star in the middle of the field; owing to the earth's rotation having brought the telescope back to its original position. In this way he will see successive *transits* of the star across the field of his telescope at intervals of twenty-four hours. Suppose, next, two observers placed at *opposite* points of the earth's equator, and therefore at stations whose longitude differs by 180 degrees, each in his turn will witness a transit of the star over his head after an interval of twelve hours; and, in like manner, four spectators placed at equal distances from each other on the equator, will in succession see the star pass through their telescopes after intervals of six hours. It is thus evident that differences of 360, 180, and 90 degrees in the longitudes of stations will cause differences of twenty-four hours, twelve hours, and six hours in the observed times of transit of a star; supposing the observers to be all furnished with watches indicating identically the same time. The difference of longitude of two stations will thus be found, provided we know the interval between the times at which a star has crossed the meridians of the two stations; and as a difference of 360 degrees of longitude corresponds to twenty-four hours, one hour of difference in the times will indicate fifteen degrees of difference in the longitudes.

We have supposed the observers' watches all to indicate the *same* time, a condition which cannot be fulfilled in practice; but it is not necessary that it should, for if we know the errors and rates of the watches, we can apply such corrections as to reduce the indications to what they would have been, on the supposition that each watch indicated the same time. It has also been assumed that all the watches were regulated to the same time, and then the differences of the observed times of transit of the star would give the difference of longitudes of the stations. The difference of the longitudes would, however, be equally well obtained if each watch was regulated so as to indicate the *same* time when the transit of the star was observed. The watches would now no longer indicate the *same time if compared;* but the *differences* in their indications when they were compared would give the differences of the longitudes of the stations from which they had been brought, at the rate of fifteen degrees of longitude to one hour of difference in the indicated time.

It has been supposed that all the watches have kept correct time, or, what comes to the same thing, that their errors have been known at every instant, so as to admit of being applied as a correction to their indications. But as the most perfect chronometers are apt to vary in their *rates*, it is obvious that the method of determining the longitude which has just been described must be liable to errors; and those errors will accumulate in proportion to the length of time that elapses after the observations of the star, before the watches are compared. Almost all error, however, could be avoided in one of two ways: the first being to afford the observer at one station the means of sending instantaneously intelligence of the time indicated by his clock to the other station, so as to compare the times at the two stations at any instant that may be desired; and the second being to send, in like manner, intelligence of the moment at which a star is seen to cross the meridian of the station.

Thus, in the case of two stations, according to the first of these methods, we shall suppose that a certain star passes through the transit telescope at one o'clock of *local* time at each station; the one observer, after witnessing the transit, transmits intelligence instantaneously to the other that his clock indicates 1 hour 15 minutes; but at this instant the latter finds that his clock is indicating 1 hour 3 minutes. There is thus found to be a difference of 12 minutes in the local time of the two stations, or 3 degrees of difference in their longitudes.

Following the second method, the one observer would transmit instantaneously the intelligence of the transit of the star, while the other watched his clock and noted the time, which we shall suppose was 1 hour 3 minutes; but the latter has to wait until 1 hour 15 minutes before he witnesses the transit of the star, which has thus been 12 minutes later in arriving at the meridian of the latter station. The difference of longitude is thus found, as before, to be 3 degrees.

Now as the apparatus of the electro-magnetic telegraph which has been described, affords the means not only of transmitting instantaneously, signals of time indicated by the clocks, or of the instants when astronomical phenomena occur, but also of noting those times mechanically, it is obvious that such arrangements may be employed for the purpose of ascertaining differences of longitude with the utmost precision.

How high a value, indeed, is set upon the electro-telegraphic method of ascertaining longitudes, may be gathered from the following statement of Sir John Herschel: —

"Whatever means can be devised of exciting in two distant observers the same sensation, whether of sound, light, or visible motion, at *precisely the same instant of time*, may be employed as a longitude signal. Wherever, for instance, an unbroken line of electro-telegraphic connection has been, or hereafter may be, established, the means exist of making as complete a comparison of clocks or watches as if they stood side by side, so that no method more complete for the determination of differences of longitude can be desired. The differences of longitude between the observatories of New York, Washington, and Philadelphia, have been very recently determined in this manner by the astronomers at those observatories."

To how many other uses the telegraph wires will be applied, we can only as yet surmise. They will very soon be employed in our own country to drop Time-balls like that at Greenwich, so as to furnish our ship-masters with the means of rating their chronometers. In Germany they have been stretched from the central police stations in certain of the large towns to each of the subsidiary offices, so that the announcement of a crime may be instantly, as it were, made to reverberate through the city, and every officer of justice be on the alert for his prey. In America it has been proposed to have the whole church bells of a district arranged so that, in the event of a fire, one electric current might set them all simultaneously ringing; and the

Sunday chimes might readily be rung by the same agency. We need not particularise further. In England we are apt to think of the telegraph as inseparable from the railway. On the Continent and in America it is in action in many places where the railway is unknown.

Wherever, in truth, wires can be stretched, whether suspended in the air, or buried in the earth, or sunk in the sea, there our wonder-working apparatus may be erected. A few square inches of zinc and copper will produce for us a force which, on the other side of a continent or an ocean, will speak for us, write for us, print for us, keep time for us, watch stars for us, and move all kinds of machinery. No distance will stop its march; for where the force of one battery is spent, it can be made to call into action another or *relay* battery, which will carry on the message, so that if the wires were laid it might sweep round the globe. Such a network of wires, we may hope, will one day connect together the ends of the earth; and, like the great nerves of the human body, unite in living sympathy all the far-scattered children of men.

THE

CHEMISTRY OF THE STARS;

AN ARGUMENT

TOUCHING

THE STARS AND THEIR INHABITANTS.

THE

CHEMISTRY OF THE STARS.

In discussing the Electric Telegraph, we have wandered in thought, far and wide, over our globe; but in our boldest flights we have not looked beyond our Home-Earth. But the same spirit which showed itself in the famous spoiled child of antiquity, Alexander the Great, when he wept that he had not another world to conquer, is in the hearts of us all. If the ends of the earth were knit together by all-embracing electric links, we should begin to sigh that we could not stretch them further, and long to entangle in their thrilling meshes, some one, at least, of the distant stars. And without waiting for the electric conquest of the earth, we are ready at all times to take up the Grecian Conqueror's lamentation; or what is better, to stifle our tears, and be visionary warriors triumphing on visionary battle-fields, and dream-kings reigning over a dream-land. Thought, which is swifter than electricity, can waft us anywhere, and whispers at our will the "Open Sesame" of the Universe. We propose with its telegraph to go forth into Space, and see if we can obtain any answer to our questionings concerning the Nature of the Stars and their Inhabitants.

We shall take for granted that they possess inhabitants, or rather shall put the question thus: "If the stars are inhabited, is it probable that the dwellers on them resemble those on this star, or Earth, or is it more likely that they are non-terrestrial beings, unlike us, and our plant and animal companions, and different in different stars?"

We are not anxious to compel the conclusion, that all the stars are inhabited. Many of the excellent of the earth have held that they universally are, and that, too, by rational creatures; and have thought that the denial of this did injustice to our own convictions, and to the omnipotence and bounty of God. But our standard of Utilitarianism can never be a safe one by which to estimate the works of him whose ways are not as our ways, nor does it require the view supposed.

It would not be a painful, but a pleasant thing, surely, to learn that some of the stars, such as the new planet Flora, were great gardens, like Eden of old before Adam was created; gardens of God, consecrated entirely to vegetable life, where foot of man or beast had never trod, nor wing of bird or insect fanned the breeze; where the trees never crackled before the pioneer's torch, nor rang with the woodman's axe, but *every* flower was

"Born to blush unseen,
And waste its sweetness on the desert air."

Neither is it the remembrance of the Arabian Nights, nor thought of Aladdin's lamp, that makes us add that we should rejoice to learn that there was such a thing as an otherwise uninhabited star, peopled solely by magnificent crystals. What a grand thing a world would be, containing, though it contained nothing else, columns of rock crystal like icebergs, and mountains of purple amethyst, domes of rubies, pinnacles and cliffs of emeralds and diamonds, and gates and foundations of precious stones, such as John saw in the Holy Jerusalem descending out of heaven! All who reach the Happy Land are to enter heaven as little children, and it may please God, besides other methods of instruction, to teach his little ones his greatness and his power, by showing them such a world as we have imagined.

And even if some heavenly messenger, "Gabriel that stands in the presence of God," or one of the other angels that excel in strength, should descend amongst us, and proclaim, "There is no life of any kind in any star but the earth," should we be entitled to murmur at the news. Such is the pride and selfishness of man, that he does not hesitate to proclaim any world a desert, from which himself or his fellows are excluded. But even if it should be certain that every star but the earth is a ball of lifeless granite, or barren lava, it would be for us, if we were wise, to say of it, as the Psalmist would have said, "Whither shall I go from thy Spirit? or whither shall I flee from thy presence?" In the most deserted and solitary of worlds, as we might call it, God is present. The fulness of him that filleth all in all, fills it; the Saviour and the Holy Spirit are there. If our ears were not stopped like the deaf adder's, we should, if visitants of such an orb, hear a voice say, "Put off thy shoes from off thy feet, for the place whereon thou standest is holy ground." We leave, then, the question of the universal habitation of the heavenly bodies untouched, and intend, moreover, to refer chiefly to the nature of the stars, and not to that of their inhabitants. The character or quality of the dwellers in the heavenly bodies is, doubtless, a more generally attractive topic than that of their habitations, as most thoughtful men would consider a forlorn and degraded savage a more truly interesting object than the grandest palace. Our only hope, however, in the meanwhile, of ascertaining anything concerning the dwellers in the stars, is founded upon what we can discover concerning the stars themselves.

The direction in which our argument must proceed may be stated in a word. If we made out a rude structure on the summit of a cliff, to have all the characters of an eagle's nest, we should fairly enough infer that its inhabitants were, or had been, eagles; if we were satisfied that another erection was a beaver's dam, we should judge that beavers dwelt within. A bee-hive would imply bees; a burrow, foxes; a mole-hill, moles; and so, if, among the heavenly bodies, we discover stars identical with our earth, we may pretty safely infer that they are, or may be, or may have been, inhabited by beings like ourselves. Direct observations on the dwellers in the stars, if dwellers there be, it is not likely we shall ever succeed in making. Of the inhabitants of the sun we shall probably never know more, than that the apostle John saw in vision an angel in it; and as for the nearest of the heavenly bodies, we may be thankful that in early life, we saw with our own eyes, as the reader knows he did, *the* man in the moon, as it is not likely that any of us who have reached maturer years shall ever see him again. Isaac Taylor thinks that our sun "may be a world of bliss, the abode of creatures endowed with incorruptibility and immutability;" in a word, Heaven. Others, whose names we are glad to leave in oblivion, have looked upon the sun as the world of woe. John Foster thought that its inhabitants might be "square, orbicular," or, as he shrewdly adds, "of any other form." We are not about to emulate these authors. The question we shall try to answer is the much simpler one,—"Are the stars and their inhabitants terrestrial or non-terrestrial, earthly or non-earthly?"

Great men have held it probable that the stars are terrestrial in nature,—i.e. fashioned of the same materials, and generally constructed like the earth. Sir Isaac Newton was of this opinion. So, to some extent, were Laplace and the elder Herschel. Humboldt has adopted it, and Mulder, the distinguished chemist of Holland. Isaac Taylor, in his "Physical Theory of Another Life," has enlarged upon it with characteristic ingenuity and eloquence. It has been widely brought before the public by Professor Nichol, and the author of the "Vestiges of the Natural History of Creation," and thus it has become a subject of popular interest.

The question may at first sight appear to be one, which, however attractive to the unscientific, cannot be pronounced upon by them; and such certainly is its character. Yet it may be curious to inquire what the decision of the general public is likely to be on a subject so alluring to unreined speculation; and it has been strongly held by certain of the advocates of the telluric or terrestrial nature of the heavenly bodies, that the untutored perception of analogy, and the unaided common sense of mankind, would justify the conclusion which they favour. Nay, it has been urged that the prejudices of the more lettered and scientific portion of the public incline them to prefer the theory of a non-terrestrial chemistry, although it is difficult to see how this can be the case. To satisfy all parties, however, we shall in the first place try, if possible, to learn what the so-called common sense verdict is, or rather would be; and as we can appeal to no existing document as formally recording it, we shall suppose a jury impanelled to try the question of the chemical identity of our globe and the sidereal universe.

All fellows of colleges and of royal societies shall be excluded: all doctors of all kinds, all professors, lecturers, and the teaching class: all clergymen, lawyers, naval and military officers, civil engineers, and in general every man who puts a title before, or prints letters after his name. All critics, reviewers, writers of books, and every one else, professionally or systematically connected with scientific or with literary polemics, shall likewise be protested against; and whosoever, moreover, can be shown, on the faintest suspicion, to have made science, however slightly, a matter of study. From the residue of mankind, after the roll has thus been purged, twelve honest men and true shall be chosen, as strongly gifted with common sense as can be found. These shall form our grand jury. The case shall be tried on successive midnights, in the open court of heaven, and the cause shall be argued according to a precedent supplied by Napoleon, though not to be found in the

Napoleon Code. When the First Consul crossed the Mediterranean on his Egyptian expedition, he carried with him a cohort of savans, who ultimately did good service in many ways. Among them, however, as might be expected at that era, were not a few philosophers of the Voltaire-Diderot school. Napoleon, for his own instruction and amusement on shipboard, encouraged disputation among these gentlemen; and on one occasion they undertook to show, and, according to their own account, *did* demonstrate, by infallible logic and metaphysic, that there is no God. Bonaparte, who hated all idealogists, abstract reasoners, and logical demonstrators, no matter what they were demonstrating, would not fence with these subtle dialecticians, but had them immediately on deck, and, pointing to the stars in the clear sky, replied, by way of counter argument, "Very good, messieurs! but who made all these?"

We shall judge this case in the same way. The stars themselves shall be appealed to for a reply to the question we are curious to have answered. They shall appear at the bar, and learn that a charge has been preferred against them, that "they are of the earth earthy." The question shall be put to each, "Earthly or not earthly?" and the jury shall give their verdict according to the answer returned. Our twelve honest men, then, having sworn in the presence of the great Judge to give a righteous verdict, shall be taken to the summit of some heaven-kissing hill, and left there as long as they please, to make acquaintance with the stars. Far away from anxious author and captious critic, they shall read for themselves the lesson of the universe. The heavens shall declare the glory of God: the firmament show his handiwork. Day unto day shall utter speech in their hearing: night unto night show knowledge before them. They shall watch the guiding of Arcturus and his sons: and behold the bands of Orion: they shall feel the sweet influences of the Pleiades, and listen to the morning stars singing together. "The Sirian star, that maketh the summer deadly," shall shine forth before them on the forehead of the sky, and they shall hearken to the solemn tread of the host of heaven, as, drawn up in their constellations, they nightly repeat their sentinel march from horizon to horizon.

And when the unsatisfied senses are still filled with desire, all needful help shall be furnished to gratify their longing. The Herschel forty-feet telescope shall be granted our jury to gaze through, and the courteous Lord Rosse will not refuse the giant reflector. Pulkowa, and Altona, and the Cape shall lend the best instruments of their observatories, and the ingenious Lassell shall record for them what he witnesses with his space-piercing tube. The wise and filial Herschel shall stand by to explain; and the eloquent Arago and sweet-tongued Humboldt make the wayfaring man, though a stranger, at home in the universe. As witnesses, however, witnesses only, shall these high priests of nature be called, and speak to facts, but offer no opinions.

Our twelve shall first cast a glance at our own solar system, and observe that no one of its planets has the same magnitude, inclination of axis, so far as that has been observed, density, time of rotation, or arrangement of orbit: but that each, in nearly all these particulars, differs greatly from its brethren. They shall notice that several of the planets have no moons: that our Earth has one relatively very large one: Jupiter, four relatively small ones: Saturn, seven of greatly varying dimensions: Uranus, as is believed, six; and Neptune, two or more. They shall see the splendid girdles which Saturn wears, and be warned that two at least of the moons of Uranus move from east to west, or in a direction opposite to that of their planet, and of all the other bodies of the solar system.

The enormous differences in the length of the planetary years shall startle them; that of Mercury, for example, being equal to about three of our months; that of Neptune, to 164 of our years. The lesser, but marked diversities in the length of their days shall awaken notice, the Mercurial day being, like our own, twenty-four hours long, the Saturnine only ten. The variations in the amount of heat and light received from the Sun by each of its attendants shall not be forgotten; Uranus, for example, obtaining two thousand times less than Mercury, which receives seven times more than the earth. They shall also observe the extent to which the planets are subject to changes of season; the Earth knowing its four grateful vicissitudes; Jupiter knowing none; whilst the winter in Saturn under the shadow of his rings is fifteen years long. All those unresembling particulars shall be made manifest to our observant twelve. Neither shall they be forgetful of those dissimilarities in relation to atmosphere, and perhaps to physical constitution, which astronomers have detected. When so much diversity has been seen to shine through the unity of the solar system, our twelve shall gaze forth into space, to see if all be sameness there. Sameness! They shall discern stars of the first magnitude, stars of the second magnitude, of the third, of the fourth, of the seventh, down to points so small, even to the greatest telescopes, that the soberest of philosophers can devise no better name for them than star-dust; and one of them declares "that for anything experience has hitherto taught us, the number of the stars may be really infinite, in the only sense in which we can assign a meaning to the word." They shall find that the Dog-star is a sun, whose light has an intrinsic splendour sixty-three times greater than that of our own solar orb, and that he is not counted chief of the stars. They shall search in vain through the abysses for a system similar to our own, and find none, but perceive instead, multitudes of double-stars or twin suns, revolving round each other. They shall learn that there are triple systems of suns, and that there may be more complex ones; and try to conceive how unlike our planetary arrangements must be the economy of the worlds to which these luminaries furnish light. They shall gaze at purple and orange suns, at blue and green and yellow and red ones; and become aware of double systems where the one twin appears to be a self-luminous sun, and the other a dark sphere of corresponding magnitude, like a sun gone out, as if modern science would assign an exact meaning to Origen's reference to "stars, which ray down darkness." Herschel shall show them the sidereal clusters, many of which "convey the complete idea of a globular space filled full of stars [i. e. suns] insulated in the heavens, and constituting in itself a family or society apart from the rest, and subject only to its own internal laws." Lord Rosse shall exhibit the nebulæ, resolved and unresolved. The continental observatories shall furnish records of those strange heavenly bodies which periodically wax and wane, now shining like "candles of the Lord," now darkening with Ichabod on their foreheads. Tycho Brahe shall tell of those mysterious unabiding stars, which have flashed almost in a moment into existence in the heavens, and have died away like all precocious things prematurely, appearing as if to verify the poet's prediction, that the sun himself will prove a transient meteor in the sky. The Chinese astronomers shall proclaim the paths of ancient comets, which neither Greek nor Roman had courage or science enough to trace through the heavens; and Humboldt, after describing the wanderings of the comets of later days, shall supply the commentary that so great are the differences among these eccentric bodies, "that the description of one can only be applied with much caution to another." The American observers shall detail how thick and fast the "fiery tears" fall from the November meteors: and a thousand other witnesses stand ready to affirm "of diversity there is no end." But we may suppose our somewhat distracted twelve, at this stage of the proceedings, to decline further evidence, and bethink themselves what their verdict shall be.

"These stars!" one juryman will say—a chandler we may guess, or oil merchant, or perhaps only a lamp-lighter—"these stars! these suns! 'these street lamps,' as Carlyle has called them, 'in the city of God,' are they to be counted, my brethren, so many argand burners, each cast in the same mould, with wick clipped to the same length, and fed with the like modicum of oil, that it may spread an equal number of rays over the same square section of heaven's pavement? Nay! are we not certain that at least they differ in size and brightness? and if thus they vary in dimensions and in splendour, as well as in colour of light and in mode of arrangement, is it likeliest that in other respects they differ only in degree, and have all but one function, or that they differ in kind and in office also? Some shall be likened to fragrant wax-candles, lighting up gay drawing rooms; and others shall be murky torches following the dead to the tomb; and others Eddystone lamps, saving goodly ships from destruction; and others, rainbow-tinted vases, making the streets gay on coronation festivals: or strontia-fires, bidding armies begin battle; or Bude flames, illuminating halls of parliament; or lime-ball and electric lights on lofty mountain-tops, measuring arcs of the globe."

A second of the twelve shall arise, a blacksmith, or stoker, by the look of him. "That visible sun of ours, it should seem, is the open furnace-door of a great locomotive engine, sweeping through space. Its train goes with it, of Jupiter-Saturn first class carriages, Mars-Earthly second class, and Ceres-Vesta third ones; satellite trucks being here and there interspersed through the train; and comet engines provided to go special messages. Those far distant stars, it should seem, are locomotives too, and like enough, propel planet-trains, though no one has seen even traces of the latter. But are we free to settle that each drags its Jupiter, its Earth and Vesta carriages behind it, with the same lord and squire passengers in the first, citizens well-to-do in the second, and stout mechanics or ragged Irishmen in the third? Are the paint and lacquer, the cushions and the paddings, the door-handles and the wheels, and all the similar coach furniture, to be looked for in these hypothetical trains, exactly as they are found in our sun's planet-carriages? Let us consider before we admit this, how many coupled engines we see; how many triplets and other locomotive wonders, which are likely to have attendants as strange as their engines, and pause before we settle that space is but a railway network, traversed by up and down trains, differing only in length and speed, and carrying in the same vehicles the same kind of passengers and goods, at the one Universal penny a mile.

"It seems, indeed, but an appeal to our ignorance to say, that that Sirius-engine, for example, differs nothing from our Sun-locomotive but in size. Its fire is far brighter and hotter than ours, and perhaps as much because it burns a different sort of fuel, as because it merely burns more of the same coke that our locomotive consumes. Neither does it seem a self-evident proposition that the Sirian machine must be made up of some sixty chemical pieces, because one of the carriages of our Sun's train consists of so many. And as for the train of the Dog-star, if there be one, it appears not unlikely that the traffic of the regions through which it runs may be very different from that of our zodiac, and that the vehicles composing the suite of Sirius may differ in many particulars from such as accompany our Sun. I, for one at least, will say that I perceive no grounds for assuming that where diversity prevails in relation to all the points that are cognizable by us, sameness should be counted to be the rule in regard to everything that is hidden from our sight."

A third juryman, who has plainly served before the mast, will make bold to ask the question—"Those ships of heaven that go sailing past, each on its mysterious God-commissioned errand, were it wisest to consider them a fleet of herring-boats or collier brigs, some larger, some smaller, but all built of the same materials, rigged in the same style, and carrying the same cargo? Or were it wiser to compare ourselves to the watchers on lonely Ascension Isle or solitary St. Helena, now signalling a man of war with its 'Mariners of England;' then an African slaver with its doleful passengers and demon-crew; now a heavy-laden Indiaman rich with the wealth of China; then a battered South Sea whaler, filled with the spoils of slaughtered monsters of the deep; light Tahitian schooners with cocoa-nuts and arrow-root; stout American ships with ice for the epicures in India; English barks with missionaries, for the heathens of all lands. Oak ships, and teak ships, and ships hammered out of iron: sailing vessels, and ocean steamers with paddles and screw-propellers. Danes, Dutchmen, and Swedes, Frenchmen, Russians, and Spaniards, each with its different build, its unlike dialect, its strange flag and unresembling crew. All sizes and shapes and kinds of navigable craft, with all sorts of unimaginable cargoes and motley companies of sea-faring men.

"If there are all these differences among our sailing vessels, are there likely to be fewer among the ships of heaven? Do you think it probable that if by means of some loudest speaking-trumpet, we could hail each shining orb with 'Star a-hoy!' and thereafter, by means of some farthest echoing reverberating hearing-horn, could get back an answer, that from every one would be returned the same doleful or trivial earthly murmur—*Californian Diggings; Kaffre War; Ministers Outvoted; Fête at Paris; Insurrection in China; His Holiness the Pope's last Bull.*

"My friends think of this. In the azure sea above us, there are no shores or landing-places; it is one boundless PACIFIC OCEAN, where the frailest bark never hides behind a bulwark, or drops anchor in a storm. The fleets of heaven are all phantom ships, for ever sailing, but never nearing port. If they are all then as nearly as possible identical, why are there so many? If the nature and object of each is the same, why are they not pieced together so as to make up one huge vessel? They might as well have been nailed and hammered into a single mighty sun, or sun-earth, lighting up, and darkening itself, while it floated through space, like a gigantic Noah's ark, laden with every living creature."

This is our Sailor-juryman's opinion; but we have an old Serjeant also among our twelve, and he claims to be heard next. "The Skipper," he begins, "the Skipper has likened the stars to men-of-war, and so will I, though in a different sense from him, but with a view to repeat his question: If the celestial bodies are all alike, why are there so many of them? The stars, I have been told, are the 'Host of Heaven,' 'the armies of the sky,' and if so, are something more than a regiment, and are likely to present other differences than merely a grenadier company of stars of the first magnitude; a light company of stars of the second; a mass of troops of the line, of the third; and drummer-boys of the fourth. An army, my friends, is not a *row* of pipe-clayed men, with stiff stocks and buttoned gaiters, turning their eyes to the right or the left as some martinet colonel gives the word of command. It counts not by men but by companies, not by companies but by regiments, not by regiments but by battalions, not by battalions but by nations. Its officers are dukes and archdukes, kings and emperors. It has cavalry and infantry, artillery battalions, rifle brigades, rocket companies, engineers, sappers and miners. In that small matter of arms and clothing how endless the difference. Plumed bonnet, helmet and shako, grenadier cap, cocked hat; plaid, cuirass, hussar-jacket, broadsword, sabre and spear, bayonet, pistol, carabine and musket: all kinds of dress and equipment, and every variety of weapon, worn by all sorts and conditions of men. And if man, bent only on fighting for his hearth and home, and without caring for diversity, nay, doing his best to provide against it, by 'tailor's uniform,' 'serjeant's drill,' 'pipe-clay,' 'orders of service,' and whatever else promised to smooth over differences,—has never been able to do more than iron straight and make uniform a single regiment at a time, and that for the shortest period, how is it likely to be with that Host of Heaven as ye call them? Scarcely among earthly hosts has some latest regulation-cap become comfortable on the head of its military wearer, before he who planted it there to realise his thirst for unity, has grown weary of its sameness, and must have the felt shaped anew. This is the lesson that nature has taught him, how not two leaves can be found alike, not even two pease: and if not two alike, still less three: least of all thirty or a thousand. If, moreover, among objects of the same class or species every additional unit shows an additional difference, how much greater the probability of variety, when there is a likelihood of the individuals belonging to different tribes! Call not, then, the heavenly bodies a host, or army, or acknowledge that they must have mighty differences among them. I say not that each 'sentinel star' is unlike all others. It is enough if it be unlike many. There may be whole battalions of the same race, wielding the same weapon, and wearing the same uniform: but will this be the case with the entire army? It was not so with Pharaoh's host, or the Roman legions, with Attila's hordes or Britain's army, or with any host that man has seen. I ask no other evidence of diversity existing among the starry night-watchers than that there are millions of millions of them. Such numbers do not exhaust unity; no numbers can; but they exclude sameness when oneness of species cannot be shown; and before we have counted even our thousands, 'all things, I doubt not, will have become new.' Yes! the faulchion that Orion wields is forged of a different metal from the flaming sword of the comet, or the fiery weapon of Mars, and the club of Hercules is carved of another wood than the shaft of Bootes' spear."

A long-haired, ample-collared young gentleman, will here interrupt our militaire. "Of regimental tailoring and army cutlery I know nothing. But did not Byron write that immortal line,

"'Ye Stars! which are the poetry of heaven;'

and what think ye did he mean by that? That our sun, with the help of his family, had once since the beginning of things composed an ode; he, after much thought, giving out the first line, his planets with difficulty furnishing a line apiece, the moons attending to the stops, whilst the comets supplied the interjections and notes of admiration. His lordship, too, would intend us to understand, either that copies of this remarkable production were handed round the universe, or that, by a striking coincidence of genius, such as happened more than once to himself and Goethe, each sun with due help composed once in its existence the very same family piece; so that for millions of centuries the stars have all been chanting like the children of an infant school, the same unchanging, meagre version of 'the hand that made us is divine.'

"That might be his lordship's meaning: but might he not, perhaps, intend us to understand something very different, and expect to have our sympathy with another view of things? Our Earth, I think, alone engages to furnish a whole epic of 'Paradise Lost,' through 'Man's first disobedience, and the fruit of that forbidden tree,' and each sphere it is likely has, like Thalaba, its wild and wondrous tale to tell. The poetry of heaven, according to my Lord Byron, or any other of the poet guild, is no solitary sonnet, or single song, but an Olympic contest of Iliads and Odysseys, epics and lyrics, tragedies and comedies, histories in twenty-four books, isolated verses, single hymns, detached odes, and separate songs, where the same poem is never recited twice by one author, nor similar compositions made public by different poets; but in endless diversity, a countless succession of abounding rhymes flows on, of 'grave and gay, and lively and severe,' recounting the history and the destinies of the universe, and glorifying him who sits enthroned as its King."

"Ay! and the Music of the Spheres," will a sweet-tongued juryman say, "is that some unaccompanied melody; some

'Gloria Patri' of three notes; or 'God save the King upon a single string,' played endlessly upon the millions of similar barrel organs that make up the universe? or is the latter some grandest cathedral organ provided not merely with '*vox humana*,' or Earthly stops, but with unnumbered Phœbus flutes, Martial trumpets, Aries horns, Serpent clarions, and pedals touched by the feet of him who walketh on the wings of the wind? Under the vault of heaven it stands a complete orchestra, now with muted voice, as the fingers of God move over one starry bank of keys, lisping under breath some simple melody, then, as they change to another, sounding out a trumpet obligato, or 'when the Highest gives his voice,' rolling forth with open diapason a 'Jupiter symphony,' or guiding the Hallelujah chorus of the morning stars singing together. The starry choir, I ween, is no African row of monotonous performers singing in unison, and able to sing only one song, but a Russian horn-band, where each individual furnishes his indispensable single, and unlike note, towards the universal harmony, and the troop can execute all kinds of music: or a German festival-chorus with its thousand voices, and its unlike parts undulating together into one vast symphony, and flowing on as a mighty river of sound. 'There is no speech or language where their voice is not heard. Their line is gone out through all the earth, and their words to the end of the world.'"

The Chancellor, or Foreman, however, of our twelve, desiring impartiality, and also, as befits his office, loving unity, shall here interpose: "My friends, let not this discerning of diversity prevail with us too far. From the evidence laid before us it should seem, that this solar system of ours is a goodly branch, on the summit of whose stem blooms a brilliant sunflower, whilst round its stalk, at due distances, are arranged the components of its foliage, some twenty broad planet-leaves, and about as many moon-leaflets. Besides these, there are myriads of sharp-pointed, swift-piercing, straggling cometthorns, which have occasioned much annoyance to those who have handled them. With these I shall not meddle; but those far distant, non-planetary stars! were it not good to count them sunflowers also, of which on some branches indeed there are two on one stalk, and on others three; larger it may be in certain cases, and fairer than ours, purer in their tints, and varied occasionally in the hue of their petals, but sunflowers all of them, and embosomed in more or fewer leaves and leaflets like those on our own stem? It were no mean and paltry idea of a universe, or meagre scheme of its unity, to compare its clustered stars to unfading flowers blossoming on the branches of one great tree. I should liken it to such a monarch of the wood as Nebuchadnezzar beheld in his night-dream, or better to such as Ezekiel saw in waking vision. 'A cedar in Lebanon with fair branches, and with a shadowing shroud, and of an high stature; and his top was among the thick boughs. . . . . All the fowls of Heaven made their nests in his boughs, and under his branches did all the beasts of the field bring forth their young, and under his shadow dwelt all great nations. . . . . The cedars in the garden of God could not hide him: the fir-trees were not like his boughs, and the chestnut-trees were not like his branches; nor any tree in the garden of God was like unto him in his beauty.'"

"Yes!" one will reply, "that truly were a goodly scheme, and a grand unity, but were it not a better thought, productive of a grander unity, and as likely to be the true one, that that starry universe is no one flowered cedar unvaried in its beauty, but such a tree of life as the Daniel and Ezekiel of the New Testament, the beloved apostle, saw, which bare '*twelve* manner of fruit,' and 'whose leaves were for the healing of the nations?'"

"And were it not," a third will say, "grandest still, and most likely, that that midnight sky shows us no Lebanon with its single cedar, however stately, nor any one tree, however different its flowers, but a whole 'Garden of God,' with its oaks, and its elms, and its fir-trees; its myrtles and its roses: ay, and its lilies of the valley, its daisies and violets too? Yes! stars are like stars, as flowers are like flowers, but they do not resemble each other as roses do roses, or lilies lilies; but as the rose does the lily, or the dark violet the star-eyed daisy."

Our Chancellor, caught like Absalom in the branches of his own metaphor, shall say no more on the matter in dispute, but content himself with pressing for a conclusion. And thereupon the twelve, various in their unity, shall stand up with uncovered heads in the stillness of night, and lift their unanimous voices to heaven. "By thee only, Judge of all the earth, and all the universe, can this cause be decided, and to the judgment of thy supreme court do we refer it for final issue. But, in the meanwhile, we are free to give our verdict according to the evidence laid before us, and it runs thus:—

"'*There are celestial bodies, and bodies terrestrial: but the glory of the celestial is one, and the glory of the terrestrial is another. There is one glory of the sun, and another glory of the moon, and another glory of the stars: star differeth from star in glory.*'" To which verdict, we, for our part, understanding the words in their widest sense, will append our heartiest Amen.

The "fulness of him that filleth all in all" is of its essence inexhaustible, as we perhaps best realise when all metaphor is set aside, and we reflect on the one quality that belongs to God's attributes: namely, that they are Infinite. It is part of his kindness to us, that he never lets us lose sight of this great prerogative of his nature, but, alike by suns and by atoms, teaches us that his power and his wisdom have no bounds.

It cannot be that he reveals himself otherwise in the oceans of space. Were we privileged to set sail among the shining archipelagoes and starry islands that fill these seas, we should search like marvelling but adoring children for wonder upon wonder, and feel a cold chill of utter disappointment if the widest diversity did not everywhere prevail. The sense of Unity is an over-ruling power which never lays aside the sceptre, and will not be disobeyed. We should not fear that it would fade away, nay, we know that it would stand forth mightiest when its kingdom seemed to have sunk under overwhelming diversity. Unity is in nature often nearest us exactly when variety seems to have put it furthest away. We are like the sailors of Magellan who first rounded the globe. Every day they sailed further as *they* reckoned from the place of their departure, and ploughed what seemed to *them* a *straight* line of increasing length, which had all to be retraced before their first harbour could be gained: but, behold, when they had sailed longest, and seemed furthest from home, they had the least to sail over, and were nearest to port. Exactly when hope of return was faintest were they called on to exclaim, like the Ancient Mariner—

> "Oh dream of joy! is this indeed
> The lighthouse top I see?
> Is this the hill? is this the kirk?
> Is this my own countree?"

A voyage through space would in like manner turn out to be a circumnavigation. We should set sail from Unity, and traverse the great circle of a universe's variety till we came round to Unity again. The words on our lips as we dropt anchor would be, "There are differences of administrations, but the same Lord, and there are diversities of operations, but it is the same God which worketh all in all."

Our readers may be disposed to think, that in all that has been said we have evasively begged the question. A phantom-jury of men, professedly unlettered, but in reality bearing the same relation to the majority of the different classes they represent, that the pedlar of Wordsworth's "Excursion" does to ordinary pedlars, have disposed of the problem under discussion, apparently unanimously enough. But if their verdict were submitted to the revision of a tribunal of men of science, it may be thought doubtful whether it would be ratified. Let us transfer, then, the question of the terrestrial or non-terrestrial character of the heavenly bodies, from the "outer court of the gentiles," in which we have hitherto heard it argued, to the "inner court of the priests," even of the high priests of Nature, who serve at her altar, the philosophers properly so called. Our space will not permit us to put on record the judgments of all of them, but we may find room to chronicle the opinions of three of the priestly dignitaries, the Astronomer, the Chemist, and the Physiologist, or Biologist.

A quotation from Sir John Herschel will show the judgment of astronomy on the question we are discussing, so far as the planets are concerned.

"Three features principally strike us as necessarily productive of extraordinary diversity in the provisions by which, if they be, like our earth, inhabited, animal life must be supported. These are, *first*, the difference in their respective supplies of light and heat from the sun; *secondly*, the differences in the intensities of the gravitating forces which must subsist at their surfaces, or the different ratios which on their several globes the *inertiæ* of bodies must bear to their *weights*; and, *thirdly*, *the difference in the nature of the materials of which, from what we know of their mean density, we have every reason to believe they consist*."— *Outlines of Astronomy*, p. 310.

The two first points of diversity noted, refer to differences in the *intensity* of certain influences, which, however, we shall presently find are, of themselves, sufficient to make terrestrial life as we see it, impossible upon at least the majority of the planets. The third is a most explicit reference to a difference in the kind of materials of which the several planets consist, which their difference in density betrays. "The density of Saturn," for example, "hardly exceeds one-eighth of the mean density of the earth, so that it must consist of materials not much heavier than cork."

We shall refer to this question more particularly presently, when discussing the testimony of Chemistry as to the components of the Spheres.

Direct telescopic observation, moreover, has also supplied the astronomer with some information concerning the physical constitution of the heavenly bodies, the chief points of which we condense here, mainly from Herschel's minute descriptions of the characteristic features of each of the members of the solar system.

So far as the sun is concerned, it may suffice our present purpose to say, that nothing certain is known regarding its constitution. It is supposed to have a kind of triple atmosphere, one portion of which is luminous; the second consists of highly reflective clouds, which float below the first, and throw off its light and heat. The third is a mass of gaseous matter, believed to include the luminous and cloudy portions, and to envelope the solid sphere of the sun. In what condition the last is, either as to temperature or to illumination, is quite uncertain; nor is anything known in relation to its composition. Observations, however, on the transit of Venus over the sun's disc, have enabled astronomers to infer that the sun has not an atmosphere of the same nature as that of the Earth; and this may be said to be the only matter tolerably certain concerning solar chemistry. Mercury is too near the sun, Uranus and Neptune too distant from it; Vesta, Ceres, Juno, Pallas, and the other minor planets, too small to permit observations as to the condition of their surfaces. Venus is thought to have an atmosphere, and some have conceived they saw hills on its disc, but the existence of these is doubtful. Mars most resembles the Earth of all the planets. The outlines of what are considered continents are very distinct, and what seem to be seas are equally visible. The polar regions, too, present appearances strongly favouring the idea, that snow or ice is collected at them, thawing in the Martial summer, and becoming more abundant in its winter. This is by far the most interesting fact, as in truth it is the only positive one, so far as we know, which the telescope has supplied in relation to planetary chemistry. To have good reasons for suspecting that so characteristic and important an earthly ingredient as water occurs in Mars, is assuredly a matter of great interest. The more abundant element of that fluid (oxygen) is also the most important constituent of air, and may perhaps exist free around the planet. A globe which had water, and an oxygen atmosphere, might certainly put in some chemical claim to be a sister of the Earth. But such speculation is premature. The presence of water does not justify the inference that free oxygen is also existent; nor does it warrant the conclusion that more than fifty other elements must be there also. It may further be noticed that the atmosphere of Mars is less distinct and abundant, and much less opaque and cloudy, than we should have expected in the case of a planet thought to possess a great body of water. Astronomers, however, appear to be by no means agreed, either as to the nature or to the extent of the Martial atmosphere. Some deny that there is one at all.

The strange fiery-red light of this star, also, implies a peculiar condition of its whole uncovered surface, very unlike what our Earth's exterior exhibits, and forbids any conclusion as to the general identity of their superficial condition or component ingredients. It still more forbids rash inferences as to terrestrial plants and animals existing on a body of unknown composition.

Nothing is known concerning the surface of Jupiter, which his cloudy atmosphere conceals from inspection; but observations on the eclipses of his moons have shown that that atmosphere does not sensibly refract light. It therefore differs from that of the Earth; but we have at present no means of ascertaining what its constituents are. The disc of Saturn is also hidden from us by a gaseous or vaporous covering, the nature of which is unknown. His rings are perhaps naked, but they are rarely objects of full telescopic observation, and the state of their surfaces has not been minutely described.

The Earth's satellite is the only moon which has been carefully examined; and we can say more concerning its superficial condition than that of any other of the heavenly bodies. It is the least terrestrial, to appearance, of them all. The moon has no atmosphere, no air, no clouds, no rain, nor dew, nor lakes, nor rivers, nor seas! It has great plains and valleys, but to appearance, barren as the Zahara, for the lunar seasons produce no change on them; nor have traces of vegetable or animal life been detected on any part of its unfruitful surface. It has gigantic mountains, nearly every one an active or extinct volcano, with craters of enormous depth; but their summits and edges relieved from the wearing and disintegrating action of air and water, and unclothed with verdure, are in all cases rugged and sharp, unlike the worn, or covered, and everywhere rounded outlines of our hills. To this astronomical description of the moon we add the remark, that there is something altogether non-terrestrial in the existence of myriads of gigantic volcanic craters, without an atmosphere floating round the sphere containing them, or water existing at its surface; for all the active earthly volcanos pour out volumes of steam and other vapours and gases, which would soon re-clothe our globe with an atmosphere, if it were deprived of its present one.

It does not appear, then, that the telescope favours the idea that a telluric or terrestrial character is common to the members of the solar system. On the other hand, at the sun, the moon, and Jupiter, it brings into view phenomena, which, so far as we can observe them, are so marked and peculiar, as to imply a state of their surfaces quite unlike that of our planet. To the consideration of this we shall return more fully, when referring to the judgment of Biology on the Stars as Theatres of Life. Meanwhile, we proceed to inquire what decision Chemistry gives on the problem before us. It is to this part of the discussion that we are most anxious to direct the reader's attention, not because it is intrinsically more important than the points already gone over, but because of its comparative novelty, and the erroneous interpretation which has been put upon it.

It might seem, at first sight, as if chemistry could have nothing to say on the matter: yet for ages she has hankered after an alliance with astronomy, and has chronicled the fact in her nomenclature. The alchemist was an astro-chemist, and twin-brother to the astrologer. Gold was Sol; Silver, Luna; Iron, Mars; Lead, Saturn, &c.; and we still speak of lunar caustic, and of martial and saturnine preparations, when referring to certain of the medicinal compounds of silver, iron, and lead. One of the most important of the metals every day reminds us, by its name, Mercury, of the affinity which was once thought to connect it with its namesake, the planet. The astrologist, however, long ago became an astronomer, and the alchemist a chemist; and for a lengthened period they had no dealings together. It has been otherwise latterly. The extension of both sciences has led to their meeting again, and this in a somewhat singular way.

His own little Juan Fernandez island of an earth, was apparently the only spot in the universe of which the chemist could declare, "I am monarch of all I survey." Towards the far distant stars, however, he cast wistful eyes. They were almost all suns, the astronomer told him, which for ages had evolved light and heat, and spread it through space. Can chemistry, then, which for centuries has been explaining—always more and more successfully—the evolution of heat and light on this earth, give no information concerning their production at the sun? It seems that perhaps it may. When a ray of sunlight is passed through a prism, certain "fixed lines" or dark spaces are seen in the resulting spectrum, unlike those which the spectra of terrestrial flames exhibit. Sirius and Castor, as well as other stars, exhibit peculiar spectra also. "Now a very recent discovery of Sir D. Brewster," as Professor Graham observes, "has given to these observations an entirely chemical character. He has found that the white light of ordinary flames requires merely to be sent through a certain gaseous medium (nitrous acid vapour), to acquire more than a thousand dark lines in its spectrum. He is hence led to infer, that it is the presence of certain gases in the atmosphere of the sun which occasions the observed deficiencies in the solar spectrum. We may thus have it yet in our power to study the nature of the combustion which lights up the suns of other systems."

Such is one example of the way in which chemistry has sought to extend her dominion into space. Another is furnished by the conclusions which Wollaston drew as to the quality of the atmospheres of the Sun and of Jupiter, from the absence in them of power to refract light sensibly, as shown in the case of the Sun, during the transits of Venus, and in that of Jupiter when his moons are eclipsed by him. It has recently, however, been found possible to apply chemical analysis directly to certain of the heavenly bodies, so that, without extravagance, we can now declare that there is a Chemistry of the Stars as well as of the Earth.

The oft-quoted Oriental proverb, which teaches, that since the "mountain will not come to Mahomet, Mahomet must go to the mountain," has in this case, for once, been reversed; for when the chemist could find no way of travelling to the spheres, behold! certain bright particular stars have come to him and submitted to analysis. We refer to the aërolites, meteorites, or meteoric stones, which, according to the most generally adopted of many theories, at one time were thought to have been projected from volcanos in the moon. They are now almost universally acknowledged to have been true stars before they reached our earth. For a statement of the reasons which have led astronomers to this conclusion, we must refer our readers to Humboldt's "Cosmos," where the whole subject is discussed at great length. It may suffice to say, that many considerations justify the conclusion, that multitudes of asteroids, starlets, or as Sir John Herschel calls them, "meteor-planets," revolve in definite orbits round the sun, and some also as invisible, or momentarily visible, minute moons round the earth. The orbits of some of the former are believed to resemble that of the earth, but to be in a different plane, so that in the course of their revolutions round the sun, these tiny planets come, at certain periods, within the sphere of the earth's attraction, and are precipitated as meteoric stones upon its surface, as weary and forlorn birds of passage, far out at sea, are entangled in the rigging of vessels, and fall helpless on deck.

This modern theory of meteorites reads like a bald rendering of the poetical myth of the angels, whom earthly loves induced to forfeit for ever their places in the heavens, but it has invested the strange fallen stars, to which it refers, with a new interest. The largest of them is but a microscopic grain of the star-dust scattered over the sky, but it is none the less of celestial origin, and may be submitted to analysis.

The meteorites have accordingly been put upon the rack by the chemist, and all their secrets have been tortured out of them, but they have revealed fewer marvels than at one time was expected. No new chemical element or primary ingredient has been found in any of them. In other words, they contain no ultimate chemical component which the earth does not contain. This remarkable fact has seemed to many to justify the belief, that other worlds have been constructed out of the same materials as our own. It is thus, for example, turned to account by the author of the "Vestiges of the Natural History of Creation." After stating that the elements, or simplest chemical constituents of the globe, are those sixty or more substances which have hitherto resisted all attempts to reduce them to simpler forms of matter, he proceeds thus*: —

"Analogy would lead us to conclude that the modifications of the primordial matter forming our so-called elements, are as universal, or as liable to take place everywhere as are the laws of gravitation and centrifugal force. We must therefore presume that the gases, the metals, the earths, and other simple substances (besides whatever more of which we have no acquaintance), exist, or are liable to come into existence under proper conditions, as well in the Astral system, which is thirty-five thousand times more distant than Sirius, as within the bounds of our own solar system, or our own globe." — *Vestiges*, Fifth Edition, p. 30.

We leave unnoticed, till we proceed with our discussion, the assumption contained in the passage just quoted, that the earth, considered as an aggregate of chemical substances, is a type of the chemistry of the universe. It is thus justified by a reference to the meteoric stones: —

"What is exceedingly remarkable, and particularly worthy of notice as strengthening the argument that all the members of the solar system, and perhaps of other systems, have a similar constitution, no new elements are found in these bodies [meteorites]; *they contain the ordinary materials of the earth*, but associated in a manner altogether new, and unlike anything known in terrestrial mineralogy." — *Vestiges*, Fifth Edition, p. 42.

The clause of this sentence, which we have marked by italics, contrives, by an unwarrantable concealment, to convey a very false impression of the true nature of meteoric stones. They are said to "contain the ordinary materials of the earth," which no doubt they do; but it should have been added, that they contain only *some* of them; so far as we know, but the smaller part.

* The exact number of chemical elements, or simple bodies, is uncertain, as recent researches still incomplete have revealed the existence of several, whose chemical relations have not yet been fully ascertained. We use the integer 60 as sufficiently near the true number for our present purpose.

We have not on record a great number of analyses of meteoric stones, for they are comparatively rare; it would be premature, therefore, to decide that we know all their constituents. But so far as our knowledge extends, it does not appear that a third of our earthly elements has been found in these bodies. Humboldt, in his "Cosmos," quoting from Rammelsberg, the greatest living authority on the subject, enumerates only eighteen of the sixty elements as occurring in them. Professor Shepard counts nineteen as certain, and adds two more as doubtful. It is to be observed, on the other hand, that not only are the majority of the terrestrial elements, including many of the most important among them, totally wanting from meteoric stones, but those which are present are not mingled (as the quotation indeed acknowledges) in earthly proportions.

Our globe consists, speaking generally, of two opposite classes of ingredients,—namely, metals and non-metallic bodies, some of which, as oxygen in the one division, and the precious metals in the other, occur free, but the greater number in combination with some body or bodies of the unlike class. There are many more *kinds* of metals than of non-metallic substances, but the latter, taken as a whole, occur in much larger *quantities* than the former. One non-metallic body alone, oxygen, is computed to form a third of the weight of the crust of the earth. In meteoric stones, on the other hand, whilst non-metallic elements are the less numerous constituents (only a half of those occurring in the earth being found in them), they also occur in much smaller quantities than the metals. Of some of them, indeed, traces only are found.

Many of the best marked aërolites are masses of nearly pure metal, chiefly iron, with a small proportion of nickel. Others contain cobalt, manganese, chromium, copper, and other metals, diffused through them in minute quantities, associated with a small percentage of oxygen, sulphur, chlorine, &c. The stony meteorites consist chiefly of silica and metallic oxides.

Whilst thus, meteoric stones contain only a portion of the elements of the earth, that portion is made up (in the greater number of meteorites), so far as the relative quantities of its components are concerned, almost entirely of metals. A meteoric stone represents, therefore, only a third of the whole constituents of the earth so far as number is concerned, and except to a small extent, but one class of them so far as nature. A globe so constituted could never, by any process of development (unless its so-called elements suffered transmutation), become possessed of water, or an atmosphere, or give birth to terrestrial plants or animals.

It may make the matter clearer to those not minutely conversant with chemistry, who may suspect us of hypercriticism, if we illustrate the force of our argument thus. The conclusion in which we are asked to acquiesce is this strange one, that an aggregate of nineteen, or at the utmost twenty-one ingredients, is the same thing as an aggregate of sixty.* According to this view, a double flageolet of two tubes should be the same thing as a pan-pipe of seven, or an organ with scores of them; and a village fife and drum should be identical with a full military band, because the latter includes a fife and drum. It should thus make no difference whether one inherited an iceberg or a green island, Terra del Fuego or the gold district in California; for the iceberg possesses *to the extent of its possession* (namely, so much ice or solid water), what the fertile island contains, and Terra del Fuego is rich to the extent of its riches in the wealth of California.

Perhaps, however, we are dealing in a misleading exaggeration. The ingredients missing from the meteor-planets may be

* Twenty-one is the aggregate number of chemical elements found in meteoric stones, but no one meteorite contains so many. Some of the best known consist almost entirely of one ingredient. We state the case, therefore, in the way most disadvantageous for our argument when we speak of the meteoric elements as twenty-one in number.

properly enough marked by the minute analyst as absent, and yet be of no great consequence in reference to the suitableness of the latter to become theatres of life. The difference between the meteorite and the earth is perhaps only such as existed between Paganini's fiddle with one string, and Thalberg's piano with some hundred, from both of which instruments the same melody might sound. If such be the case, the author of the "Vestiges" could have no objection to allow us to place him within the receiver of an air-pump, and deprive him of only one of the sixty ingredients,—namely, oxygen—which is absent from many of the meteoric stones. Only twenty-one elements, it should seem, are needed, and we have been kinder to him than he is on paper to himself, for we have allowed him fifty-nine. Why does he pant so? and gasp for breath? Oxygen, it should seem, is no needless superfluity or choice luxury. The lung was not made to breathe without the breath of life being provided for it; and a meteoric stone, as our author before being let out of our receiver shall confess, would be as fatal as a vacuum to every terrestrial creature. Let it be further noticed that the missing elements of the meteoric stone are exactly those which are most abundant in plants and animals, and the worth of our author's reasoning will appear; but to this we shall return.

The chemical argument stripped of all exaggeration, stands thus. Several specimens of the bodies of space have been subjected to analysis,—namely, the earth, so far as its crust or accessible portion is concerned, and meteoric stones. The latter have not a common chemical composition, but are divisible into sections, each of which represents a separate example of planetary chemistry.* When the meteorites and the earth are compared, they are found to differ immensely, so far as the mode of arrangement, the relative quantities, the

* Prof. Shepard divides meteorites into two Classes—*Metallic*, and *Stony*; and each Class into three Orders, under which *thirteen* sections are included.

number and nature of their constituents are concerned. Here, then, are several unlike chemical specimens of the universe. To which among them are the other heavenly bodies to be compared? Analysis has succeeded in making one step beyond this earth, and has immediately brought to light a non-terrestrial chemistry. If it could stride on to sun, moon, and stars, what should it find? Different chemistries? or that of the earth or the meteoric stones endlessly repeated? Different chemistries, we think, and this for many reasons.

If the heavenly bodies were constructed of the terrestrial or the meteoric chemical elements, arranged in the way these are in the earth, or in the meteorites, the densities of the heavenly bodies should, within no very wide limits, be identical with the specific gravity of the earth, or of some one of the meteoric stones; but the opposite is the fact, for the Sun, Jupiter, Saturn, Uranus, and Neptune, have all a density much below that of our planet, or of any of the meteor-planets, as the following table, where the specific gravity of the earth is made unity, will show *: —

Earth, 1; Sun, 0·25; Jupiter, 0·24; Uranus, 0·17; Saturn, 0·14; Neptune, 0·23.

Apart altogether from this difference in density, it is manifest, that confining ourselves to purely chemical considerations, we could assign no satisfactory reason for preferring the earth to the meteoric stones, or the latter to the earth, as types of

* In the table in the text we have not given the sp. gr. of any of the meteorites, because their densities vary so much, that the mean of their specific gravities does not afford a datum of any value in reference to our argument. For the satisfaction, however, of the reader, we may mention that, according to Humboldt, "the specific weight of aërolites varies from 1·9 to 4·3. Their general density may be set down as 3, water being 1." Humboldt's maximum is certainly too low, for various of the American meteorites, examined by Prof. Shepard, have a density above 7; whilst, therefore, the earth is 5·6 times heavier than water, the densest of the meteorites are 7 times heavier, and the lightest within a tenth of being twice as heavy as water.

the chemical composition of one or all of the heavenly bodies; neither can we venture to affirm that we have exhausted in our globe and the meteor-planets the only existing examples of variation in composition which the universe presents, so that every star must be classed with the one or the other, inasmuch as they comprise all the diversities which occur in sidereal chemistry. On the other hand, it is not difficult to show that chemistry amply provides for every star having a different composition, and renders it exceedingly probable that different stars in this respect differ greatly.

In the first place, the chemical elements do not present that character of completeness and unity, considered as a great family, which we should expect in the raw material of a whole universe. When we subdivide them into groups, they arrange themselves unequally. Thus in several cases we find divisions of elements, such as chlorine, bromine, iodine; barium, strontium, calcium; niobium, pelopium, tantalum, in which the characteristic properties of each of the components of the group pass into those of its other members by the most delicate shadings. In other examples, again, although analogous properties are not wanting in related bodies, the particular substance (*ex. gr.*, nitrogen, or mercury) stands apart, isolated as it were, and exhibiting but remote affinities to its nearest neighbours. In all science, however, and strikingly in chemistry, isolation is the exception, and association the rule. In these cases of apparent isolation, it is possible that elements which would make up a group, and connect the solitary in friendly alliance with the families about it, may exist in other worlds, as animals supplying gaps in the zoological circles are found extinct in the strata of other eras than our own. Such hypothetically deficient elements no doubt may yet be found in our own globe, but for the present, we must adopt the rule, "de non apparentibus, et de non existentibus, eadem ratio." Or we may find all the so-called elements to be modifications of some simpler or simplest forms or form of matter, and be able to convert that into unknown substances of the same grade as our present elements, and so satisfy the supposed need of harmony. Even if we should, however, achieve this result, it would only alter the mode of stating the problem, which would then run thus,—What forms of the primary matter are likely to occur in different globes?

Secondly, it may be remarked that some of our terrestrial elements, such as the metals of the earths proper (except aluminum) and also selenium, tellurium, molybden, vanadium, tungsten, as well as others, are not known to be of service in our globe. It would be very rash to permit our ignorance to be the measure of a question like this. These bodies may have been, or may yet be, even if they are not at present, (which, however, is only an assumption,) of the utmost value in effecting necessary changes on the earth. Man, too, as his knowledge extends, may discover economical applications of the elements in question of the greatest importance. Withal, however, we may suppose that some, at least, of these substances may not have been specially destined to be of use on our globe, but may bear the same relation to it that rudimentary organs do to the bodies of the animals possessing them, so that they are of little or no service to the structure in which they occur, but are typical of much more highly developed instruments, or arrangements, in other organisms or spheres. These seemingly useless, and sparingly distributed bodies in our earth, may be the prevailing or most important constituents of other globes, and may perform functions there of which we have no conception. Other elements, such as arsenic, yield compounds so deadly to vegetable and animal life, and so apparently unserviceable in the mineral kingdom, that one is almost driven to believe that it was not primarily for us, but for some other beings in a different world, such bodies were provided. At least, we suppose there are few who will consider the slight service which arsenical preparations have rendered to medicine, or their efficacy in poisoning rats and flies, and the fact of their furnishing certain pigments, as an equivalent for the multitude of human beings whom they have consigned to untimely graves, and the many crimes to which they have furnished temptations.

Thirdly, nature has been very niggard to us of certain of the elements, for example, of one peculiar and very valuable class, the noble or precious metals, gold, platina, palladium, rhodium, &c. We do not refer to the scarcity of these as limiting our luxury, or count them precious in the sense of being costly. Gold and platina, to mention no others, have the desirable properties of never wasting, rusting, or corroding, and platina will not melt in the heat of a blast-furnace. Were these or the allied metals more abundant, our eating, drinking, and cooking vessels would be made of one or other of them. Our steam-boilers, railroads, furnace-bars, lamp-posts, and the like, would be constructed of platina, rhodium, or palladium, and our lighter and more elegant instruments and utensils of gold, which would be too cheap to tempt thieves to steal. One may suppose that other worlds may have been more richly favoured than we are with supplies of these or other goodly bodies, which find so limited scope for exhibiting their manifold virtues here. Can platina, *ex. gr.*, considered as a veritable, simple substance, be supposed to have been created solely to supply the terrestrial chemist with tests and crucibles? The chemist will probably think that a very satisfactory final cause for its creation, and we will not cry nay to it. But what if there be worlds where this metal is so abundant that they are sick of the sight of it, and would be glad to see a piece of rusty old iron, where the thieves steal the costly magnesia, and the royal crowns are made of the precious metal, lead? To speak more soberly, is it very unlikely that so marked and striking a metal as platina, as well as its congeners, may occur more abundantly in other worlds framed on a different ideal from ours? We have no wish, however, to try our hand at improving God's fair and beautiful world.

To sum up the matter, we observe, without insisting on more, that we have no ground for assuming that we see on this earth all the kinds of elementary, or quasi-elementary matter which can exist. Still less are we justified in affirming that we have manifested on this globe the only modes of arrangement or of distribution, so far as relative quantity is concerned, of which our elements are susceptible. The very opposite is likely to be the case. The fact of their being *many* chemical elements awakens the suspicion that they were intended to be arranged in *many* ways. Had our globe been a ball of iron, or of lead, we should have had nothing to suspect in space but iron or lead. But when there are more than sixty earthly constituents, arranged, too, in a quite arbitrary way, we cannot resist the expectation that they will be found apportioned among the celestial spheres, not in that one way, but in various ways: here a few, there many together; in one globe, bodies of one class; in another, of another; in no one, perhaps, exactly the arrangement that prevails in any of the rest. Our globe may be called a mosaic of some sixty pieces, but it has not pleased the Great Artist to make equal use of each of the sixty. Not more than a half of them can be detected except by minute inspection, and the predominating tints are only some six or seven. Other stars may be mosaics constructed out of more or fewer of the same pieces, but they are, in all probability, put together according to different patterns. Let it not be forgotten that the omission of a single element would make a great difference. A globe in all other respects identical with ours would be utterly unfitted for being the theatre of life such as we see, if it wanted, as we have already noticed, but the one body oxygen, or hydrogen, or nitrogen, or carbon. The addition in considerable quantity of a single new potent element would equally derange the economy of a world. The arrangement in a different way, without addition or abstraction, of existing elements would be as efficacious a cause of disturbance. If, for example, the nitrogen and oxygen of our atmosphere were suddenly to combine (and every thunderstorm occasions combination), we might be maddened by laughing-gas, or drowned in an ocean of nitric acid. The shades of variation in such a case would become shadows of most portentous depth and darkness.

If any one, indeed, will consider how many tunes can be made with the seven primary notes of music; how many numbers can be combined out of the ten numerals; how many words out of the twenty-four letters of the alphabet, he may conceive how enormously great is the number of worlds, each quite distinct, which could be constructed out of the sixty elements. In the first place, there is a means of variety in the *number* of the simple bodies. One globe, like our earth, contains them all. Others, like the meteoric stones, may contain only some of them. Secondly, the *relative quantities* of the elements may vary. On one globe, the abounding element may be oxygen, as in our earth; in another, platina. A third cause of variety will be the *condition* of the elements. With us, hundreds of tons of chlorine are locked up in mountains of rock salt. In other worlds, that gas may be free, and form an atmosphere like our air.

Add these modes of varying composition together, and employ them all, and where will the variety stop? Millions of millions of worlds would not exhaust it. To what extent this susceptibility of variation has been taken advantage of by the Architect of the Heavens we cannot tell; but to suppose that it has been turned to no account seems a conception meagre beyond endurance. If we but knew the use to which the spheres are put, we might possibly hazard a conjecture concerning their composition, but of that we are altogether ignorant. Yet to suppose that the Infinite One has exhausted the counsels of his wisdom in arranging the chemistry of our globe, and could only therefore repeat that endlessly through space, or to affirm that such a monotonous arrangement of the great world or universe is in keeping with the endless diversity visible in the little one which we inhabit, is a view of things that may not be entertained for a moment.

We close this long chemical discussion with one remark. Speculation set aside, the testimony of chemistry in reference to the heavenly bodies is neither more nor less than this, that every one of them which has been submitted to analysis, differs in composition from all the rest. Absolute chemical identity of any two or more has never been observed, whilst the extremes of difference between those least like each other, if denoted on a scale, would be 60 and 1; the maximum of this scale being the earth with its sixty ingredients, the minimum, those well known meteorites, which are little else than lumps of malleable iron. The importance of this fact has been overlooked, because, beginning with the earth, we have found the meteor-planets composed of fewer ingredients than it, and these all terrestrial.

Assuredly it would have been a more remarkable circumstance, if the meteoric elements had all been novel, and possessed of striking and unfamiliar properties; and something like disappointment has been felt because they are not. But we must not on this account disregard the fact that the meteorites are non-telluric in their chemical characters. They are so, as much by the terrestrial elements they want, as they would have been by the novel elements they might have possessed. Had a single non-terrestrial element been found in a meteoric stone, our philosophers would have been lost in wonder. Yet within the last ten years, six or seven new elements, namely, Didymium, Lanthanum, Niobium, Pelopium, Tantalum, Erbium, Terbium, have been discovered in our own planet, and none but professed chemists have paid any attention to the fact, nor has the discovery perceptibly altered any of our scientific beliefs. Had but one of those obscure metals been found in a meteorite, and in it alone, speculations would have abounded on its nature and uses. Nevertheless, the addition of six or seven such metals to our globe, by the tacit confession of all science, is of infinitely less importance to the earth, than the loss of one such element as oxygen, hydrogen, nitrogen, or carbon would be. To find, therefore, one of the latter absent, is truly a more interesting fact in relation to terrestrial chemistry, than it would be to find *all* of the recently discovered metals, or as many more similar elements, present. The most richly endowed of the meteoric stones, moreover, contain not a majority, but less than a fourth of the terrestrial elements, and of many of the most characteristically terrestrial elements, only traces. As soon as this fact is distinctly perceived, men will cease to complain that there are no new meteoric elements, and none will refuse to acknowledge that so far as analysis has proceeded, terrestrial and sidereal chemistry are quite different.

It remains now only to consider what the judgment of physiology or biology is likely to be concerning the manifestation of life in the heavenly bodies. It has to a considerable extent been anticipated or implied, in what has been stated already.

Life, as it exists on this globe, is compatible only with certain conditions, which may not be overstepped without causing its annihilation. The whole of these need not be enumerated, as the failure of one is as fatal to existence, as the absence of all. The three to which Sir John Herschel has referred, namely, difference in the quantity of heat and light reaching each globe; variation in the intensity of gravity at its surface; and in the quality of its component materials, may suffice to illustrate this. Light and heat are essential to the development and maintenance of earthly life, but their excess is as destructive to it as their deficiency. What, then, shall we say of the sun, whose heat we know by direct trial to be of such intensity, that after great degradation or reduction, it can still melt the most infusible minerals, and dissipate every metal in vapour; and whose light is so intolerably brilliant, "that the most vivid flames disappear, and the most intensely ignited solids appear only as black spots on the disc of the sun, when held between it and the eye?" If the temperature of the solid sphere or body of the sun be such as those phenomena imply, it must be the abode, if inhabited at all, of beings such as Sir Thomas Browne refers to, who can "lie immortal in the arms of fire." It is within possibility, however, that the body of the sun, is black as midnight and cold as death, so that as the eye sees all things but itself, he illuminates every sphere but his own, and is light to other stars, but darkness to his own gaze. Or the light and heat of his blazing envelope may be so tempered by the reflective clouds of his atmosphere, which throw them off into space, that an endless summer, a nightless summer-day, reigns on his globe. Such an unbroken summer, however, though pleasant to dream of, would be no boon to terrestrial creatures, to whom night is as essential as day, and darkness and rest as light and action. The probabilities are all in favour of the temperature of the sun's solid sphere being very high, nor will any reasonable hypothesis justify the belief that the economy of his system in relation to the distribution of light and heat can resemble ours.

We can assert this still more distinctly of the planets. We should be blinded with the glare and burnt up if transported to Mercury, where the sun acts as if seven times hotter than on this earth; and we should shiver in the dark, and be frozen to death if removed to Uranus, where the sun is three hundred times colder than he is felt to be by us. To pass from Uranus to Mercury, would be to undergo in the latter exposure to a temperature some two thousand times higher than we had experienced in the former, whilst on this earth the range of existence lies within some two hundred degrees of the Fahrenheit thermometer.

As for our satellite, Sir John Herschel says of it, "The climate of the moon must be very extraordinary: the alternation being that of unmitigated and burning sunshine, fiercer than an equatorial noon, continued for a whole fortnight, and the keenest severity of frost, far exceeding that of our polar winters, for an equal time." It would seem, then, that though all else were equal, the variations in amount of light and heat, would alone necessitate the manifestation of a non-terrestrial life upon the sun, and the spheres which accompany the earth in its revolutions around it. All else, however, is not equal. The intensity of gravity at the surfaces of the different heavenly bodies differs enormously. At the sun it is nearly twenty-eight times greater than at the earth. "The efficacy of muscular power to overcome weight is therefore proportionably nearly twenty-eight times less on the sun than on the earth. An ordinary man, for example, would not only be unable to sustain his own weight on the sun, but would literally be crushed to atoms under the load." "Again, the intensity of gravity, or its efficacy in counteracting muscular power, and repressing animal activity on Jupiter, is nearly two and a half times that on the earth, on Mars is not more than one-half, on the moon one-sixth, and on the smaller planets probably not more than one-twentieth; giving a scale of which the extremes are in the proportion of sixty to one."

From this account it appears that we should be literally mercurial in Mercury, saturnine in Saturn, and anything but jovial in Jupiter, where we should be two and a half times heavier and duller than here. On the smaller planets we should feel like swimmers in the Dead Sea, or as if in a bath of quicksilver, where to sink is impossible. "A man placed on one of them would spring with ease sixty feet high, and sustain no greater shock in his descent than he does on the earth from leaping a yard. On such planets giants might exist, and those enormous animals which on earth require the buoyant power of water to counteract their weight, might there be denizens of the land." If the fixed stars be suns, of what ponderous adamant must the beings be fashioned which exist on their surfaces! Were it possible for us, clothed in some frigorific asbestos garment, to endure unscathed the flames of Sirius, it would only be to be crushed to powder against his enormous globe. Here, then, is a second point of diversity, of itself sufficient to forbid the development of the earth-life we see here on almost any other of the heavenly bodies.

And we do not require to enlarge upon the third point of diversity—variation in the chemical composition of the spheres. The absence of an atmosphere from the moon, and the peculiar characters of that of Jupiter and of the sun, have already been referred to as forbidding the appearance of terrestrial life under their skies. The impossibility of its manifestation on meteor-planets such as have reached our earth has also been sufficiently dwelt upon.

In the face of the immense diversity which has thus been shown to prevail through space, it should seem impossible to hold the belief that the stars are all but so many Earths. The author of the "Vestiges," however, in his blind zeal for the nebular hypothesis of a common physical origin of all worlds, and solicitous to save God the trouble of taking care of his own universe, thinks otherwise.

"We *see*," says he, speaking as if the nebular hypothesis were an established fact, "that matter has originally been diffused in one mass, of which the spheres are portions. Consequently, *inorganic matter must be presumed to be everywhere the same*, although probably with differences in the proportions of ingredients in different globes, and also some difference of conditions. Out of a certain number of the elements of inorganic matter are composed the elements of organic bodies, both vegetable and animal, *such must be the rule* in Jupiter and in Sirius as it is here. We are, therefore, *all but certain* that herbaceous and ligneous fibre, that flesh and blood, are the constituents of the organic beings of all those spheres which are as yet seats of life." (p. 171.)

He proceeds a little further on to say, "Where there is light, there will be eyes; and these, in other spheres, will be the same in all respects as the eyes of tellurian animals, with only such differences as may be necessary to accord with minor peculiarities of condition and of situation. It is," he adds, "but a small stretch of the argument to suppose that one conspicuous organ of a large portion of our animal kingdom being thus universal, a parity in all the other organs,—species for species, class for class, kingdom for kingdom,—is highly likely, and that thus the inhabitants of all the other globes of space have not only a general but a particular resemblance to those of our own." (p. 172.) How baseless this reasoning is, with its "small stretch" at the close, we need not stop to demonstrate anew, but a few words may be added, in reference to the concluding argument concerning the relation of eyes to light.

It is a hasty and unwarrantable conclusion that every illuminated globe must contain living eyes. On our own earth there are many animals without organs of vision; so that we cannot conclude that eyes are a necessary reaction of light and life upon each other. Worlds may be supplied with light for other reasons than to endow their inhabitants with the faculty of sight. Our sun is a centre of many influences. We know at least three which may be separated from each other—light, heat, and what has been called actinic or chemical force; but probably electricity and magnetism also emanate from his orb. Terrestrial plants and animals are powerfully affected by most, probably by all of those; but the inhabitants of other spheres may not have organs enabling them to take advantage of more than some, perhaps only of one of the forces in question. On the other hand, the sun may be the source of agencies of which we know nothing, which are about us and yet do not affect us, because we have no channels or senses by which they can find access to us. The dwellers in other planets may have organs of which we have no conception, enabling them to enjoy these either as substitutes for the influences which affect us, or in addition to them.

Our sun, it is true, sends light to his several planets and their moons, but that they all make the same use of it is in no degree probable. They may, some of them at least, be "old in rayless blindness," yet not like Schiller's Proserpine, "aching for the gold-bright light in vain." They may have "knowledge at one entrance quite shut out;" but so likely enough have we, and at more entrances, perhaps, than one. The sun may impartially distribute the same gifts, though in unequal quantities, to his family; but it depends on each member of the circle what improvement is made of them. Mercury, who receives Benjamin's portion, may well be expected to show a different result from the newly-discovered, scantily-endowed Neptune, who has so long and so mysteriously tempted Uranus from his course. We would liken the different planets and satellites of our system to so many pieces of stained glass in a cathedral window; on every one, the same seven-tinted light falls, but the chemical composition, and molecular arrangement of each transparent sheet determines whether it turns to account the whole seven and gleams white, or profits only by certain of them, and shows, in consequence, green or red, blue, purple, or yellow. If some tiny fly, whose dominion was limited to the inside of a single pane, should suppose that, as its kingdom was bathed in unchanging red, every other sheet of glass must be "vermeil tinctured" also, because it knew that on every one the same light fell, it would greatly err, as we are wise enough to know. But we who are "crushed before the moth," probably err as widely, if we affirm that each of the planets is a mirror reflecting the sun in the same way. He is probably like a fountain, sending forth a river charged with many dissimilar substances, and each of the planets resembles a filter, separating from the stream what its construction enables it to retain, and what was intended and is fitted to be appropriated by it.

Even, however, if we should concede to our author that wherever there is light there will be eyes, surely a few more data are necessary, before a whole animal can be assumed. Can we infer that lungs or other breathing-organs exist, unless we make it probable that there is an atmosphere to breathe? Can we take for granted wings of birds or of insects, unless we show that there is air to fan? or, may we count on the "hearing ear" before we establish that there is a gaseous or aqueous medium to transmit the undulations of sound? If there be no water, will there be paddles of whales or of turtles, or fins of fishes? If no carbon, will there be leaf or stem of flower or tree? If no lime, bone or skeleton of any animal? The existence of all these organs cannot be assumed merely because there is light. But, in truth, as little can organs of vision. For if there be no water, there can be no blood; and if no blood, then not even eyes, at least earthly eyes, however constant and brilliant the light may be.

The unequivocal testimony, then, of physical science, as it seems to us, is against the doctrine that life, as it appears on the stars, must be terrestrial in its nature, though we are far from wishing to affirm that planets closely resembling the earth may not occur in space. It is enough for our argument to show that there are myriads of stars, which, for the reasons already given, are altogether non-terrestrial in their characters.

It remains, then, to inquire, whether we are to come to the conclusion, that the stars are uninhabited, inasmuch as terrestrial life is the only possible one, or to believe that there exists a diversified astral life which is manifested on them. Abstaining from anything like an attempt to define positively the probable characteristics of the latter, if it exists, we may say this much on the matter. There are fewer characters of universality in terrestrial life than in terrestrial chemistry. There is a plant-life and an animal-life, which are quite separable, and may exist apart, and there are different kinds of each. To mention but one example: the egg of the butterfly has one life, and the caterpillar which springs from it has another; and the chrysalis into which the caterpillar changes has a third, and the butterfly which rises from the chrysalis has a fourth; and so there may be worlds which know only a germinal, or a caterpillar, a chrysalis, or a butterfly life.

Further, in this world we see plants and the lowest animals possessing only the sense of touch, if the former can be said to be endowed even with that. Gradually as we ascend in the animal scale, additional senses are manifested, till four more appear in the highest animals. But who shall tell us that these five are the only possible, or even the only existing channels of communication with the outer world? We might, besides the general argument from analogy against such a conception, refer to those agencies influencing living beings, which have been recognised for centuries as implying some supersensuous relation to external nature. It would be unwise to allow the extravagances of animal magnetism to prevent us from recognising the indications which several of its phenomena afford, of perceptions of outward things not easily referable to the operation of any of the known senses. Nevertheless, that so-called, and as yet questionable science, has, for a season at least, fallen into the hands of those with whom the gratification of wonder is a much greater object than the discovery of truth, and we fear to build much upon it. We can find, in another and quite unexceptionable quarter, a substantial foundation on which to assert the probability of life being manifested very differently in other spheres than it is in our own globe. We refer to the assurance which the New Testament gives us, that our human spirits are destined to occupy bodies altogether unlike our present ones.

From the remarkable way in which the Apostle Paul likens the "natural body" to a seed which is to be sown, and grow up a "spiritual body," one is led to believe that the immortal future tabernacle is to bear the same relation of difference, and yet of derivation to the present mortal one which a tree does to a seed. The one will be as unlike the other as the oak is unlike the acorn, though but in a sense the expansion of it.

Whether this be the doctrine or not which the Apostle teaches, it is at least certain, that he announces that a great and inconceivable alteration is to come over our bodies. Doubtless, our spirits are to be changed also, but more, as it seems, in the way of intensification of faculties, desires, passions, and affections—on the one hand, good, on the other, evil—which have been exercised or experienced, in their fainter manifestations, in the present state of existence, than by the introduction of positively new elements into our intellectual and moral being. We do not urge this point; it is enough if it be acknowledged to be a Scripture doctrine, that human spirits, reminiscent of their past history, and conscious of their identity, are, however otherwise changed, to occupy bodies totally unlike our present ones. If, however, it be supposed that the "spiritual" occupants of our future tabernacles are to differ totally from us, it only adds to the force of the argument, as it implies the greater diversity as to the manner in which being may manifest itself. It is part, then, of the scheme of God's universe, that spirits clothed in non-earthly bodies shall dwell in it. It is idle, therefore, to say that terrestrial life is certainly the probable sidereal one, since it is not the only existing, or at least the only contemplated mode of being. In looking at the stars as habitations of living creatures, we have at least two unlike examples of the way in which mind and matter admit of association to choose from, as patterns of what astral life may be. But the further lesson is surely taught us, that there may exist other manifestations of life than only these two. For the spell of simplicity once broken by a single variation, we know not how many more to expect, whilst the conclusion is not to be resisted, that other variations there will be. The same Apostle who dwells on the resurrection, tells us, in reference to the happy dead, that eye "hath not seen, nor ear heard, neither have entered into the heart of man, the things which God hath prepared for them that love him." They are not only, therefore, to have bodily organs different from ours, but these are to be gratified by sights which our eyes have not witnessed, by sounds to which our ears have never listened, and by a perception of phenomena inconceivable by us. There are here indicated the two great elements of variety to which we have already referred; a theatre of existence totally unlike the present one, and organs of relation to it different from those of terrestrial beings.

The argument might be greatly extended, but we cannot attempt here an exhaustive discussion of the subject. The sum of the whole inquiry is this:—Astronomy declares that there are unlike theatres of existence in the heavens,—suns, moons, and planets; Chemistry demonstrates that different kinds of construction, that of the earth, and those of the meteoric stones, prevail through space; Physiology contemplates the possibility of a non-terrestrial life unfolding itself in the stars; and the Bible reveals to us, that there is an immortal heavenly, as well as a mortal earthly life.

The consideration of all this leaves no place for the thought, that the tide of life which ebbs and flows through the universe is but the undulation of so many streamlets identical with that which bathes the shores of our globe. In our Father's house are many mansions, and the Great Shepherd watches over countless flocks, and has other sheep which are not of this fold.

THE END.

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New-street-Square.

LECTURES AND ADDRESSES

IN AID OF

POPULAR EDUCATION;

INCLUDING

A LECTURE ON THE POETRY OF POPE.

BY

THE RIGHT HONOURABLE

THE EARL OF CARLISLE.

LONDON:

LONGMAN, BROWN, GREEN, AND LONGMANS.

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ADVERTISEMENT.

THIS collection of LECTURES and ADDRESSES, delivered by the Earl of Carlisle before Mechanics' Institutions and other Societies of a like nature, is published, with his Lordship's permission, by the Committee of the "Yorkshire Union of Mechanics' Institutes."

In Yorkshire, this valuable class of institutions has flourished more than in any other part of the kingdom, owing, in a considerable measure, to the existence of a "Union" which now comprises 120 Institutes, containing about 20,000 members. Of that "Union," and of many of the individual Institutes, the Earl of Carlisle has been one of the earliest, most constant, and most generous friends; he gave them his high sanction and active assistance whilst Member for the West Riding, and did not withdraw it after his removal from the Lower to the Upper House of Parliament.

The LECTURES on "The Poetry of Pope" and on his Lordship's "Travels in America" were spontaneously offered by the Noble Earl to the Mechanics' Institution and Literary Society of Leeds, as the central Institution of Yorkshire, and were delivered to crowded and admiring audiences. The manuscript being presented to the Committee of the "Yorkshire Union," they were published in a cheap form, and many thousand copies were circulated among the Institutes of that and the neighbouring counties. They have also been published in various and large impressions in the United States.

The ADDRESSES now collected were delivered, in the order of their appearance, before several Institutions, including, besides Mechanics' Institutes, the Huddersfield College, the Manchester and Sheffield Athenæums, and the associated Sunday Schools of Halifax. They are reprinted from the newspaper reports, taken at the time; but the Noble Author has kindly taken the trouble of correcting them.

In their collected form, these Lectures and Addresses exhibit the zealous efforts of a public man, high in rank and in office, for the intellectual entertainment and moral improvement of the humbler classes of his fellow countrymen. Whilst they inform and delight the reader, may they exercise a yet higher influence; may the example of Lord Carlisle induce many men of eminent station and attainments to lend their aid to the multitudes who are seeking the means of self-improvement; and thus may the different classes of society be bound together in mutual good will, and the whole mass be leavened with knowledge, virtue, and religion!

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LECTURE I.

ON THE POETRY OF POPE.

I HAVE undertaken to read a paper on "The Poetry of Pope." My hearers, however, will be sorely disappointed, and my own purpose will have been singularly misconstrued, if any expectation should exist that I am about to bring any fresh matter or information to the subject with which I am about to deal. Such means of illustration, I trust, may be amply supplied by Mr. Croker, who has announced a new edition of Pope,—a task for which both his ability and his long habits of research appear well to qualify him. As little is it within either my purpose or my power to present you with any novelty of view, or originality of theory, either upon poetry in general, or the poetry of Pope in particular. The task that I have ventured, perhaps rashly, to impose upon myself, has a much more simple, and, I am willing to hope, less personal aim.

It is briefly this. It has seemed to me for a very long time,—I should say from about the period of my own early youth,—that the character and reputation of Pope, as a poet, had sunk, in general cotemporary estimation, considerably below their previous, and their proper level. I felt ruffled at this, as an injustice to an author whom my childhood had been taught to admire, and whom the verdict of my maturer reason approved. I lamented this, because I thought that the extent of this depreciation on the one side, and of the preferences which it necessarily produced on the other, must have a tendency to mislead the public taste, and to misdirect the powers of our rising minstrels.

I allow myself the satisfaction of thinking, that there are already manifest some symptoms of that re-action, which, whenever real merit or essential truth is concerned, will always ensue upon unmerited depression. I remember that it gave me quite a refreshing sensation to find, during my travels in the United States of America, that among some of the most literary and cultivated portions of that great community, (although I would not more implicitly trust to young America than I would to young England upon this point), the reverence for Pope still partook largely of the sounder original faith of the parent land. I fear, however, that there is still enough of heresy extant among us, to justify one who considers himself a true worshipper, who almost bows to the claim of this form of Popish infallibility, in making such efforts as may be within his power to win back any doubtful or hesitating votary to the abandoned shrine.

The attitude, then, in which I appear before you on the present occasion, is this. I look on myself as a counsel, self-constituted it is true, but for whose sincerity the absence of any fee may be considered as a sufficient guarantee; and here, then, in the short space which can be allowed by this Court for the business of the defence, I consider myself bound to put before you such pleas as I may think best calculated to get a verdict from you on my side of the case.

The best plan, which, as it appears to me, I can adopt for disarming any reasonable suspicion on the part of my jurors, (all, I feel sure, candid and enlightened men), as well as for doing justice to my own character as a critic, is to state frankly what I do not claim for my client, the late Alexander Pope. I do not, then, pretend to place him on the very highest pedestal of poetry, among the few foremost of the tuneful monarchs and lawgivers of mankind. Confining ourselves to our own country, I do not, of course, ask you to put him on a level with the universal, undisputed, unassailable, supremacy of Shakspeare — nor with Milton, of whom Mr. Macaulay has lately thus beautifully spoken: —

"A mightier spirit, unsubdued by pain, danger, poverty, obloquy, and blindness, meditated, undisturbed by the obscene tumult which raged all around, a song so sublime and so holy, that it could not have misbecome the lips of those ethereal beings whom he saw, with that inner eye which no calamity could darken, flinging down on the jasper pavement their crowns of amaranth and gold."

I fancy that some might wish to make a further reserve for the gentle fancy of Spenser, though the obsolete character of much of his phraseology, and the tediousness inseparable from all forms of sustained allegory, must, I apprehend, in these days, very considerably contract the number of his readers. Nay, I can quite allow for the preference being given to Pope's more immediate predecessor, Dryden, whose compositions, though certainly less finished and complete, undoubtedly exhibit a more nervous vein of argumentative power, and a greater variety of musical rhythm. When I have mentioned these august names, I have mentioned all, writing in the English tongue, who, in my humble apprehension, can possibly be classed before Pope.

I may observe, that in this estimate I appear to be confirmed by the present Commissioners of Fine Arts, who, in selecting the Poets from whose works subjects for six vacant spaces in the new Palace of Westminster were to be executed by living artists, named Chaucer, (who by his antiquity as well as his merits was properly appointed to lead the line of English bards), Shakspeare, Spenser, Milton, Dryden, and Pope.

Though I conceive, and you will readily concur, that the case I am endeavouring to make good must be mainly established by my client's own precise words, — and the anticipated pleasure of quoting them to attentive ears has been, perhaps, my chief inducement to undertake the office which I am now fulfilling, — yet I consider it will not be out of place for the object I have in view, especially before an audience of a nation which much delights in, and is indeed much ruled by, precedent, if I should quote a few approved authorities, (had time permitted I might have availed myself of a great number), merely for the purpose of showing that if you should be pleased to side with me in this issue, we shall find ourselves in company of which we shall have no need to be ashamed.

I shall also thus furnish a proof of what I have stated above, that I am not straining after originality or novelty of remark; indeed, I feel that I shall make way in proportion as the testimony I adduce proceeds from lips more trustworthy than my own.

What says Savage, a poet himself of irregular but no mean genius? He thus speaks of Pope: —

> "Though gay as mirth, as curious thought sedate,
> As elegance polite, as power elate,

Profound as reason, and as justice clear,
Soft as persuasion, yet as truth severe,
As bounty copious, as persuasion sweet,
Like nature various, and like art complete:
So fine her morals, so sublime her views,
His life is almost equalled by his muse."

Part of this commendation, I must admit, appears even to me overstrained. Some of Pope's compositions are marred by occasional coarseness and indelicacy, and his mind and character, I fear it must be allowed, were at times disfigured by envy, resentment, and littleness. Compared, however, with most of his predecessors of the reign of Charles II., and with many of his own cotemporaries, both his muse and his life may have been deemed decent and severe. He seems himself, at all events, to have indulged in this estimate of the tenor of his own productions: —

"Curst be the verse, how well soe'er it flow,
That tends to make one honest man my foe,
Give virtue scandal, innocence a fear,
Or from the soft-eyed virgin steal a tear."

I return to my authorities.

I do not quote Bishop Warburton, as he was the avowed apologist, as well as executor and editor, of Pope.

Dr. Joseph Warton, who wrote an essay on the genius and writings of Pope, chiefly with a view of proving what I have admitted above, that he ought not to be ranked in the highest class of poets, and who appears to wish, as I certainly do not, to have a hit at him whenever he can, concedes, however, thus much to him: —

"In the species of poetry wherein Pope excelled, he is superior to all mankind, and I only say that this species of poetry is not the most excellent one of the art. He is the great poet of reason, the first of ethical authors in verse."

Dr. Johnson, in his well-known and most agreeable "Life of Pope," says thus: —

"Of his intellectual character, the constituent and fundamental principle was good sense;" and then, "Pope had likewise genius, a mind active, ambitious, and adventurous, always investigating, always aspiring, in its widest searches longing to go forward, in its highest flights still wishing to be higher."

And at the close of the masterly contrast which he draws between Dryden and Pope, he thus sums it up: —

"If the flights of Dryden are higher, Pope continues longer on the wing; if of Dryden's fire the blaze is brighter, of Pope is the heat more regular and constant. Dryden often surpasses expectation, and Pope never falls below it; Dryden is read with frequent astonishment, and Pope with perpetual delight."

Mason, also a poet and very accomplished man, who had done so much in editing and illustrating the works of another most eminent and admirable master of his art (I refer to Gray), has shown what an exalted estimate he had formed of Pope, in the passage where he reproaches him for the undue praise which he had lavished on the famous Henry St. John, Viscount Bolingbroke: —

"Call we the shade of Pope from that blest bower,
Where throned he sits with many a tuneful sage;
Ask, if he ne'er repents that luckless hour,
When St. John's name illumined glory's page.

Ask, if the wretch who dared his honour stain,
Ask, if his country's, his religion's foe,
Deserved the wreath that Marlboro' failed to gain,
The deathless meed, he only could bestow?"

George, Lord Lyttelton, another poet himself, calls him "The sweetest and most elegant of English poets, the severest chastiser of vice, and the most persuasive teacher of wisdom."

How speaks Campbell, the author of "The Pleasures of Hope," and "The Battle of the Baltic"? If any one is entitled to speak of what true poetry is, that right will not be denied to Thomas Campbell. He calls Pope "a genuine poet," and says with true discrimination: —

"The public ear was long fatigued with repetitions of his manner; but if we place ourselves in the situation of those to whom his brilliancy, succinctness, and animation were wholly new, we cannot wonder at their being captivated to the fondest admiration."

I will only further cite from the poets whom many of us remember in our own day, one still more illustrious name. The fervid, wayward, irregular, muse of Lord Byron, presented the strongest points of contrast with the measured, even, highly-trained, smoothly-polished, temperament of Pope. What did Lord Byron think of Pope? He terms him, "The most perfect and harmonious of poets — he, who, having no fault, has had reason made his reproach. It is this very harmony which has raised the vulgar and atrocious cant against him — (Lord Byron was fond of using strong language): — because his versification is perfect, it is assumed that it is his only perfection; because his truths are so clear, it is asserted that he has no invention; and because he is always intelligible, it is taken for granted that he has no genius. I have loved and honoured the fame and name of that illustrious and unrivalled man, far more than my own paltry renown, and the trashy jingle of that crowd of schools and upstarts who pretend to rival or even surpass him. Sooner than a single leaf should be torn from his laurel, it were better that all which these men, and that I, as one of their set, have ever written, should line trunks."

There is another and more general testimony to the reputation, at least, if not to the actual merits of Pope, which may be here mentioned; this is, the extent to which his lines are quoted as familiar maxims and illustrations of the daily incidents of life, and the common meanings of men, — quoted often, probably, by persons who have little knowledge or recollection where the words are to be found. I am inclined to believe that, in this respect, — and it is one not to be considered slightingly, — he would be found to occupy the second place, next, of course, to the universal Shakspeare himself. Allow me to cite a few instances.

When there has been a pleasant party of people, either in a convivial or intellectual view — I wish we might think it of our meeting this evening — we say that it has been —

> "The feast of reason, and the flow of soul."

How often are we warned — I have sometimes even heard the warning addressed to Mechanics' Institutes, that —

> "A little learning is a dangerous thing."

How often reminded,

> "An honest man's the noblest work of God."

Or, with nearly the same meaning,

> "Who taught the useful science, to be good."

There is a couplet which I ought to carry in my own recollection—

> "What can ennoble sots, or slaves, or cowards?
> Alas! not all the blood of all the Howards."

It is an apt illustration of the office of hospitality,

> "Welcome the coming, speed the going guest."

How familiar is the instruction,

> "To look, through Nature, up to Nature's God."

As rules with reference to composition,—

> "The last and greatest art—the art to blot."
> "To snatch a grace beyond the reach of art;"

And then as to the best mode of conveying the instruction,—

> "Men must be taught as if you taught them not."

There is the celebrated definition of wit,—

> "True wit is nature to advantage dressed;
> What oft was thought, but ne'er so well expressed."

Do you want to illustrate the importance of early education? You observe—

> "Just as the twig is bent, the tree's inclined."

Do you wish to characterise ambition somewhat favourably? You call it,

> "The glorious fault of angels and of gods."

Or describing a great conqueror,—

> "A mighty hunter, and his prey was man."

Do you seek the safest rule for architecture or gardening?

> "Consult the genius of the place in all;"

Or, with exquisite good sense,

> "'Tis use alone that sanctifies expense,
> And splendour borrows all her rays from sense."

Are you tempted to say any thing rather severe to your wife or daughter, when she insists on a party of pleasure, or an expensive dress? You tell her,

> "That every woman is at heart a rake."

And then if you wish to excuse your own submission, you plead —

> "If to her share some female errors fall,
> Look on her face, and you'll forget them all."

How often are we inclined to echo the truth —

> "That fools rush in where angels fear to tread."

And this too, —

> "That gentle dulness often loves a joke."

Who has not felt this to be true?—

> "Hope springs eternal in the human breast;
> Man never is, but always to be blest."

When an orator, or a Parliamentary candidate — in which last capacity I have often appeared before some of you — wishes to rail at absolute governments, he talks of —

> "The monstrous faith of many made for one."

Then there are two maxims, one in politics and one in religion, which have both been extensively found fault with; but the very amount of censure proves what alone I am now attempting to establish, not the truth or justice of Pope's words, but their great vogue and currency —

> "For forms of government let fools contest;
> Whate'er is best administered is best:
> For modes of faith let graceless zealots fight;
> His can't be wrong whose life is in the right."

It is now time to judge Pope from his own works, by which, of course, his place in the estimate of posterity must finally stand.

I shall pass hurriedly by his earlier compositions. He tells us himself of the precocity of his genius:

> "I lisped in numbers, for the numbers came."

But his very youthful productions, on the whole, appear to be more remarkable for their dates than their intrinsic merits. He wrote his "Pastorals" at sixteen. Independently of the age at which they were written, they appear to me trivial, forced, out of keeping with the English soil and life to which they are avowedly assigned. One piece of praise is justly their due: after the publication of these verses by a youth—we may call him a boy—of sixteen, I do not see why a rugged or inharmonious English verse need ever again have been written; and what is more, I believe very few such have been written. Mr. Macaulay says on this point, "From the time when the 'Pastorals' appeared, heroic versification became matter of rule and compass, and, before long, all artists were on a level." It was surely better that this level should be one upon which the reader could travel smoothly along, without jolts or stumbles.

In the short poem of the "Messiah," I do justice to the stately flow of verse upon the highest of human themes. Both Dr. Johnson and Dr. Warton give it a decided preference over the "Pollio" of Virgil, which is concerned with topics of close and wonderful similarity. I do not know how far they are right, but I feel quite sure that both the "Pollio" of Virgil and the "Messiah" of Pope fall immeasurably below the prose translation of Isaiah in our Bibles.

"Windsor Forest" appears to be on the whole a cold production. It contains some good lines on the poet Earl of Surrey—

> "Matchless his pen, victorious was his lance,
> Bold in the lists, and graceful in the dance"—

an extremely pretty account of the flight and plumage of a pheasant, a very poetical list of the tributaries of the Thames, and some well-sounding verses on the Peace of Utrecht, then recently concluded, from which in the early part of this year I was induced to quote some lines which I thought very apposite to the proposed Exhibition of Industry of All Nations, at London, in 1851:—

> "The time shall come, when, free as seas or wind,
> Unbounded Thames shall flow for all mankind,
> Whole nations enter with each swelling tide,
> And seas but join the regions they divide;
> Earth's distant ends our glories shall behold,
> And the new world launch forth to meet the old."

The Odes written by Pope are decidedly of an inferior caste. I need not say how inferior to the immortal "Ode on St. Cecilia's Day," by Dryden, who preceded—or how inferior to Gray or Campbell, who have followed him. The Ode, perhaps, of every species of poetical composition, was the most alien to the genius of Pope; its character is rapt, vehement, abrupt; his is composed, polished, methodical; his haunt would not be the mountain top or the foaming cataract, but the smooth parterre and the gilded saloon. You may prefer one bent of mind, as you would one form of scenery; the question with which I now invite you to deal is, not in what style Pope wrote, but in the style which he chose, and for which his nature best fitted him, how far he excelled.

Among the very youthful productions of Pope, there were also some adaptations from Chaucer, Ovid, and one or two more ancient authors; in point of execution they are only distinguished by their smooth versification, and the matter of them ought to have forbidden the attempt.

In speaking as I have done of many of Pope's earlier compositions, however I may assume myself to be a devoted admirer—partisan, if you should so please to term it—I conceive that I have at least shown that hitherto I am no indiscriminate praiser, who thinks that everything which proceeds from his favourite must be perfect. On the contrary, though his facility in writing verses was almost precocious, the complete mastery of his art seems to have been gradually and laboriously developed. "So regular my rage," was the description which he has himself applied to his own poetry. It was not so much "the pomp and prodigality of heaven," which have been allotted to a few; it was rather, in the edifice of song which he has reared, that nicety of detail, and that completeness of finish, where every stroke of the hammer tells. and every nail holds its exact place.

His early friend and admirer, Walsh, seems accurately to have discerned the path of excellence which was open for him, when he told him that there was one way in which he might excel any of his predecessors, which was by correctness, for, though we had before him several great poets, we could boast of none that were perfectly correct. Pope justified the advice; and if correctness is not the highest praise to which a poet can aspire, it is no mean distinction to show how an author can be almost faultlessly correct, and almost as invariably the reverse of all that is tame, mean, or flat.

There come, however, among compositions which in any one else would most strictly be called early, a few which will not bear to be dismissed with such a hasty or superficial notice. The "Essay on Criticism" was written when he was twenty or twenty-one years old, and as such it appears a positive marvel. But he had now entered a field on which he was quite a master—the domain of good sense and of good taste, applied to the current literature of a scholar, and the common topics of life.

Very soon after, however, as if to show that, if he had willed it, he could have exercised as full a mastery over the region of light fancy and sportive imagery, as of sober reflection and practical wisdom, he wrote what is termed a heroi-comic poem, the Rape of the Lock. Dr. Johnson calls this the most exquisite example of ludicrous poetry, though I do not think the word ludicrous a happy epithet of the Doctor's; Dr. Warton calls it the best satire extant; and we are told that Pope himself considered the intermixture of the machinery of the Sylphs with the action of the story, as the most successful exertion of his art. As my business to-night is more with Pope on the whole as a poet, than with the details and the conduct of his single poems, I must not suffer myself to linger on the details of this delicious work. It is so finished and nicely fitted together that it would scarcely answer to separate any isolated passages from the context; besides, exquisite as the entire poem is, yet, the subject being professedly trivial, any single extract might appear deficient in importance and dignity. The whole is as sparkling as the jewelled cross upon the bosom of the heroine, —

> "On her white breast a sparkling cross she bore,
> Which Jews might kiss, and Infidels adore."

It is as stimulating as the pinch of snuff he so compactly describes,

> "The pungent grains of titillating dust."

But there was one other chord of the poetic lyre which Pope, still young in years, had yet to show his power to strike, and it is the most thrilling in the whole compass of song—the poetry of the passions and the heart. To this class I assign the Elegy to the Memory of an unfortunate Lady, and the ever memorable Epistle from Eloisa to Abelard. A few words will suffice here for the Elegy; its moral tendency cannot be defended, as it appears, incidentally at least, to excuse and consecrate suicide. In its execution it combines in a high degree poetic diction with pathetic feeling. The concluding lines are most touching:—

"Poets themselves must fall, like those they sung,
Deaf the praised ear, and mute the tuneful tongue.
Ev'n he, whose soul now melts in mournful lays,
Shall shortly want the generous tear he pays;
Then from his closing eyes thy form shall part,
And the last pang shall tear thee from his heart,
Life's idle business at one gasp be o'er,
The Muse forgot, and thou belov'd no more."

I must pause somewhat longer on the Epistle from Eloisa to Abelard. I ought, however, before I give vent to the full glow of panegyric, to make two admissions; one, that a sensitive delicacy would have avoided the subject; the other, that the matter is not original, but is supplied in great degree by the actual letters of the distinguished and unfortunate pair who gave their names to the epistle. Where the adaptation, however, is so consummate, this makes a very slight deduction from the merit of the author. The poem is not long, but in point of execution it appears to me one of the most faultless of human compositions; every thought is passion, and every line is music. The struggle between aspiring piety and forbidden love forms its basis, and the scenery and accessaries of monastic life and the Roman Catholic ritual furnish a back-ground highly congenial, solemn, and picturesque.

I must endeavour to justify my panegyric by a few quotations. The commendation of letter-writing is well known.

"Heaven first taught letters for some wretch's aid,
Some banish'd lover, or some captive maid;
They live, they speak, they breathe what love inspires,
Warm from the soul, and faithful to its fires,
The virgin's wish without her fears impart,
Excuse the blush, and pour out all the heart;
Speed the soft intercourse from soul to soul,
And waft a sigh from Indus to the Pole."

I give the description of the Convent founded by Abelard:—

"You rais'd these hallowed walls; the desert smil'd,
And Paradise was open'd in the wild.
No weeping orphan saw his father's stores
Our shrines irradiate, or emblaze the floors;

> No silver saints, by dying misers given,
> Here bribe the rage of ill-requited heaven;
> But such plain roofs as piety could raise,
> And only vocal with the Maker's praise."

There is the same scene coloured by Eloisa's own state of mind:—

> "But o'er the twilight groves and dusky caves,
> Long sounding aisles, and intermingled graves,
> Black Melancholy sits, and round her throws
> A death-like silence, and a dread repose.
> Her gloomy presence saddens all the scene,
> Shades every flower, and darkens every green,
> Deepens the murmur of the falling floods,
> And breathes a browner horror o'er the woods."

This is surely eminently poetical and expressive.

Let me give the description of her first acquaintance with Abelard:—

> "Thou know'st how guiltless first I met thy flame,
> When love approach'd me under friendship's name;
> My fancy form'd thee of angelic mind,
> Some emanation of th' All-beauteous mind.
> Those smiling eyes, attemp'ring every ray,
> Shone sweetly lambent with celestial day.
> Guiltless I gaz'd; heaven listened while you sung,
> And truths divine came mended from that tongue."

In that beautiful line, the force of human passion seems to obtain the mastery over the concerns of another life; but I will close my extracts from this poem with the wishes she forms for their last meeting, in which piety appears finally to predominate over passion:—

> "Thou, Abelard! the last sad office pay,
> And smooth my passage to the realms of day.
> See my lips tremble, and my eye-balls roll,
> Suck my last breath, and catch my flying soul!
> Ah no — in sacred vestments may'st thou stand,
> The hallowed taper *trembling* in thy hand.

(You remark all the force in that word "trembling:" in the next line, observe how the words "present" and "lifted" carry on the drama of the scene):—

Present the cross before my *lifted* eye,
Teach me at once, and learn of me to die;
Ah then, thy once-loved Eloisa see,
It will be then no crime to gaze on me.

(That is, I think, a highly impassioned and pathetic line.)

See from my cheek the transient roses fly.

("Transient," in the literal meaning of the word, passing off.)

See the last sparkle languish in my eye!
Till every motion, pulse, and breath be o'er;
And ev'n my Abelard be loved no more.
O death, all eloquent! you only prove,
What dust we doat on when 'tis man we love."

It would be a strange omission in an estimate of the poetical achievements of Pope, to make no mention of his translation of Homer, though the fact of its being a translation, and its length, would both rather put it beyond the limits of my present criticism. Dr. Johnson calls his Iliad, and I am inclined to believe with no more than perfect truth, the noblest version of poetry which the world has ever seen. The main objection alleged against it is, that being a professed translation of Homer, it is not Homeric,—that it is full of grace and sparkle, but misses the unmatched simplicity and majesty of that great father of verse,—that, if I may so express myself, it has not the twang of Homer. All this, I think, must be admitted; by some the poems of Sir Walter Scott, and old ballads like Chevy Chase, have been thought to convey a better notion of this Homeric twang than can be gathered from all the polished couplets of Pope. Cowper (an honoured name) tried a more literal version in blank verse, which certainly may be said to represent more closely at least the simplicity of the original. Let us, however, come to the practical test—as Lord Byron has asked concerning these two translations, "Who can ever read Cowper, and who will ever lay down Pope, except for the original? As a child I first read Pope's Homer with a rapture which no subsequent work could ever afford, and children are not the worst judges of their own language." It is no mean praise that it is the channel which has conveyed the knowledge of Homer to the general English public,—not to our scholars, of course. Though it is far less to the purpose how I felt about this as a child, than how Lord Byron felt, I too remember the days (I fear, indeed, that the anecdote will savour of egotism, but I must not mind the imputation of egotism, if it illustrates my author,) when I used to learn Pope's Iliad by heart behind a screen, while I was supposed to be engaged on lessons of more direct usefulness; and I fancy that I was under the strange hallucination at the time that I had got by heart the four first books. I do not mention this as a profitable example, but in order to show the degree in which this translation was calculated to gain the mastery over the youthful mind.

All the poems of Pope, to which I have already referred, belong to that period of life which, in all ordinary cases, would be called youth. I believe that they must have been nearly altogether completed before he was thirty. Those which I may further have to quote from (in doing which I shall hardly think it necessary to observe so much separate order between the different poems as heretofore), were the fruits of his matured years and settled powers. They henceforth fall under one class of composition, that which treats of men, their manners, and their morals; they are comprised under the titles of satires and moral essays. He himself speaks of the bent which his genius now adopted,

> " That not in fancy's maze he wander'd long,
> But stoop'd to truth, and moraliz'd his song."

Upon which I again feel happy to find myself in full acquiescence with Lord Byron, who says, "He should have written, *rose* to truth. In my mind the highest of all poetry is ethical poetry, as the highest of all earthly subjects must be moral truth."

Lord Bolingbroke and Bishop Atterbury, certainly no mean judges of intellectual merit, declared that the strength of Pope's genius lay eminently and peculiarly in satire. What shall I, then, single out as an illustration of his satiric vein? The character of Lord Hervey, under the name of Sporus, is cited by Lord Byron as a specimen of his rich fancy, (generally, but most erroneously, assumed to be the quality in which Pope was chiefly deficient,) and with this specimen of fancy Lord Byron defied all his own cotemporaries to compete. That it does manifest injustice at least to the abilities of Lord Hervey, will be acknowledged by all who have read his very entertaining memoirs lately published; but moreover, able and brilliant as it is, it is too disagreeable to repeat. Let me quote, then, his famous character of Addison, who had given offence to him, whether with good reason or not it is no part of my present purpose, nor would it be in my power, to decide. Pope thought that Addison had treated him slightingly and superciliously, and I believe took specially amiss the kind of notice he had bestowed upon the Rape of the Lock. He speaks of him under the name of Atticus; you will remark the consummate skill with which he first does justice to his genius, and then detracts from its lustre. It is also a great proof of the cleverness of the satire, that, sincere as our respect is both for the genius and character of Addison, it is impossible to go through this piece of dissection without believing that it must have touched upon some points of real soreness.

"Peace to all such! but were there one whose fires
True genius kindles, and fair fame inspires;
Blest with each talent and each art to please,
And born to write, converse, and live with ease:
Should such a man, too fond to rule alone,
Bear, like the Turk, no brother near the throne,
View him with scornful, yet with jealous eyes,
And hate for arts that caus'd himself to rise;
Damn with faint praise, assent with civil leer,
And without sneering, teach the rest to sneer;
Willing to wound, and yet afraid to strike,
Just hint a fault, and hesitate dislike;
Alike reserv'd to blame or to commend,
A tim'rous foe, and a suspicious friend;
Dreading ev'n fools, by flatterers besieg'd,
And so obliging, that he ne'er oblig'd;
Like Cato, give his little Senate laws,
And sit attentive to his own applause;
While wits and templars every sentence raise,
And wonder with a foolish face of praise —
Who but must laugh, if such a man there be?
Who would not weep, if Atticus were he!"

Then I will take the character of the able, versatile, and unprincipled Duke of Wharton: —

"Wharton, the scorn and wonder of our days,
Whose ruling passion was the lust of praise:
Born with whate'er could win it from the wise,
Women and fools must like him, or he dies;
Tho' wondering senates hung on all he spoke,
The club must hail him master of the joke.

(This couplet has been applied to the celebrated Mr. Sheridan, and does not ill suit the author of the speeches on Warren Hastings's trial, and the School for Scandal.)

Thus with each gift of nature and of art,
And wanting nothing but an honest heart,
Grown all to all, from no one vice exempt;
And most contemptible, to shun contempt;
His passion still, to covet general praise,
His life, to forfeit it a thousand ways;
A constant bounty which no friend has made;
An angel tongue, which no man can persuade;
A fool, with more of wit than half mankind,
Too rash for thought, for action too refin'd;
A tyrant to the wife his heart approves,
A rebel to the very king he loves;
He dies, sad outcast of each church and state,
And, harder still! flagitious, yet not great.
Ask you why Wharton broke thro' every rule?
'Twas all for fear the knaves should call him fool."

I have given the characters of two men; fairness demands that at least I should give you one of a woman. I take that of Chloe; most of us will feel that we have known people, to whom some parts of it at least might fit:—

"Yet Chloe sure was form'd without a spot—
Nature in her then err'd not, but forgot.
'With ev'ry pleasing, ev'ry prudent part,
'Say what does Chloe want?' She wants a heart.
She speaks, behaves, and acts just as she ought,
But never, never reach'd one generous thought.
Virtue she finds too painful an endeavour,
Content to dwell in decencies for ever.

So very reasonable, so unmov'd,
As never yet to love, or to be lov'd.
She, while her lover pants upon her breast,
Can mark the figures on an Indian chest:
And when she sees her friend in deep despair,
Observes how much a chintz exceeds mohair.
Forbid it heav'n, a favour or a debt
She e'er should cancel! but she may forget.
Safe is your secret still in Chloe's ear;
But none of Chloe's shall you ever hear.
Of all her Dears she never slander'd one,
But cares not if a thousand are undone.
Would Chloe know if you're alive or dead?
She bids her footman put it in her head.
Chloe is prudent!—Would you too be wise?
Then never break your heart when Chloe dies."

Having thus attempted to do justice to Pope's powers of satire, I must not omit to mention what I consider to be another of his felicities almost of an opposite character, though I have perceived with pleasure since I noted this topic, that I have been anticipated in the same line of remark by the late Mr. Hazlitt; I say with pleasure, because that ingenious person was one of the guides and favourites of a school the most opposed in theory and practice to that of Pope; I allude to the extreme tact, skill, and delicacy with which he conveys a compliment, and frequently embodies in one pregnant line or couplet a complete panegyric of the character he wishes to distinguish. Let me instance this by a few examples. Sometimes the compliment appears merely to be thrown out almost as it were by chance to illustrate his meaning. So of the Duke of Chandos, whom at another time he is supposed to have intended to ridicule under the character of Timon—

"Thus gracious Chandos is belov'd at sight."

Then of Lord Cornbury—

"Would ye be blest? despise low joys, low gains,
Disdain whatever Cornbury disdains."

Of General Oglethorpe, the founder of Georgia—

"One driv'n by strong benevolence of soul
Shall fly, like Oglethorpe, from pole to pole."

These have reference to manly virtues; sometimes there is the same oblique reference to female claims;

> "Hence Beauty, waking all her tints, supplies,
> An angel's sweetness, or Bridgewater's eyes."

At other times the eulogium is more direct. Take that fine application to Lord Cobham of the effect of man's ruling passion, developing itself in death, which he has been pursuing through a number of instances,—the man of pleasure, the miser, the glutton, the courtier, the coquette, all, for the most part, under circumstances derogatory to the pride of human nature, when he thus sums them up —

> "And you, brave Cobham, to the latest breath
> Shall feel your ruling passion strong in death;
> Such, in these moments, as in all the past,
> 'Oh, save my country, Heav'n!' shall be your last."

How beautiful is the couplet to Dr. Arbuthnot, his physician and friend —

> "Friend of my life! which did not you prolong,
> The world had wanted many an idle song."

How ingenious that to the famous Philip Stanhope, Earl of Chesterfield, on being desired to write some lines in an album with his pencil —

> "Accept a miracle instead of wit,
> See two *dull* lines by Stanhope's pencil writ."

How happy is the allusion to Lord Peterborough, who made a brilliant campaign in Spain within a wonderfully short time. He represents him as assisting to lay out his grounds —

> "And he whose lightning pierc'd th' Iberian lines
> Now forms my quincunx, and now ranks my vines,
> Or tames the genius of the stubborn plain,
> Almost as quickly as he conquer'd Spain."

He always speaks of Murray, the great Lord Mansfield, with pride and affection. It is true, that one of the worst lines he ever wrote is about him, the second in this couplet —

> "Grac'd as thou art with all the power of words,
> So known, so honour'd, at the House of Lords."

An instance how much delicacy it requires to introduce with effect familiar names and things; sometimes it tells with great force; here it is disastrously prosaic; we almost forgive it, however, when he turns from the Palace of Westminster to the Abbey opposite —

> "Where Murray, long enough his country's pride,
> Shall be no more than Tully, or than Hyde."

He again alludes to the aptitude for poetical composition which Murray had exhibited, and also to the talent for epigram which he assumes that the great orator Pulteney would have displayed if he had not been engrossed by politics.

> "How sweet an Ovid, Murray, was our boast;
> How many Martials were in Pulteney lost."

These were for the most part his political friends, but when he mentions Sir Robert Walpole, to whom his friends, more than himself, were virulently opposed, how respectful and tender is the reproach, how adroit and insinuating the praise —

> "Seen him I have, but in his happier hour,
> Of social pleasure, ill exchang'd for power, —
> Seen him, uncumber'd with a venal tribe,
> Smile without art, and win without a bribe."

I might adduce many other instances; I might quote at full length the noble epistle to Lord Oxford, but I will sum up this topic with that striking passage in which, while he enumerates the persons who encouraged and fostered his earlier productions, he presents us with a gallery of illustrious portraits, sometimes conveys by a single word an insight into their whole character, and concludes the distinguished catalogue with the name of that St. John whom he uniformly regarded with feelings little short of idolatry, and which, however misplaced and ill-grounded, have even in themselves something of the poetical attribute —

> "But why then publish? Granville the polite,
> And knowing Walsh would tell me I could write;
> Well-natured Garth inflamed with early praise,
> And Congreve loved, and Swift endured, my lays.

(Observe how the gentle and amiable Congreve "loved," and the caustic and cynical Swift "endured.")

The courtly Talbot, Somers, Sheffield, read,
E'en mitred Rochester would nod the head,

(said to have been the ordinary symptom of Bishop Atterbury being pleased; then comes the swelling climax,)

And St. John's self, great Dryden's friend before,
With open arms receiv'd one Poet more.
Happy the studies, when by these approv'd,
Happier the author, when by these belov'd."

I feel that I ought not entirely to omit all mention of the long satiric poem of the Dunciad, upon which Pope evidently bestowed much care and labour; but it is throughout disfigured by great ill-nature, and by a pervading run of unpleasant and unsavoury images. There is much spirit in the account of the young high-born Dunce, who makes, what is called, the Grand Tour—

"Europe he saw, and Europe saw him too;"

and tells how he

"Judicious drank, and, greatly daring, dined."

There is a luscious kind of burlesque softness in these lines,

"To happy convents, bosom'd deep in vines,
Where slumber abbots, purple as their wines;
To isles of fragrance, lily-silver'd vales,
Diffusing languor in the panting gales;
To lands of singing and of dancing slaves,
Love-whisp'ring woods, and lute-resounding waves."

One of the most distinguishing excellencies of Pope is the vividness which he imparts to all the pictures he presents to the mind, and which he attains by always making use of the very most appropriate terms which the matter admits. This, in conjunction with his wonderful power of compression, which he has probably carried further than any one before or since, gives a terseness and completeness to all he says, in which he is unrivalled. As instances of this perfect picture painting, I would refer you, as I must not indefinitely indulge in long citations, to the descriptions, all in the same Epistle on Riches, of the Miser's House, the Man of Ross's charities, and of the death of Villiers, Duke of Buckingham:

"In the worst inn's worst room, with mat half hung,
The floors of plaister, and the walls of dung,
On once a flock bed, but repaired with straw,
With tape-tied curtains, never meant to draw,
The George and Garter dangling from that bed
Where tawdry yellow strove with dirty red,
Great Villiers lies — alas! how changed from him,
That life of pleasure, and that soul of whim!"

If any should object that this is all very finished and elaborate, but it is very minute—only miniature painting after all, what do you say to this one couplet on the operations of the Deity?

"Builds life on death, on change duration founds,
And gives the eternal wheels to know their rounds."

I would beg any of the detractors of Pope to furnish me with another couple of lines from any author whatever, which encloses so much sublimity of meaning within such compressed limits, and such precise terms.

I must cite another passage, in which he ventures on the same exalted theme, with somewhat more enlargement; it would be impossible, however, for you to hear it, and bring against it any charge of diffuseness:

"All are but parts of one stupendous whole,
Whose body Nature is, and God the soul;
That, chang'd through all, and yet in all the same,
Great in the earth, as in the ethereal frame;
Warms in the sun, refreshes in the breeze,
Glows in the stars, and blossoms in the trees,
Lives through all life, extends through all extent,
Spreads undivided, operates unspent.

(There is a couplet indeed.)

Breathes in our soul, informs our mortal part,
As full, as perfect, in a hair as heart;
As full, as perfect, in vile man that mourns,
As the rapt seraph that adores and burns:
To Him no high, no low, no great, no small;
He fills, He bounds, connects, and equals all."

Let me invite your attention to the few following lines on the apportionment of separate instincts or qualities to different animals, and be good enough to observe how the single words clench the whole argument. They are as descriptive as the bars of Haydn's music in the oratorio of the Creation:—

"What modes of sight betwixt each wide extreme,
The mole's dim curtain, and the lynx's beam;
Of smell, the headlong lioness between,
And hound sagacious on the tainted green;
Of hearing, from the life that fills the flood,
To that which warbles through the vernal wood;
The spider's touch, how exquisitely fine,
Feels at each thread, and lives along the line."

What a couplet again is that! It is only about a spider; but I guarantee its immortality.

If I set down the Terse, the Accurate, the Complete, the pungency of the Satiric point, the felicity of the well-turned Compliment, as the distinctive features of Pope's poetical excellence, it should not escape us that there are occasions when he reaches a high degree of moral energy and ardour. I have purposely excluded from our present consideration all scrutiny and dissection of Pope's real inner character. I am aware, that, taking it in the most favourable light, it can only be regarded as formed of mixed and imperfect elements; but I cannot refuse to myself the belief that when the Poet speaks in such strains as the following, they in some degree reflect and embody the spirit of the Man. I quote from his animated description of the triumph of vice:—

"Let Greatness own her, and she's mean no more;
Her birth, her beauty, crowds and courts confess,
Chaste matrons praise her, and grave bishops bless;
In golden chains the willing world she draws,
And her's the Gospel is, and her's the laws;
Mounts the tribunal, lifts her scarlet head,
And sees pale virtue carted in her stead.
Lo! at the wheels of her triumphal car,
Old England's genius, rough with many a scar,
Dragg'd in the dust! his arms hang idly round,
His flag inverted trails along the ground!"

And, again with more special reference to himself,

"Ask you what provocation I have had?
The strong antipathy of good to bad.
When truth or virtue an affront endures,
Th' affront is mine, my friend, and should be yours.
Yes, I am proud, I must be proud to see,
Men not afraid of God, afraid of me:
Safe from the bar, the pulpit, and the throne,
Yet touch'd and sham'd by ridicule alone.
O sacred weapon! left for truth's defence,
Sole dread of folly, vice, and insolence!
To all but heav'n-directed hands deny'd,
The muse may give thee, but the gods must guide:
Rev'rent I touch thee! but with honest zeal;
To rouse the watchmen of the public weal,
To virtue's work provoke the tardy Hall,
And goad the prelate slumbering in his stall.
Let envy howl, while heav'n's whole chorus sings,
And bark at honour not conferr'd by kings;
Let flatt'ry sickening see the incense rise,
Sweet to the world, and grateful to the skies:
Truth guards the poet, sanctifies the line,
And makes immortal verse as mean as mine."

My limits, more than my materials, warn me that I must desist. As, however, with reference to the single object which I have all along had in view, I think it more politic that I should let the words of Pope, rather than my own, leave the last echoes on your ear, I should like to conclude this address with his own concluding lines to perhaps the most important and highly-wrought of his poems, the "Essay on Man." They appear to me calculated to leave an appropriate impression of that orderly and graceful muse, whose attractions I have, feebly I know and inadequately, but with the honesty and warmth of a thorough sincerity, endeavoured to place before you; if I mistake not, you will trace in them, as in his works at large, the same perfect propriety of expression, the same refined simplicity of idea, the same chastened felicity of imagery, all animated and warmed by that feeling of devotion for Bolingbroke, which pervaded his poetry and his life:

"Come then, my friend! my genius! come along;
Oh master of the poet, and the song!

And while the muse now stoops, or now ascends,
To man's low passions, or their glorious ends,
Teach me, like thee, in various nature wise,
To fall with dignity, with temper rise;
Form'd by thy converse, happily to steer
From grave to gay, from lively to severe;
Correct with spirit, elegant with ease,
Intent to reason, or polite to please.
Oh! while along the stream of time thy name
Expanded flies, and gathers all its fame;
Say, shall my little bark attendant sail,
Pursue the triumph, and partake the gale?
When statesmen, heroes, kings, in dust repose,
Whose sons shall blush their fathers were thy foes,
Shall then this verse to future age pretend,
Thou wert my guide, philosopher, and friend, —
That urg'd by thee, I turn'd the tuneful art
From sounds to things, from fancy to the heart;
For wit's false mirror held up nature's light;
Show'd erring pride, whatever is, is right;
That reason, passion, answer oue great aim;
That true self-love and social are the same;
That virtue only makes our bliss below;
And all our knowledge is ourselves to know."

Gentlemen of the jury, that is my case.

LECTURE II.

TRAVELS IN AMERICA.

It may be known to some of those whom I have the pleasure to see around me, that when circumstances to which I need not further allude, occasioned a breach, temporary indeed, and soon repaired, in my connection with the West Riding of Yorkshire,—when, as the phrase goes, some of your neighbours, and probably of yourselves, had given me leave to go upon my travels,—I thought I could make no better use of this involuntary leisure than by acquiring some personal knowledge of the United States of America. I accordingly embarked in the autumn of the year 1841, and spent about one whole year in North America, having within that period passed nearly over the length and breadth of the Republic, trod at least the soil of twenty-two out of the twenty-six States of which the Union was then composed, and paid short visits to the Queen's dominions in Canada, and to the Island of Cuba. I determined to keep a journal during my travels, and only at the end of them to decide what should become of it when it was completed. I found it was written in too hurried and desultory a manner, and was too much confined to my own daily proceedings, to make it of interest to the public at large. Still more strongly I felt that, after having been received with uniform civility and attention, nay, I may say, with real warmth and openness of heart, I should not wish, even where I had nothing but what was most favourable to communicate, immediately to exhibit myself as an inquisitive observer of the interior life to which I had been admitted; and this very feeling would probably have disqualified me for the office of an impartial critic. Now, however, that above eight years have elapsed since my return, in turning over the pages then written, it has seemed to me allowable to endeavour, for a purpose like the present, to convey a few of the leading impressions which I derived from the surface of nature and society as they exhibited themselves in the New World.

It must follow necessarily from such limits as could be allowed to me on an occasion of this kind, that any account which I can put together from materials so vast and so crowded, must be the merest superficial skimming of the subject that can be conceived. All I can answer for is, that it shall be faithful to the feelings excited at the moment, and perfectly honest as far as it goes. I must premise one point with reference to what I have just now glanced at — the use of individual names. I came in contact with several of the public men, the historical men they will be, of the American Republic. I shall think myself at liberty occasionally to depart in their instance from the rule of strict abstinence which I have otherwise prescribed to myself, and to treat them as public property, so long as I say nothing to their disadvantage. On the other hand, the public men of the United States are not created faultless beings, any more than the public men of other countries; it must not, therefore, be considered when I mention with pleasure anything which redounds to their credit, that I am intending to present you with their full and complete portraits.

It was on the 21st day of October, upon a bright crisp morning, that the *Columbia* steam-packet, upon which I was a passenger, turned the lighthouse outside the harbour of Boston. The whole effect of the scene was cheerful and pleasing; the bay is studded with small islands, bare of trees, but generally crowned with some sparkling white building, frequently some public establishment. The town rises well from the water, and the shipping and the docks wore the look of prosperous commerce. As I stood by some American friends acquired during the voyage, and heard them point out the familiar villages, and villas, and institutions, with patriotic pleasure, I could not altogether repress some slight but not grudging envy of those who were to bring so long a voyage to an end in their own country, amidst their own family, within their own homes. I am not aware I ever again experienced, during my whole American sojourn, the peculiar feeling of the stranger. It was, indeed, dispelled at the moment, when their flag ship, the *Columbus*, gave our *Columbia* a distinguished, and, I thought, touching reception; the crew manned the yards, cheered, and then the band played, first, "God Save the Queen," and then "Yankee Doodle." I spent altogether, at two different intervals, about a month in Boston.

I look back with fond recollection to its well-built streets — the swelling dome of its State-house — the pleasant walks on what is termed the Common — a park, in fact, of moderate size, in the centre of the city, where I made my first acquaintance with the bright winter sunsets of America, and the peculiar transparent green and opal tints which stripe the skies around them — the long wooden causeways across the inner harbour, which rather recalled St. Petersburgh to my recollection — the newly-erected granite obelisk on a neighbouring height, which certainly had no affinity with St. Petersburgh, as it was to mark the spot, sacred to an American, of the battle of Bunker's Hill — the old elm tree, at the suburban university of Cambridge, beneath which Washington drew his sword in order to take the command of the national army — the shaded walks and glades of Mount Auburn, the beautiful cemetery of Boston, to which none that we yet have can be compared, but which I trust before long our Chadwicks and Paxtons may enable us to imitate. and perhaps to excel. These are some of my external recollections of Boston; but there are some fonder still, of the most refined and animated social intercourse—of hospitalities which it seemed impossible to exhaust—of friendships which I trust can never be effaced. Boston appears to me, certainly, on the whole, the American town in which an Englishman of cultivated and literary tastes, or of philanthropic pursuits, would feel himself most at home. The residence here was rendered peculiarly agreeable to me by a friendship with one of its inhabitants, which I had previously made in England; he hardly yet comes within my rule of exception, but I do not give up the notion of his becoming one of the historical men of his country. However, it is quite open for me to mention some of those with whom, mainly through his introduction, I here became acquainted. There was Mr Justice Story, whose reputation and authority as a commentator and expounder of law stand high wherever law is known or honoured, and who was, what at least is more generally attractive, one of the most generous and single-hearted of men. He was an enthusiastic admirer of this country, especially of its lawyers; how he would kindle up and flow on if he touched upon Lord Hardwick or Lord Mansfield — "Sir," as an American always begins, "on the prairies of Illinois, this day Lord Mansfield administers the law of commerce." He had also a very exalted opinion of the judgments of Lord Stowell, which his own studies and practice had lead him thoroughly to appreciate; and I may permit myself to say that he had formed a high estimate of the judicial powers of Lord Cottenham.

I must admit one thing—when he was in the room few others could get in a word; but it was impossible to resent this, for he talked evidently not to bear down others, but because he could not help it. Then there was Dr. Channing. I could not hear him preach, as his physical powers were nearly exhausted; but on one or two occasions I was admitted to his house. You found a fragile frame, and a dry manner, but you soon felt that you were in a presence in which nothing that was impure, base, or selfish, could breathe at ease. There was the painter, Alston, a man of real genius, who suffices to prove that the domain of the fine arts, though certainly not hitherto the most congenial to the American soil, may be successfully brought, to use their current phrase, into annexation with it. These, alas! have, since my visit, all been taken away. In the more immediate department of letters there are happily several who yet remain—Mr. Bancroft, the able and accomplished historian of his own country—Mr. Ticknor, who has displayed the resources of a well-stored and accomplished mind in his recent work on the literature of Spain—Mr. Longfellow, with whose feeling and graceful poetry many must be acquainted—Mr. Emerson, who has been heard and admired in this country—and I crown my list with Mr. Prescott, the historian of Ferdinand and Isabella, of Mexico, and of Peru, with respect to whom, during the visit he paid to England in the past summer, I had the satisfaction of witnessing how all that was most eminent in this country confirmed the high estimate I had myself formed of his head, and the higher one of his heart.

The public institutions of Boston are admirably conducted. The Public or Common Schools there, as I believe in New England generally, are supported by a general rate, to which all contribute, and all may profit by. I am not naturally now disposed to discuss the question, how far this system would bear being transplanted and engrafted on our polity; but it would be uncandid if I did not state that the universality of the instruction, and the excellence of what fell under my own observation, presented to my mind some mortifying points of contrast with what we have hitherto effected at home. It is well known that a large proportion of the more wealthy and cultivated part of the society of Boston belong to the Unitarian persuasion; but a considerable number of the middle classes, and especially of the rural population of New England, comprising the six Northern States of the Union, still retain much of the Puritan tenets and habits of their immediate ancestors,—their Pilgrim Fathers.

Before I leave Boston, let me add one observation on a lighter topic. I lodged at the Tremont Hotel, which was admirably conducted, like very many of those imposing establishments in the chief cities of the Union. Here I learnt that one is apt to receive false impressions at first; I was struck with the clean, orderly, agile appearance of the waiters. "The Americans beat us hollow in waiters," was my inner thought; on inquiring I found that of the twenty-five waiters in the house, four were English and twenty-one Irish. I could not help wishing that a large number of the Irish might come and be waiters for a little while.

Within three or four days of my landing I grew impatient to see the falls of Niagara, without loss of time; if any sudden event should have summoned me home, I felt how much I should have grudged crossing the Atlantic without having been at Niagara; and I also wished to look upon the autumn tints of the American forests, before the leaves, already beginning to fall, had entirely disappeared. The Western Railway, which appeared to me the best constructed that I saw in America, took me to Albany, a distance of 200 miles. The railway carriages, always there called cars, consist of long rooms, rather like a dining-room of a steam-packet, with a stove inside, often a most desirable addition in the American winter; and you can change your seat or walk about as you choose. They are generally rougher than our railways, and the whole getting-up of the line is of a ruder and cheaper character; they do not impede the view as much as with us, as they make no scruple of dashing across or alongside of the main street in the towns or villages through which they pass. But I ought to remark about this as about every thing else, that the work of progress and transformation goes on with such enormous rapidity, that the interval of eight years since my visit will probably have made a large portion of my remarks thoroughly obsolete.

The New England country through which we passed looks cheerful, interspersed with frequent villages and numerous churches, bearing the mark at the same time of the long winter and barren soil with which the stout Puritan blood of Britain has so successfully contended; indeed, the only staple productions of a district which supplies seamen for all the Union, and ships over all the world, are said to be ice and granite.

Albany is the capital of the state of New York, — the Empire State, as its inhabitants love to call it, and it is a name which it deserves, as fairly as our own old Yorkshire would deserve to be called the Empire County of England. It is rather an imposing town, rising straight above the Hudson river, gay with some gilded domes, and many white marble columns, only they are too frequently appended to houses of very staring red brick. From Albany to Utica, the railroad follows the stream of the Mohawk, which recalls the name of the early Indian dwellers in that bright valley, still retaining its swelling outline of wood-covered hills, but gay with prosperous villages and busy cultivation. I was perhaps still more struck the next evening, though it was a more level country, where the railway passes in the midst of the uncleared or clearing forest, and suddenly bursts out of a pine glade or cedar swamp into the heart of some town, probably four, three, or two years old, with tall white houses, well-lighted shops, billiard-rooms, &c.; and emerging, as we did, from the dark shadows into the full moonlight, the wooden spires, domes, and porticoes of the infant cities looked every bit as if they had been hewn out of the marble quarries of Carrara. I am aware that it is not the received opinion; but there is something both in the outward aspect of this region and the general state of society accompanying it, which to me seemed eminently poetical. What can be more striking or stirring, despite the occasional rudeness of the forms, than all this enterprise, energy, and life welling up in the desert? At the towns of Syracuse, of Auburn, and of Rochester, I experienced the sort of feeling which takes away one's breath; the process seemed actually going on before one's eyes, and one hardly knows whether to think it as grand as the Iliad, or as quaint as a harlequin farce. I will quote the words I wrote down at the time: —

"The moment is not come for me yet, if it ever should come, to make me feel myself warranted in forming speculations upon far results, upon guarantees for future endurance and stability; all that I can now do is to look and to marvel at what is before my eyes. I do not think I am deficient in relish for antiquity and association: I know that I am English, not in a pig-headed adhesion to everything there, but in heart to its last throb. Yet I cannot be unmoved or callous to the soarings of Young America, in such legitimate and laudable directions too; and I feel that it is already not the least bright, and may be the most enduring, title of my country to the homage of mankind, that she has produced such a people. May God employ them both for his own high glory!"

I am bound here in candour to state that I think what I first saw in America was, with little exception, the best of its kind; such was the society of Boston — such was the energy of progress in the western portion of the State of New York.

At Rochester, an odd coincidence occurred to me, striking enough I think to be mentioned, though it only concerned myself. After the arrival of the railway carriage, and the usual copious meal of tea and meat that ensues, I had been walking about the town, which dates only from 1812, and then contained 20,000 inhabitants, and as I was returning to the hotel, I saw the word Theatre written up. Wishing to see everything in a new country, I climbed up some steep stairs into what was little better than a garret, where I found a rude theatre, and ruder audience, consisting chiefly of boys, who took delight in pelting one another. There was something, however, at which I had a right to feel surprised. In a playhouse of strollers, at a town nearly five hundred miles in the interior of America, which, thirty years before, had no existence, thus coming in by the merest chance, I saw upon the drop-scene the most accurate representation of my own house, Naworth Castle, in Cumberland.

A great improvement has recently occurred in the nomenclature of this district; formerly a too classical surveyor of the State of New York had christened — I used the wrong term, had heathenised, to make a new one, — all the young towns and villages by the singularly inapplicable titles of Utica, Ithaca, Palmyra, Rome: they are now reverting to the far more appropriate, and, I should say, more harmonious Indian names, indigenous to the soil, such as Oneida, Onondaga, Cayuga.

I thought my arrival at Niagara very interesting. We had come to Lockport, where there is a chain of magnificent locks, on the Erie Canal, one of the great public works of America, and which has done much to enrich this Empire State of New York. The surplus of the receipts has enabled it to execute a variety of other public works. We arrived too late for the usual public conveyance. The proprietor of the stage-coach agreed to give me, with one or two other Englishmen, a lumber waggon to convey us to the falls. The Colonel, for he was one, as I found the drivers of the coaches often were, drove his team of four horses himself. I generally found the stage-coach driving in the United States indescribably rough, but the drivers very adroit in their steerage, and always calling their horses by their names, and addressing them as reasonable beings, to which they seemed quite to respond. Altogether, the strangeness of the vehicle, the cloudless beauty of the night, the moonlight streaming through the forest glades, the meeting a party of the Tuscarora Indians, who still have a settlement here, the first hearing the noise of Niagara about seven miles off, and the growing excitement of the nearer approach, gave to the whole drive a most stirring and enjoyable character. When I arrived at the hotel, the Cataract House, I would not anticipate by any moonlight glimpses the full disclosures of the coming day, but reserved my first visit for the clear light and freshened feelings of the morning.

I staid five days at Niagara on that occasion; I visited it again twice, having travelled several thousands of miles in each interval. I have thus looked upon it in the late autumn, in the early spring, and in the full summer. Mrs. Butler, in her charming work on America, when she comes to Niagara, says only, "Who can describe that sight?" and, with these words, finishes her book. There is not merely the difficulty of finding adequate words, but there is a simplicity and absence, as I should say, of incidents in the scenery, or, at least, so entire a subordination of them to the main great spectacle, that attempts at description would seem inapplicable as well as impotent. Nevertheless, I have undertaken, however inadequately, the attempt to place before you the impressions which I actually derived from the most prominent objects that I saw in America. How, then, can I wholly omit Niagara? The first view neither in the least disappointed, or surprised, but it wholly satisfied me. I felt it to be complete, and that nothing could go beyond it: volume, majesty, might, are the first ideas which it conveys: on nearer and more familiar inspection, I appreciated other attributes and beauties—the emerald crest—the seas of spray—the rainbow wreaths. Pictures and panoramas had given me a correct apprehension of the form and outline; but they fail, for the same reason as language would, to impart an idea of the whole effect, which is not picturesque, though it is sublime; there is also the technical drawback in painting of the continuous mass of white, and the line of the summit of the Fall is as smooth and even as a common mill-dam. Do not imagine, however, that the effect could be improved by being more picturesque; just as there are several trivial and unsightly buildings on the banks, but Niagara can be no more spoiled than it can be improved. You would, when on the spot, no more think of complaining that Niagara was not picturesque, than you would remark in the shock and clang of battle that a trumpet sounded out of tune. Living at Niagara was not like ordinary life; its not over loud but constant solemn roar has in itself a mysterious sound: is not the highest voice to which the Universe can ever listen compared by inspiration to the sound of many waters? The whole of existence there has a dreamy but not a frivolous impress; you feel that you are not in the common world, but in its sublimest temple.

I naturally left such a place and such a life with keen regret, but I was already the last visitor of the year, and the hotels were about to close. I was told that I had already been too late for the best tints of autumn (or fall, as the Americans picturesquely term that season), and that they were at no time so vivid that year as was usual; I saw, however, great richness and variety of hue; I think the bright soft yellow of the sugar maple, and the dun red of the black oak, were the most remarkable. These and the beech, the white cedar, the hemlock spruce, the hickory, with occasionally the chesnut and walnut, seemed the prevailing trees in all this district. I can well imagine a person being disappointed in the American Forest; trees, such as those at Wentworth and Castle Howard (may I say?) seem the exception, and not the rule. The mass of them run entirely to height, and are too thick together, and there is a great deal too much dead fir; still there is a great charm and freshness in the American forest, derived partly perhaps from association, when you look through the thick tracery of its virgin glades.

On my going back I paid two visits at country houses; one to an old gentleman, Mr. Wadsworth, most distinguished in appearance, manner, and understanding, who had settled where I found him, fifty years before, when he had not a white neighbour within thirty miles, or a flour mill within fifty; he lived entirely surrounded by Indians, who have now disappeared. On some occasion, there had been a review of a corps of militia. A neighbouring Indian Chief had been present, and was observed to be very dejected; Mr. Wadsworth went up to him, and offered refreshment, which was usually very acceptable, but he declined it. Upon being pressed to say what was the matter, he answered with a deep sigh, pointing to the east, "You are the rising sun"—then to the west, "We are the setting." The face of the country is now, indeed, changed; a small flourishing town, the capital of the county, stretches from the gate; and the house overlooks one of the richest and best cultivated tracts in America, the valley of the Gennessee. I fancy that quotations of the price of Gennessee wheat are familiar to the frequenters of our corn markets. My host was one of the comparatively few persons in the United States who have tenants under them holding farms; among them I found three Yorkshiremen from my own neighbourhood, one of whom showed me what he called the *gainest* way to the house, which I recognised as a genuine Yorkshire term; he told me that his landlord was the first nobleman in the country, which is also clearly not an Americanism. While on this topic I may mention that, on another occasion, I was taken to drink tea at a farmer's house in New England. We had been regaled most hospitably, when the farmer took the friend who had brought me aside, and asked what part of England Lord Morpeth came from? "From Yorkshire, I believe," said my friend. "Well, I should not have thought that from his manner of talking," was the reply.

My other visit was to Mr. Van Buren, who had been the last President of the United States, and who, I suspect, shrewdly reckoned on being the next. It seemed, indeed, at that time to be the general expectation among his own, the Democratic, or, as they were then commonly called, the Loco-foco party. He was at that time living on his farm of Kinderhook; the house was modest and extremely well ordered, and nothing could exceed the courtesy or fullness of his conversation. He abounded in anecdotes of all the public men of his country. In his dining-room were pictures of Jefferson and General Jackson, the great objects of his political devotion. On my return through Albany, I had an interview with Mr. Seward, then for the second time Governor of the State of New York. I find that I noted at the time, that he was the first person I had met who did not speak slightingly of the Abolitionists; he thought they were gradually gaining ground. He had already acted a spirited part on points connected with slavery, especially in a contest with the legislature of Virginia concerning the delivery of fugitive slaves.

I approached the city of New York by the Hudson. The whole course of that river from Albany, as seen from the decks of the countless steamers that ply along it, is singularly beautiful, especially where it forces a passage through the barriers of the Highlands, which, however, afford no features of rugged grandeur like our friends in Scotland; but though the forms are steep and well-defined, their rich green outlines of waving wood, inclosing, in smooth many-curved reaches, the sail-covered bosom of the stately river, present nothing but soft and smiling images. I then took up my winter quarters at New York. I thought this, the commercial and fashionable, though not the political, capital of the Union, a very brilliant city. To give the best idea of it, I should describe it as something of a fusion between Liverpool and Paris — crowded quays, long perspectives of vessels and masts, bustling streets, gay shops, tall white houses, and a clear brilliant sky overhead. There is an absence of solidity in the general appearance, but in some of the new buildings they are successfully availing themselves of their ample resources in white marble and granite. At the point of the Battery, where the long thoroughfare of Broadway, extending some miles, pushes its green fringe into the wide harbour, with its glancing waters and graceful shipping, and the limber, long raking masts, which look so different from our own, and the soft swelling outline of the receding shores, New York has a special character and beauty of its own. I spent about a month here very pleasantly; the society appeared to me on the whole to have a less solid and really refined character than that of Boston, but there is more of animation, gaiety, and sparkle in the daily life. In point of hospitality, neither could outdo the other.

Keeping to my rule of only mentioning names which already belong to fame, I may thus distinguish the late Chancellor Kent, whose commentaries are well known to professional readers: he had been obliged, by what I think the very unwise law of the State of New York, to retire from his high legal office at the premature age of sixty, and there I found him at seventy-eight, full of animation and racy vigour, which, combined with great simplicity, made his conversation most agreeable.—Washington Irving, a well-known name both to American and English ears, whose nature appears as gentle and genial as his works—I cannot well give higher praise:

—Mr. Bryant, in high repute as a poet, and others. I had the pleasure of making acquaintance with many of the families of those who had been the foremost men in their country, Hamiltons, Jays, Livingstones. I lodged at the Astor House, a large hotel conducted upon a splendid scale; and I cannot refrain from one, I fear rather sensual, allusion to the oyster cellars of New York; in no part of the world have I ever seen places of refreshment as attractive—every one seems to eat oysters all day long. What signifies more, the public institutions and schools are extremely well conducted. The churches of the different denominations are very numerous and well filled. It is my wish to touch very lightly upon any point which among us, among even some of us now here, may be matter of controversy; I, however, honestly think that the experience of the United States does not as yet enable them to decide on either side the argument between the Established and Voluntary systems in religion: take the towns by themselves, and I think the voluntary principle appears fully adequate to satisfy all religious exigencies; then it must be remembered that the class which makes the main difficulty elsewhere, scarcely if at all exists in America; it is the blessed privilege of the United States, and it is one which goes very far to counterbalance any drawbacks at which I may have to hint, that they really have not, as a class, any poor among them. A real beggar is what you never see. On the other hand, over their immense tracts of territory, the voluntary system has not sufficed to produce sufficient religious accommodation; it may, however, be truly questioned, whether any establishment would be equal to that function. This is, however, one among the many questions which the republican experience of America has not yet solved. As matters stand at present, indifference to religion cannot be fairly laid to her charge; probably religious extremes are pushed farther than elsewhere; there certainly is a breadth and universality of religious liberty which I do not regard without some degree of envy.

Upon my progress southward, I made a comparatively short halt at Philadelphia. This fair city has not the animation of New York, but it is eminently well built, neat, and clean beyond parallel. The streets are all at right angles with each other, and bear the names of the different trees of the country; the houses are of red brick, and mostly have white marble steps and silver knockers, all looking bright and shining under the effect of copious and perpetual washing. It still looks like a town constructed by Quakers, who were its original founders; but by Quakers who had become rather dandified. The waterworks established here are deservedly celebrated; each house can have as much water as it likes, within and without, at every moment, for about 18*s.* a year. I hope our towns will be emulous of this great advantage. I think it right to say that in our general arrangements for health and cleanliness we appear to me very much to excel the Americans, and our people look infinitely healthier, stouter, rosier, jollier; the greater proportion of Americans with whom you converse would be apt to tell you they were dyspeptic, whether principally from the dry quality of their atmosphere, the comparatively little exercise which they take, or the rapidity with which they accomplish their meals, I will not take upon myself to pronounce. There is one point of advantage which they turn to account, especially in all their new towns, which is, that their immense command of space enables them to isolate almost every house, and thus secure an ambient atmosphere for ventilation. In my first walk through Philadelphia I passed the glittering white marble portico of the United States Bank, which, after the recent crash it had sustained, made me think of whited sepulchres. Near it was a pile, with a respectable old English appearance, of far nobler association; this was the State House, where the Declaration of American Independence was signed, — one of the most pregnant acts of which history bears record. It contains a picture of William Penn and a statue of Washington. While I was there, a sailor from the State of Maine, with a very frank and jaunty air, burst into the room, and in a glow of ardent patriotism inquired, "Is this the room in which the Declaration of Independence was signed?" When he found that I was an Englishman, he seemed, with real good breeding, to be afraid that he had grated on my feelings, and told me that in the year 1814 our flag had waved over the two greatest capitals of the world, Washington and Paris. I looked with much interest at the great Model Prison of the separate system. I was favourably impressed with all that met the eye, but I refrain from entering upon the vexed question of comparison between this and the silent and other systems, as I feel how much the solution must depend upon ever recurring experience. The poor-house, like that at New York, is built and administered on a very costly scale, and also has a great proportion of foreigners as inmates, and of the foreigners a great proportion Irish. This seems to enhance the munificence of the provision for destitution; at the same time, it is not to be forgotten that the foreign labour is an article of nearly essential necessity to the progress of the country. On the only Sunday which I sent in Philadelphia, I went to a church which was not wanting in associations; the communion plate had been given by Queen Anne, and I sat in the pew of General Washington. I was told by some one that his distinguished cotemporary, Chief Justice Marshall, said of him, that, in contradiction to what was often thought, he was a man of decided genius, but he was such a personification of wisdom, that he never put anything forward which the occasion did not absolutely require. It seemed to me that there was at Philadelphia a greater separation and exclusiveness in society, more resemblance to what would be called a fashionable class in European cities, than I had found in America elsewhere.

My next brief pause was at Baltimore. At a halt on the railroad on the way thither, I heard a conductor or guard say to a negro, "I cannot let you go, for you are a SLAVE." This was my first intimation that I had crossed the border which divides Freedom from Slavery. I quote from the entry which I made upon noting these words that evening: — "Declaration of Independence which I read yesterday — pillar of Washington which I have looked on to-day — what are ye?"

I must now give myself some little vent. It was a subject which I felt during my whole sojourn in America, as I feel it still, to be paramount in interest to every other. It was one on which I intended and endeavoured to observe a sound discretion; we have not ourselves long enough washed off the stain to give us the right to rail at those whom we had originally inoculated with the pest; and a stranger abundantly experiencing hospitality could not with any propriety interfere wantonly upon the most delicate and difficult point of another nation's policy. I could not, however, fail often and deeply to feel, in the progress of my intercourse with many in that country — "Come not, my soul, into their secret; to their counsel, my honour, be not thou united." At the same time, I wished never to make any compromise of my opinion. I made it a point to pay special respect to the leading Abolitionists — those who had laboured or suffered in the cause — when I came within reach of them; at Boston, I committed the more overt act of attending the annual anti-slavery fair, by which I believe some thought I unduly committed myself. I was much struck in the distinguished and agreeable companies which I had the good fortune to frequent, with a few honourable exceptions, at the tone of disparagement, contempt, and anger, with which the Abolitionists were mentioned; just as any patrician company, in this country, would talk of a Socialist, or a Red Republican. I am, of course, now speaking of the free Northern States; in the South an Abolitionist could not be known to exist. My impression is, that in the interval since my visit, the dislike, the anger, has remained, and may, probably, have been heightened, but that the feeling of slight, of ignoring (to use a current phrase) their very existence, must have been sensibly checked. There were some who told me that they made it the business of their lives to superintend the passage of the runaway slaves through the free States; they reckoned, at that time, that about one thousand yearly escaped into Canada. I doubt whether the enactment and operation of the Fugitive Slave Bill will damp the ardour of their exertions. It may be easy to speak discreetly and plausibly about the paramount duty of not contravening the law; but how would you feel, my countrymen, if a fugitive was at your feet and the man-hunter at the door? I admit that the majesty of the law is on one side; but the long, deep misery of a whole human life is on the other. What you ought to feel is fervent gratitude to the Power which has averted from your shores and hearths this fearful trial, and, let me add, a heartfelt sympathy with those who are sustaining it.

At Baltimore I thought there was a more picturesque disposition of ground than in any other city of the Union: it is built on swelling eminences, commanding views of the widening Chesapeake, a noble arm of the sea. There are an unusual number of public monuments for an American town, and hence it has been christened the Monumental City. I found the same hospitality which had greeted me everywhere, and the good living seemed to me carried to its greatest height; they have in perfection the terrapin, a kind of land tortoise, and the canvass-back duck, a most unrivalled bird in any country. With reference to the topic I have lately touched upon, a Slave-holders' Convention was being held at the time of my visit for the State of Maryland. They had been led to adopt this step by their apprehensions both of the increase of the free coloured population, and what they termed their demoralising action on the slaves. The language, as reported, did not seem to have been very violent, but they very nearly subjected to lynch-law a man whom they suspected to be a reporter for an abolitionist newspaper. I dined with the daughter of Charles Carroll, who, when signing the Declaration of Independence, was told by a bystander that he would incur no danger, as there were so many of the same name — " of Carrollton," he added to his name, and I think it is the only one upon the document which has any appendage. Being thus nobly fathered, it is rather curious that this venerable lady should have been the mother of three English peeresses. The Roman Catholic Archbishop of Baltimore was one of the company; the assumption of that title does not appear in any degree to discompose the serenity of the Great Republic.

From Baltimore I transferred myself to Washington, the seat of government and capital of the American Union. I never saw so strange a place; it affords the strongest contrast to the regularity, compactness, neatness, and animation of the Atlantic cities I had hitherto visited. It is spread over a very large space, in this way justifying the expression of some one who wished to pay it a compliment, but did not know very well what attribute to select, so he termed it a " city of magnificent distances," over which it extends, or rather sprawls; it looks as if it had rained houses at random, or like half a dozen indifferent villages scattered over a goose common. Here and there, as if to heighten the contrast with the meanness of the rest, there are some very handsome public buildings; and the American Capitol, the meeting-place of the legislature and the seat of empire, though not exempt from architectural defects, towers proudly on a steep ascent, commanding the subject town and the course of the broad Potomac, which makes the only redeeming feature of the natural landscape. In short, while almost every other place which I saw in America gives the impression of life and progress, Washington not only appears stagnant, but retrograde. No busy commerce circulates in its streets; no brilliant shops diversify its mean ranges of ill-built houses; but very few equipages move along its wide, splashy, dreary avenues. I saw it, too, in the prime of its season, during the sitting of Congress. When it is not sitting, the members of the legislature and officers of the government dispose themselves over the breadth of the Union, and leave the capital to the clerks of the public offices, and

— does it not seem profanation to say it? — the *Slaves*, who are still permitted to inhabit what should rightly be the Metropolis of Freedom. It is at least gratifying to know that, in the last session of Congress, the slave-trade has been abolished in the district of Columbia, the small portion of territory immediately annexed to Washington. When they are here, the members of Congress are mostly packed together in large and very inferior boarding-houses, a great portion of them not bringing their wives and families over the immense distances they have to traverse; hence it also happens that Washington will appear to the stranger not merely one of the least thriving but also the least hospitable of American cities. I spent nearly a month there, and it was the only place in which I (what is termed) kept house, that is, I resided in private lodgings, and found my own food, a method of life, however, which, in the long run, has more comfort and independence than that of the huge hotels. It was a contrast, however, to the large armies of waiters to which I had grown accustomed, to have no one in the house but an old woman and a negro boy, the first of whom my English servant characterised as cross, and the second as stupid. I believe it was the policy of the founders of the Republic to place the seat of government where it would not be liable to be distracted by the turmoil of commerce, or over-awed by the violence of mobs; we have heard very lately of speculations to remove the seat of the French Government from Paris. Another cause which has probably contributed to check any designs for the external improvement and development of Washington, must have been the doubt how far in a nation which is extending its boundaries westward at so prodigious a rate, it will be desirable or possible long to retain as the seat of government a spot which will have become so little central.

What gave most interest to my stay at Washington naturally was the opportunity of attending the sittings of Congress. The interior of the Capitol is imposing, as well as the exterior; in the centre hall there were five large pictures, illustrating the prominent points of American history, which must be more agreeable to American than to British eyes. There is also a fine colossal statue of Washington, who is universally and not unduly called the father of his country. The chamber where the Senate meets is handsome and convenient. The general aspect of the assembly, which (as is well known) shares largely both in the legislative and executive powers of the constitution, is grave and decorous. The House of Representatives, the more popular branch of the government, returned by universal suffrage, assemble in a chamber of very imposing appearance, arranged rather as a theatre, in shape like the arc of a bow, but it is the worst room for hearing I ever was in: we hear of complaints occasionally of our Houses of Parliament, old and new, but they are faultless in comparison. In parts of the House it is impossible to hear any body, in others it answers all the purposes of a whispering gallery, and I have heard members carry on a continuous dialogue while a debate was storming around them. Both in theSenate and the House every member has a most commodious arm-chair, a desk for his papers, and a spitting-box, to which he does not always confine himself. I came very often, and it was impossible to surpass the attention I received; some member's seat in the body of the House was always given to me, and I was at liberty to remain there during the whole of the debate, listen to what was going on, or write my letters, as I chose. The palpable distinction between them and our House of Commons I should say to be this, we are more noisy, and they are more disorderly. They do not cheer, they do not cough, but constantly several are speaking at a time, and they evince a contemptuous disregard for the decisions of their Speaker. They have no recognized leaders of the different parties, the members of Government not being allowed to have seats in either House of Congress, and the respective parties do not occupy distinct quarters in the Chamber, so that you may often hear a furious wrangle being carried on between two nearly contiguous members. While I was at Washington, the question of slavery, or at least of points connected with slavery, gave the chief colour and animation to the discussions in the House of Representatives. Old Mr. Adams, the ex-president of the United States, occupied, without doubt, the most prominent position; he presented a very striking appearance, standing up erect at the age of 73, having once filled the highest post attainable by an American citizen, with trembling hands and eager eyes, in defence of the right of petition, — the right to petition against the continuance of slavery in the district of Columbia—with a majority of the House usually deciding against him, and a portion of it lashed into noise and storm. I thought it was very near being, and to some extent it was, quite a sublime position, but it rather detracted from the grandeur of the effect at least, that his own excitement was so great as to pitch his voice almost into a screech, and to make him more disorderly than all the rest. He put one in mind of a fine old game-cock, and occasionally showed great energy and power of sarcasm. I had certainly an opportunity of forming my opinion, as I sat through a speech of his that lasted three days; but then it is fair to mention that the actual sittings hardly last above three hours a day — about four dinner is ready, and they go away for the day, differing much herein from our practice; and on this occasion they frequently allowed Mr. Adams to sit down to rest. All the time I believe he was not himself for the discontinuance of slavery, even in the district of Columbia, but he contended that the constitution had accorded the free right of petition.* One morning he presented a petition for the dissolution of the Union. which raised a great tempest. Mr. Marshall, of Kentucky, a fine and graceful speaker, moved a vote of censure upon him. Another member, whom I need not name, the ablest and fiercest champion whom I heard on the southern or slave-holder side, made a most savage onslaught on Mr. Adams; then up got that "old man eloquent," and no one could have reproached him with not understanding how to speak even daggers. His brave but somewhat troublous spirit has passed from the scenes upon which he played so conspicuous a part, but he has left behind him some words of fire, the sparks of which are not yet extinct. Nothing came of all this stir; I used to meet Mr. Adams at dinner while it went on, very calm and undisturbed. After seeing and hearing what takes place in some of these sittings, one is tempted to think that the Union must break up next morning; but the flame appeared generally to smoulder almost as quickly as it ignited. The debates in the Senate, during the same period, were dignified, business-like, and not very lively; so it may be judged which House had most attraction for the passing traveller. I heard Mr. Clay in the Senate once, but every one told me that he was labouring under feebleness and exhaustion, so that I could only perceive the great charm in the tones of his voice. I think this most attractive quality was still more perceivable in private intercourse, and I certainly never met any public man, either in his country or in mine, always excepting Mr. Canning, who exercised such

* I have lately met with a curious proof that this very eminent man was not exempt from the usual susceptibility of his countrymen on the subject of colour. In a letter to the accomplished American actor, Mr. Hackett, he says, that the moral of the tragedy of Othello is to show how improper it is to mix white blood with black.

evident fascination over the minds and affections of his friends and followers, as Henry Clay. I thought his society most attractive, easy, simple, and genial, with great natural dignity. If his countrymen made better men presidents, I should applaud their virtue in resisting the spell of his eloquence and attractions; when the actual list is considered, my respect for the discernment elicited by universal suffrage does not stand at a very high point. Another great man, Daniel Webster, I could not hear in either House of Congress, because he then filled, as he does now, the high office of Secretary of State; but it is quite enough to look on his jutting dark brow, and cavernous eyes, and massive forehead, to be assured that they are the abode of as much, if not more, intellectual power than any head you perhaps ever remarked. For many, if not for all reasons, I am well content that he should be again at the head of the American Cabinet, for I feel sure that while he is even intensely American, he has an enlightened love of peace, and a cordial sympathy with the fortunes and glories of the old, as well as the new, Anglo-Saxon stock. The late Mr. Calhoun, who impressed most of those who were thrown in his way with a high opinion of his ability, his honesty, and, I may add, his impracticability, I had not the good fortune to hear in public, or meet in private society. It is well known that his attachment to the maintenance of slavery went so far as to lead him to declare that real freedom could not be maintained without it. Among those who at that time contributed both to the credit and gaiety of the society of Washington, I cannot forbear adding the name of Mr. Legare, then the Attorney-general of the Union, now unhappily, like too many of those whom I have had occasion to mention, no longer living. He appeared to me the best scholar, and the most generally accomplished man, I met in all the Union. I may feel biassed in his favour, for I find among my entries, "Mr. Legare spoke to-night of Pope as he ought."

I have not mentioned what might be thought of a very prominent object at Washington — the President of the United States. He resides for his term of office at a substantial plain building, called the White House. Mr. Tyler filled the office when I was there, and appeared a simple, unaffected person. Washington is the head quarters of another branch of the Constitution, which works perhaps with less of friction and censure than any other — the Supreme Court of Judicature. The large federal questions between State and State give great weight and interest to its proceedings. I heard an interesting cause between the States of Maryland and Pennsylvania; it was an action to try the constitutional validity of an Act of the State of Pennsylvania, which gave a trial by jury to the fugitive slave. How this subject pursued and pervaded every thing! It was argued with great ability on both sides; it was ultimately ruled against the power of the free states to pass such an act; and the recent Fugitive Slave Law may probably have arisen out of some such debateable questions of right; at all events, it has entirely swept away the intervention of a jury.

The last day of my abode at Washington was spent becomingly at Mount Vernon, the residence, and now the grave, of Washington. It is well placed on a wooded hill above the noble Potomac, here a mile and a half broad. The tomb is a sad affair for such a man; it has an inscription upon it denoting that it was erected by John Strutters, marble mason! It is placed under a glaring red building, something between a coach-house and a cage. The Senate once procured the consent of the family to have it removed to the Capitol, when a bricklayer, a labourer, and a cart arrived to take it off one morning, at which their indignation naturally rose. There are few things remarkable in the house, except the key of the Bastille sent by General Lafayette to General Washington, and a sword given to him by Frederick the Great, with this address, "From the Oldest General of the age to the Best." I was gratified to see a print from my picture of the Three Maries. I wonder if it ever excited the interest and the piety of Washington?

I made a rapid journey, by steamboat and railroad, through the States of Virginia and North Carolina; the country wore a universal impress of exhaustion, desertion, slavery. It appears to be one of the trials for the cupidity of man, that slavery, notwithstanding all its drawbacks, has a certain degree of adaptation, not, I trust, in the mercy of God, a necessary adaptation, to the culture of fertile soils in hot climates; but in sterile or exhausted soils, where the energy of man must be called out to overcome difficulties, it is evident that slavery has no elastic spring or restorative power.

Richmond, the capital of Virginia, has a certain resemblance in position to its namesake in Surrey. I saw the local legislature in session; it was very full of coarse-looking farmers from the western portion of the state: it struck me that the acute town lawyers must manage matters much as they choose. I never saw a country so hopeless as all that I passed through in North Carolina — a flat, sandy waste of pines, with scarcely a habitation. I spent a fortnight at Charleston, the capital of her more energetic sister, South Carolina. This town and state may be looked upon as the head-quarters of the slave-holding interest; and repeatedly, when they have thought the policy of the North too encroaching, either upon questions relating to what they term their peculiar institutions, which is their euphonious description of slavery, or, when we should feel a juster sympathy with them, upon questions relating to the protection of the northern manufactures in opposition to a liberal commercial policy, they have not only held the very highest tone in favour of a dissolution of the Union, but have proceeded to overt acts of resistance. I am bound to say that I spent my time there very pleasantly; there was much gaiety, and unbounded hospitality. I have made no disguise of what my opinions upon slavery were, are, and ever must be; but it would be uncandid to deny that the planter in the Southern States has much more in his manner and mode of intercourse that resembles the English country gentleman than any other class of his countrymen; he is more easy, companionable, fond of country life, and out-of-door pursuits. I went with a remarkably agreeable party to spend a day at the rice plantation of one of their chief proprietors; he had the credit of being an excellent manager, and his negroes, young and old, seemed well taken care of and looked after; he repelled the idea—not of educating them—that is highly penal by the law of the State, but of letting them have any religious instruction. I was told by others that there was considerable improvement in this respect. Many whom I met entertained no doubt that slavery would subsist among them for ever; others were inclined to think that it would wear out. While I was willing not to shut my eyes to any of the more favourable external symptoms or mitigations of slavery, other indications could not come across my path without producing deep repugnance. On the very first night of my arrival, I heard the deep sound of a curfew bell: on inquiry I was told, that after it had sounded every night at about nine o'clock, no coloured person, slave or *free* — mark that — might be seen in the streets. One morning, accordingly, I saw a great crowd of coloured persons in the street, and I found they were waiting to see a large number of their colour, who had been taken up the night before on their return from a ball, escorted in their ball dresses from the

Gaol to the Court-house. Indeed, it was almost principally with relation to the free blacks that the anomalous and indefensible working of the system appeared there to develop itself. I was told that the slaves themselves looked down upon the free blacks, and called them rubbish. I must not omit to state that I saw one slave auction in the open street, arising from the insolvency of the previous owner: a crowd stood round the platform, on which sat the auctioneer, and beside him were placed in succession the lots of from one to five negroes. The families seemed to be all put up together, but I imagine they must often be separated; they comprised infants and all ages. As far as I could judge, they exhibited great indifference to their changing destiny. I heard the auctioneer tell one old man, whom I could have hardly distinguished from a white person, that he had been bought by a good master. One could not help shuddering at the future lot of those who were not the subjects of this congratulation.

I went into the Head Court of Justice at Charleston, and found seven persons present; five of them were judges, one was the lawyer addressing them, the other was the opposing counsel, who was walking up and down the room. I attended a meeting of the convention of the Episcopal Church of South Carolina; whether it may be for encouragement or warning to those who wish for the introduction or revival of such synods at home, I mention the point then under discussion; it was how far it was proper to show deference for the opinion of the Bishop.

In point of neatness, cleanliness, and order, the slave-holding States appeared to stand in about the same relation to the free, as Ireland does to England; every thing appears slovenly, ill-arranged, incomplete; windows do not shut, doors do not fasten; there is a superabundance of hands to do every thing, and little is thoroughly done. The country round Charleston for scores, and I believe hundreds of miles, is perfectly flat, and full of swamps, but there I had the first indications of the real genius of the south, in the white houses lined with verandahs, the broad-leaved deep green magnolias and wild orange trees in the gardens, the large yellow jessamine and palmeto in the hedges, and the pendant streamers of grey moss on the under-branches of the rich evergreen live oak, which supplies unrivalled timber for ship-building.

I left Charleston in a small American mail-packet, for the island of Cuba. I must not dwell on the voyage, which, from our being much becalmed, lasted twelve days, double its due; we were long off the low flat coasts of Georgia and Florida, and I felt inclined to say with Goldsmith —

"And wild Altama echoed to our woe."

On the 14th of March we passed under the impregnable rock of the Castle, called the Moro, and, answering the challenge from its terraced battlements, we found ourselves in the unrivalled harbour of the Havana. How enchanting, to the senses at least, were the three weeks I spent in Cuba! How my memory turns to its picturesque forms and balmy skies. During my whole stay, the thermometer scarcely varied from 76° to 78° in the shade. I am disposed to wonder that these regions are not more resorted to by our countrymen for enjoyment of life, and escape from death. Nothing was ever so unlike either Europe or America as the Havana; at least I had never been in Spain, the mother country, which I suppose it most resembles. The courts of the gleaming white houses have a Moorish look, the interiors are much covered with arabesques, and on the outside towards the street they have immense open spaces for windows, in which they generally find it superfluous to put any glass; the carriages are called Volantès, and look as if they had been intended to carry Don Quixote. Then how delicious it used to be, late in the evening, under a moonlight we can scarcely imagine, to sit in the square called the Place of Arms, where in a space flanked by some gleaming palm trees, and four small fountains, a gay crowd listened to excellent music from a Spanish military band. It is certainly the handsomest town I saw in the New World, and gives a great idea of the luxury and splendour of Spain in her palmy days. The billiard rooms and ice-saloons streamed with light; the great theatre is as large and brilliant as almost any in Europe. Again, how full of interest were some visits I paid in the interior, both to Spanish and American households. I cannot condense my impressions of the scenery better than by repeating some short stanzas which with such influences around me I could not help perpetrating. I hope that while they bear witness to the intoxicating effects of the landscape and the climate, they do not wholly leave out of view the attendant moral.

Ye tropic forests of unfading green,
  Where the palm tapers, and the orange glows,
Where the light bamboo weaves her feathery screen,
  And her tall shade the matchless seyba throws:

Ye cloudless ethers of unchanging blue,
Save as its rich varieties give way,
To the clear sapphire of your midnight hue,
The burnished azure of your perfect day.

Yet tell me not my native skies are bleak,
That, flushed with liquid wealth, no cane-fields wave;
For Virtue pines, and Manhood dares not speak,
And Nature's glories brighten round the Slave.

Among the country houses I visited was the sugar estate of one of the chief Creole nobles of the island—(I do not know whether my hearers will be aware that the proper meaning of a Creole is a person of European descent born in America)—I was treated there with the most refined and courteous hospitality; and what a view it was from the terrace of golden cane-fields, and fringing woods, and azure sea! The treatment of the domestic slaves appeared kind and affectionate, and all the negro children on the estate repeated their catechism to the Priest, and were then brought in to dance and romp in the drawing-room. Generally there does not appear to be the same amount of repulsion between the white and coloured races as in the United States, and there is the pleasant spectacle of their being mixed together in the churches. Still the crying, conclusive fact remains, that the average negro population died off in ten years, and had to be recruited by continuous importations, which are so many breaches of the solemn treaties between Spain and us. On one coffee estate which I visited—(and generally the coffee cultivation is far lighter than that of the sugar cane)—a still darker shade was thrown upon the system, as I was told from a most authentic source that there was great difficulty in preventing mothers from killing their offspring. General Valdez, who was Captain-general of the island during my visit, is thought to have exerted himself honestly in putting down the slave trade. I believe it has been as much encouraged as ever under some of his successors. The politics of Cuba are rather delicate ground to tread upon just now, and are likely to be continually shifting; it appeared to me that all the component parties held each other in check, like the people who are all prevented from killing each other in the farce of the Critic. The despotism and exclusiveness of the Mother country were complete; every one gave the same picture of the corruption and demoralization which pervaded every department of administration and justice. The Creoles are prevented from rising against this system, from dread of the negroes rising against them, over and above the large Spanish force always kept on foot there; the Americans, who have got possession of a large proportion of the estates, do not like to hazard any attempt at annexation, without at least adequate aid from other quarters, as they would have to deal with the Spanish army, some of the Creoles, and all the Negroes: and the Negroes, the most deeply wronged party of any, would bring down on themselves in case of any general rising amongst them, the Spaniards, Creoles, Americans within, and Americans without. May the providence of God reserve for these enchanting shores more worthy destinies then they have ever yet enjoyed!

I availed myself of the magnificent accommodation of one of our West India line-of-packet steamers, which deposited us at the mouth of the Mississippi. I repined at the course of the vessel, receding from the sun, and at first I thought everything looked dingy, after the skies and vegetation of the tropics. I missed especially the palm, the cocoa, and the seyba, but there was still the orange tree, and, what they have not in Cuba, the magnolia, a forest tree in full blossom: the sugar plantations of Louisiana seemed kept in very trim order: we passed the ground made memorable by the victory of General Jackson over the English, and soon drew up among the numerous tiers of masts and steam-boats that line the crescent outline of New Orleans.

The good I have to say of New Orleans must be chiefly confined to the St. Charles Hotel, which is the most splendid of its kind that I saw even in the United States. When it is at its full complement 560 dine there every day—350 of whom sleep in the house; there are 160 servants, 7 French cooks; all the waiters, whites—Irish, English, French, German, and American: the very intelligent proprietor of the hotel told me he thought the Irish made the best; he has them altogether every day at noon, when they go through a regular drill, and rehearse the service of a dinner. Nothing can be more distinct than the appearance of the American and French portions of the town; the American is laid out in broad streets, high houses, and large stores; the French in narrow streets, which suits a warm climate better perhaps, and a great proportion of one-storied houses, which they thought a better security against hurricanes. I spent my time not unpleasantly, particularly two days at the plantation of an opulent proprietor, where the slaves seemed the subject of much thoughtful attention as far as their physical condition is concerned: the weather at this season,—the middle of April, — was delicious, but it is the last place in the world I should choose for a residence. For long periods the climate is most noxious to human life; it is the occasional haunt of the yellow fever, the river runs at a higher level than the town, and the putrid swamp is ever ready to ooze through the thin layer of rank soil above it; and, worse than any merely natural malaria, the dregs of the worst type of the French and American character, notwithstanding the more wholesome elements by which their influence is undoubtedly tempered, impart a moral taint to the social atmosphere.

Though in my journey henceforward I passed over immense spaces, and saw great varieties of scenes and men, yet as it became now more of a matter of real travelling, and did not show me so much of the inner social life, it will be a relief to you to hear, especially after the lengthened trespass I have already made on your attention, that I shall get over the remaining ground far more rapidly. I went from New Orleans to Louisville, on board the *Henry Clay* steamer, 1500 miles, which lasted six days; the first 1100 miles were on the Mississippi. It is impossible to be on the "Father of Waters," as I believe the name denotes, without some emotion; its breadth hardly appears so imposing as that of many far inferior streams; at New Orleans it must be under three-quarters of a mile, but its width rather paradoxically increases as you recede from its mouth; its colour is that of a murky, pulpy, yellowish mud, but still its full, deep, brimming volume pleases, chiefly, I suppose, from the knowledge that thus it rolls on for 5000 miles, and waters a valley capable of feeding the world; there is little break of outline, but the continuous parallel lines of forest are partially dotted, first by the sugar fields of Louisiana, then by the cotton enclosures of the states of Mississippi and Tennessee, then by the rich meadows of Kentucky. For the last 400 miles we left the sovereign river, and struck up the Ohio, christened by the French the "Beautiful River," and deserving the name, from the swelling wooded slopes which fringe its current; its soft native name of Ohio means "the gently flowing." Louisville is a flourishing town. Thence I dived into the interior of Kentucky, and paid a visit of two or three days to Mr. Clay, at his country residence of Ashland. The qualities which rivet the Senate and captivate his adherents, seemed to me both heightened and softened by his frank, courteous, simple intercourse. He lives with his family in a modest house, among fields of deep red soil and the most luxuriant grass, growing under very thriving and varied timber, the oak, sycamore, locust tree, cedar, and that beautiful ornament of American woods, the sugar maple. He likes showing some English cattle. His countrymen seem to be in the habit of calling upon him without any kind of previous introduction. Slavery, generally mild in the pastoral state of Kentucky, was certainly seen here in its least repulsive guise; Mr. Clay's own negro servant, Charles, was much devoted to him; he took him with him on a tour into Canada, and when some abolitionists there wanted him to leave his master, "Not if you were to give me both your Provinces," was the reply.

My next halt was at the White Sulphur Springs in the western portion of Virginia. The season had not yet commenced, early in May, so I was in sole possession of the place. One of my southern friends had kindly placed a delightful little cottage at my disposal, and I enjoyed in the highest degree the unwonted repose in the solitude of virgin forests, and the recesses of the green Alleghanies. Here were my brief Farewell lines to the small temple-like cupola over the bright sulphur well from which I used to drink many times in the day:—

Hail dome! whose unpresuming circle guards
Virginia's flowing fountain: still may health
Hover above thy crystal urn, and bring
To cheeks unus'd their bloom! may Beauty still
Sit on thy billowy swell of wooded hills,
And deep ravines of verdure; may the axe,
Improvement's necessary pioneer,
Mid forest solitudes, still gently pierce,
Not bare their leafy bowers! This votive lay,
Like wreath of old on thy white columns hung,
Albeit of scentless flowers from foreign soil,
Scorn not, and bid the Pilgrim pass in peace.

I had, at this time, much travelling in the stage coaches, and I found it amusing to sit by the different coachmen, who were generally youths from the Eastern States, pushing their way in life, and full of fresh and racy talk. One said to me, lamenting the amount of debt which the State through which we were travelling had incurred, "I suppose your State has no debt," — a compliment I could not quite appropriate. Another, who probably came from New York, where they do not like to use the word Master in speaking of their employers, but prefer an old Dutch name, Boss, said to me, "I suppose the Queen is your Boss now."

I again turned my face to the West, and passed Cincinnati, which, together with all that I saw of the State of Ohio, seemed to me the part of the Union where, if obliged to make the choice, I should like best to fix my abode. It has a great share of all the civilization and appliances of the old settled States of the East, with the richer soil, the softer climate, the fresher spring of life, which distinguish the West. It had besides to me the great attraction of being the first Free State which I reached on my return from the region of slavery; and the contrast in the appearance of prosperity and progress is just what a friend of freedom would always wish it to be. One of my visitors at Cincinnati told me he remembered when the town only contained a few log cabins; when I was there it had 50,000 inhabitants. I shall not easily forget an evening view from a neighbouring hill, over loamy cornfields, wooded knolls, and even some vineyards, just where the Miami River discharges its gentle stream into the ample Ohio. I crossed the States of Indiana and Illinois, — looked for the first time on the wide level and waving grass of a prairie — stopped a short time at St. Louis, once a French station, now the flourishing capital of the State of Missouri. I passed the greatest confluence of rivers on the face of our globe, where the Mississippi and Missouri blend their giant currents: the whole river ought properly to have gone by the name of the Missouri, as it is by far the most considerable stream, its previous course before the junction exceeding the entire course of the Mississippi, both before and after it; it is the Missouri, too, which imparts its colour to the united stream, and for two or three miles you distinguish its ochre-coloured waters as they line the hitherto clear current of the Upper Mississippi. At Jacksonville, in Illinois, I was told a large colony of Yorkshiremen were settled; and I was the more easily induced to believe it, as it seemed to me about the most thriving and best cultivated neighbourhood I had seen. I embarked at Chicago, on the great lakes: but here I must desist from pursuing my devious wanderings on those large inland seas, and on the opposite shore of Canada. Many thousands of miles have I steamed away over Lakes Michigan, Huron, Erie, Ontario, the Rideau Canal, the St. Lawrence and Ottawa rivers; some of these I traversed twice, and they supplied some of the most interesting and picturesque features of my long journeyings. I should have scrupled in any case to touch upon the politics of Canada, and, indeed, my pauses at any fixed spot were too short to qualify me for the attempt, even if it had been desirable. It is a magnificent region, especially its western portion,—happy in climate, soil, and scenery. I will, however, only attempt to dash off two slight sketches from my Canadian recollections.

Here is the first. I stood in a terraced garden on the summit of a high promontory, running with a steep angle into the basin made by the river St. Lawrence, of which it is no exaggeration to say that the water is as clear, bright, and, above all, green as any emerald; here, upon I believe the most imperial site in the world, stand the citadel and city of Quebec. The shipping was lying in great quantity close under the rocky steep, and was dotted for a considerable way along the shining river. In front was the island of Orleans, well-shaped and full-peopled; ridge upon ridge beyond, ending with Cape Tourment, descended on the river; the shore on either side gleamed with white villages, and the town below seemed to climb, or almost leap, up the straight precipice, broken with high convent-roofs and glittering tinned spires. The flag of England waved upon the highest bastion that crowned the rock; the band of the Queen's Guards was playing in the garden; the clearest blue of western skies was above my head; and, rising above the whole glowing scene, was the commemorative pillar to that General Wolfe, who on this spot transferred to us Englishmen, by his own victory and death, and with the loss of forty-five men, the mastery of a Continent.

The only other scene I will attempt to sketch shall be in the centre of Lake Huron, on one of its countless islands. I am justified in using that epithet, since, not long ago, our Government ordered a survey to be made of the islands; they counted 40,000, and then gave it up, and some of these were of no contemptible size, one of them being ninety miles long. I was one of a party which, at that time, went annually up the lake to attend an encampment of many thousand Indians, and make a distribution of presents among them. About sunset, our flotilla of seven canoes, manned well by Indian and French Canadian crews, drew up, some of the rowers cheering the end of the day's work with snatches of a Canadian boat-song. We disembarked on some rocky islet which, as probably as not, had never felt the feet of man before. In a few moments the utter solitude had become a scene of bustle and business, carried on by the sudden population of some sixty souls; tents had been pitched in which we were to sleep; small trees had been cut for fuel; fires had been lighted, round which the motley crews were preparing the evening meal; some were bathing in the transparent little bays, some standing on a jutting piece of cliff, fishing; and here and there an Indian in the water, motionless, watching with an intent gaze, a spear in his hand ready to dart on his prey beneath. A large oil-cloth had been spread for our party on a convenient ledge of rock; hot pea-soup, hot fish, the chase of the day, and large cold rounds of beef, showed that, though we were in the desert, we did not fare like anchorites; and the summer moon rose on the scattered fires, and the gay bivouac, and the snatches of song and chorus that from time to time woke the unaccustomed echoes of Lake Huron.

Entering the United States again, I made a rapid journey by Lakes Champlain and George, by Ticonderoga and Saratoga,—historic names; spent four very delightful days in most attractive society in a New England village, revived the beauteous impressions of the Hudson, and, taking leave of friends not soon to be forgotten, on the quay of New York, left the hospitable shore.

You will have perceived that in these desultory notes I have not attempted to pronounce any formal judgment upon the American people, or the great experiment they are conducting in the face of the world. The extreme diversity of habits, manners, opinions, feelings, race, and origin, in the several parts of the wide extent of country I traversed, would render the difficulty, great in any case, of such an undertaking, still more subtle and complicated. The striking contrasts in such a shifting and variegated aspect of society, make me feel that any such general and dashing summary could only be attempted after the fashion of a passage which I have always much admired in Gibbon, where, wishing to give a fair view of the poetical character of Claudian, he sums up separately his merits and defects, and leaves his reader to strike the just balance. In some such mode it might be stated, that

North America, viewed at first with respect to her natural surface, exhibits a series of scenery, various, rich, and, in some of its features, unparalleled; though she cannot, on the whole, equal Europe in her mountain elevations, how infinitely does she surpass her in rivers, estuaries, and lakes! This variegated surface of earth and water is seen under a sky warm, soft, and balmy in some — clear, blue, and brilliant in all its latitudes, with a transparency of atmosphere which Italy does not reach, with varieties of forest-growth and foliage unknown to Europe, and with a splendour of views in autumn before which painting must despair. With respect to the moral aspect, I naturally feel the difficulty of any succinct or comprehensive summary infinitely heightened. The feature which is the most obvious, and probably the most enviable, is the nearly entire absence, certainly of the appearance, and, in a great degree, of the reality of poverty; in no part of the world, I imagine, is there so much general ease and comfort among the great bulk of the people, and a gushing abundance struck me as the prominent characteristic of the land. It is not easy to describe how far this consideration goes to brighten the face of nature, and give room for its undisturbed enjoyment. Within a mere span of time, as compared with the general growth and progress of nations, the industry, at once steady and persevering, of the inhabitants, has cleared enormous tracts of forest, reared among their untrodden glades spacious and stately cities, opened new highways through the swamp and the desert, covered their unequalled rivers with fleets of steam-boats and craft of every form, given an extension to canals beyond all previous experience, and filled land and water with hardy miracles of successful enterprise. The traveller, wafted with marvellous ease by steam-boats and railways over prodigious spaces, cannot but indulge in what may appear a more superficial satisfaction at the accommodation he meets with in the hotels of the principal cities, which are regulated on a scale, and with a splendour and even cleanliness which he will find scarcely rivalled in the capitals of Europe. However absorbed in the pursuits of business, agriculture and trade, the citizens of these young republics may be, and though it would seem to be their obvious vocation in life to cultivate almost boundless wastes, and connect almost interminable distances, circles are nevertheless to be found among them which, in point of refined and agreeable intercourse, of literary taste, and general accomplishment, it would be difficult for the same capitals of the elder world to surpass; the Bench and Bar, as well as other professions, can boast both of the solid and brilliant qualities by which they are adorned; and while much occurs in Congress that must be deemed rough and unseemly, the chords of high and generous feeling are frequently struck within its walls to accents of noble eloquence; in the universal fluency of their public speaking, they undoubtedly surpass ourselves. In rural life, I doubt whether the world can produce more examples of quiet simplicity and prosperous content than would be found, I might say most prominently, in the embowered villages of New England, or the sunny valleys of Pennsylvania. I am sure that I am not wanting in respect for our own operative classes; but neither can I conceal from myself that the appearance of the female factory population of Lowell presents some points of favourable contrast. Among the more opulent portion of society, an idle man without regular profession or fixed pursuit is the exception which excites observation and surprise. The purity of the female character stands deservedly high, and society has been deemed by some to be rendered less agreeable by the rigid devotion of the young married women to their households and nurseries. It is something to have travelled nearly over the whole extent of the Union without having encountered a single specimen either of servility or incivility of manner; by the last I intend to denote intentional rudeness. Elections may seem the universal business, topic, and passion of life, but they are, at least with but few exceptions, carried on without any approach to tumult, rudeness, or disorder; those which I happened to see were the most sedate, unimpassioned processes I can imagine. In the Free States, at least, the people at large bear an active, and, I believe, on the whole, a useful part in all the concerns of internal government and practical daily life; men of all classes, and especially of the more wealthy and instructed, take a zealous share in almost every pursuit of usefulness and philanthropy; they visit the hospitals and asylums; they attend the daily instructions of the schools; they give lectures at Lyceums and Institutes. I am glad to think that I may be treading in their foot-steps on this occasion. I have already mentioned with just praise, the universal diffusion and excellent quality of popular education, as established especially in the States of New England, the powerful Empire State of New York, and, I may add, the prosperous and aspiring State of Ohio. Without venturing to weigh the preponderating recommendations or deficiencies of the Voluntary System, I may fairly ask, what other communities are so amply supplied with the facilities of public worship for all their members? The towns, old and young, bristle with churches; they are almost always well filled; the Sabbath, in the Eastern and Northern States at least, is scrupulously observed; and with the most unbounded freedom of conscience, and a nearly complete absence of polemical strife and bitterness, there is apparently a close unity of feeling and practice in rendering homage to God.

Though it would appear difficult, and must certainly be ungracious, to paint the reverse side of such a country and such a people, a severe observer would not be long at fault. With respect to their scenery itself, while he could not deny that within its vast expanse it contained at times both sublimity and beauty, he might establish against it a charge of monotony, to which the immense continuities of the same surfaces, whether of hill, valley, wood, lake, or river — the straight unbroken skirt of forest, the entire absence of single trees, the square parellelograms of the cleared spaces, the uniform line of zig-zag fences, the staring squareness of the new wooden houses, all powerfully contribute. In regard to climate, without dwelling on such partial influences as the malària which desolates the stunted pine-barrens of North Carolina, and banishes every white native of South Carolina from their rice-plains during the entire summer, the hot damps which festoon the trees on the southern coast with a funereal drapery of grey moss, the yellow fever which decimates the Quays of New Orleans, and the feverish agues which line the banks of the Mississippi, it would be impossible to deny the violent alternations of temperature which have a more general prevalence; and it is certain that much fewer robust forms and ruddy complexions are to be seen than in our own more even latitudes. Passing from the physical to the moral atmosphere, amidst all the vaunted equality of the American freemen, there seemed to be a more implicit deference to custom, a more passive submission to what is assumed to be the public opinion of the day or hour, than would be paralleled in many aristocratic or even despotic communities. This quiet acquiescence in the prevailing tone, this complete abnegation of individual sentiment, is naturally most perceptible in the domain of politics; but

I thought that it also in no inconsiderable degree pervaded the social circle, biassed the decisions of the judicial bench, and even infected the solemn teachings of the pulpit. To this source may probably in some measure be traced the remarkable similarity in the manners, deportment, conversation, and tone of feeling, which has so generally struck travellers from abroad in American society. Who that has seen, can ever forget the slow and melancholy silence of the couples who walk arm-in-arm to the tables of the great hotels, or of the unsocial groups who gather round the greasy meals of the steam-boats, lap up the five minutes' meal, come like shadows, so depart? One of their able public men made an observation to me, which struck me as pungent, and perhaps true, that it was probably the country in which there was less misery and less happiness than in any other of the world. There are other points of manners on which I am not inclined to dilate, but to which it would at least require time to be reconciled: I may just intimate that their native plant of tobacco lies at the root of much that we might think objectionable. However necessary and laudable the general devotion to habits of industry and the practical business of life may be, and though there are families and circles in which no grace, no charm, no accomplishment, are wanting, yet it cannot be denied, that among the nation at large, the empire of dollars, cents, and material interests, holds a very preponderating sway, and that art and all its train of humanities exercise at present but an enfeebled and restricted influence. If we ascend from social to political life, and from manners to institutions, we should find that the endless cycles of electioneering preparations and contests, although they may be carried on for the most part without the riotous turbulence, or overt bribery, by which they are sometimes but too notoriously disgraced among ourselves, still leave no intermission for repose in the public mind; enter into all the relations of existence; subordinate to themselves every other question of internal and foreign policy; lead their public men—I will not say their best, but the average of them—to pander to the worst prejudices, the meanest tastes, the most malignant resentments of the people; at each change of administration incite the new rulers to carry the spirit of proscription into every department of the public service, from the Minister at a great foreign court, to the post-master of some half-barbarous out-post, — thus tending to render those whose functions ought to withdraw them the most completely from party influences the most unscrupulous partisans; and would make large masses welcome war and even acquiesce in ruin, if it appeared that they could thus counteract the antagonist tactics, humiliate the rival leader, or remotely influence the election of the next President. It is already painfully felt that as far as the universal choice of the people was relied on to secure for the highest office of the state the most commanding ability or the most signal merit, it may be pronounced to have failed. There may be less habitual and actual noise in Congress than in our own Parliament, but the time of the House of Representatives, not without cost to the constituent body which pays for their services, is continuously taken up, when not engrossed by a speech of some days' duration, with wrangles upon points of order and angry recriminations; the language used in debate has occasionally sounded the lowest depths of coarse and virulent acrimony, and the floor of the Legislative Hall has actually been the scene of violent personal rencounter. The manners of the barely civilized West, where it has been known that counsel challenge judges on the Bench, and Members of the Legislature fire off rifles at the Speaker as he sits in the chair, would appear to be gradually invading the very inner shrine of the Constitution. Having done justice to the strictness and purity of morals which distinguish many of the more settled portions of the continent, it cannot be concealed that the reckless notions an dhabits of the vagrant pioneers of the West, evinced as these are by the practices of gambling, drinking, and licentiousness, by an habitual disregard of the Sabbath, and by more constant swearing than I ever heard any where else, fearfully disfigure that great valley of the Mississippi, destined inevitably, at no distant day, to be the preponderating section of the entire Union. It is at this day impossible to go into any society especially of the older and more thoughtful men, some of whom may themselves have borne an eminent part in the earlier struggles and service of the commonwealth, without hearing the degeneracy of modern times, and the downward tendency of all things, despondingly insisted upon. At the period of my visit, besides the numerous instances of individual bankruptcy and insolvency, not, alas, peculiar to the New World, the doctrine of repudiation, officially promulgated by sovereign States, had given an unpleasing confirmation to what is perhaps a prevailing tendency among retired politicians. I have reserved for the last topic of animadversion the crowning evil—the capital danger—the mortal plague-spot—Slavery. I have not disclaimed the original responsibility of my own country in introducing and riveting it upon her dependencies; I do not disguise the portentous difficulties in the way of adequate remedy to the great and growing disease. But what I cannot shut my eyes on is, that while it lasts, it must still continue, in addition to the actual amount of suffering and wrong which it entails on the enslaved, to operate with terrible re-action on the dominant class, to blunt the moral sense, to sap domestic virtue, to degrade independent industry, to check the onward march of enterprise, to sow the seeds of suspicion, alarm, and vengeance in both internal and external intercourse, to distract the national councils, to threaten the permanence of the Union, and to leave a brand, a bye-word, and a jest, upon the name of Freedom.

Having thus endeavoured, without consciousness of any thing mis-stated or exaggerated, though of much that is wanting and incomplete, on either side, to sum up the good and the bad, I leave my hearers to draw their own conclusions from the whole; there are large materials both for approval and attack, ample grounds both for hope and fear. Causes are occasionally at work which almost appear to portend a disruption of the Federal Union; at the same time a strong sentiment of pride about it, arising partly from an honest patriotism, partly from a feeling of complacency in its very size and extent, may tend indefinitely to postpone any such pregnant result; but whatever may be the solution of that question, whatever the issue of the future destinies assigned to the great American Republic, it is impossible to have contemplated her extent, her resources, the race that has mainly peopled her, the institutions she has derived or originated, the liberty which has been their life-blood, the industry which has been their offspring, and the free Gospel which has been published on her wide plains and wafted by her thousand streams, without nourishing the belief, and the hope, that it is reserved for her to do much, in the coming generations, for the good of man and the glory of God.

ADDRESSES.

DISTRIBUTION OF PRIZES AT HUDDERSFIELD COLLEGE.

(*December*, 1843.)

Ladies and Gentlemen,

Though this is the first time that I have had the gratification of attending any meeting in connection with the Huddersfield College, yet you must give me leave to assure you that it has so happened, not from any want of friendly invitation on the part of its friends and supporters, or from the want of any good will or interest on my part. Hitherto, parliamentary and official duties, and such material hindrances as the interposition of seas, whether the Irish Channel, or, more recently, the Atlantic Ocean, have prevented my complying both with their friendly summons and with my own strong inclination; but I have taken advantage of the first opportunity of unengrossed leisure which I have enjoyed in the county of York, to attend the half-yearly examination of the Huddersfield College. There is much in the design and in the constitution of this establishment — there is much in my judgment at least — which entitles it to warm sympathy and active support. My own prepossessions — prejudices, if you like to call them — have been long powerfully associated with the ancient endowed institutions, generally called the great public schools of this country; but I have been long convinced, that in many portions of our land, especially in districts like this, where a long course of successful industry and enterprise has drawn together large masses of people, and has elevated many of them, I do not say to any overweening luxury and opulence, but to honourable and dignified competence, it was most expedient that the means of useful and liberal education should be brought near to their own doors and homes, and that a system should be introduced in which scarcely any of the polite and humanizing branches of study should be omitted, but, in addition to this, more of a practical character, as well as of a comprehensive range, should be given to the customary methods of instruction. I rejoice to perceive in the plan and the very fundamental constitution of this establishment, a full admission of the principle, — of the indispensable principle, in my view, — that all acquirements should be grounded on a religious basis; and I am equally impressed with the urgency, that in any new system aiming at general utility, placed not merely in such districts as that to which I have adverted, but subsisting in such times as those we live in, its benefits should not be fenced in by any exclusive barriers, or founded upon any denominational tests. I do not mean to depreciate the immense importance of our own conscientious convictions; but while I would never discountenance adherence to our own sense of right and duty, I would most strongly recommend the establishment of such institutions, as, without wounding the susceptibilities of the individual conscience, will give the fullest participation of their common benefits to all who may be disposed to enjoy them; and, indeed, I feel no surprise, from knowing those by whom this Institution was mainly founded, and upon looking round me, as at this day, upon many by whom it is still upheld and fostered, that I can trace in the constitution and character of this establishment no deviation from the great principles of religious freedom. Depend upon it, there is no more fitting and genial shelter under which all sound and useful studies, and ornamental accomplishments, can thrive and spread, protecting them alike from the chilling and nipping blight of indifference, and from the blasting breath of bigotry; and tempering habits of independence and self-relying thought with profound humility for that which is supreme, and with tenderness and reverence for the conscientious convictions of others.

I should now just wish, with your kind allowance, to address one or two words of sympathy and counsel to the younger portion of the audience, to those who are the peculiar subjects of the exhibition of this morning. I feel that I may spare all congratulation to the actual receivers of the prizes — to the victors in the lettered ring. The palm that has been assigned to them in the face of an interested and applauding auditory, must be quite sufficient reward in itself, and they will not want any words of mine to enhance it. What I want all, whether successful or unsuccessful competitors, to remember, is, that the acquisition of knowledge is its own chief reward. It is to be valued mainly not for the light in which it exhibits us before others, or the position in which it places us in society, but for what it makes us in ourselves—susceptible of what is beautiful, pursuers of what is useful, practisers of what is right, masters of ourselves, and beyond and above the reach of circumstances. In this attempt to enumerate the proper and best results which can be derived from the acquisition of knowledge, I intend to include all its branches—from the highest and most indispensable, to what are considered the more practical and common-place, or the mere subsidiary and ornamental. None of them, in their several spheres and degrees, ought to be overlooked or slighted. When I allude to high and spiritual matters as the most indispensable, I hope I sufficiently indicate my own meaning. Take away the higher truths, and the most practical pursuits are but labour in vain, and the most graceful acquirements are but fading wreaths hung round empty bowers. But in just subordination to these, I am very glad to observe that considerable attention is bestowed upon what are called classical studies, the knowledge of the Greek and Latin languages, and others. Perhaps you will think that in this observation I am betraying some of the prepossessions or prejudices connected with my own early education, to which I before adverted; but I am most deeply persuaded, that a knowledge and acquaintance with the immortal works contained in those languages,—not, however, I admit, to be too exclusively, or encroachingly, or universally insisted upon,—tend more, perhaps, than any thing else, to train the judgment in composition and criticism, to refine and educate the general taste, and to give at once vigour and grace to literature and to thought; not to mention the never failing sources of refreshment and delight which they secure to their individual votaries. If I do not refer so pointedly to what may be considered the more useful and practical branches of study, whether you include the knowledge of modern languages, the mastery of all resources of arithmetic, and the rudiments of the leading sciences, it is not from underrating their great and prominent importance, but because their advantages, though immense, are of a more obvious character. They come home almost to all our pursuits and occupations, and cross us in almost every path of life. Well, then, my young friends, if you will allow me to turn myself to you,—when the motives for diligent application are so varied and important, when the returns to it are so sure and so promising,—for though we hear very often of bad bargains and ruinous speculations, yet I feel sure, however long your life may be, you will hardly, in the course of it, ever meet with a man who will tell you that he regrets the time which he has spent in the acquisition of knowledge, or repents of having become a scholar,—resolve now, if you never did so before, not to lose those precious hours, the weight of which may be prized in gold, while they have the speed and lightness of feathers; and most of all, I wish you to prize beyond all other acquisitions — beyond the acquisition of learning, however solid, or the mastery of accomplishments, however brilliant; prize before them all, the formation of individual character, the building up of moral habits, the whole pervading discipline of duty. Join docility and teachableness in your studies to that independence and resolution of will, which will enable you to apply and to appropriate to yourselves the teachings of others' wisdom, and the lessons of your own experience; so that when the time shall come for your leaving the friendly shelter of this institution, and for launching out your small barks into the wide and stormy sea of life, you may not only carry with you those honourable certificates of approval of your past exertions and conduct, which I have had the satisfaction of delivering to two of your number this day, but you may go forth into the busy arena of the world, and there, whatever may be your special calling,—in literature and art, in science or in business, amidst public avocations or among family connections,—you may at last, one and all of you, be fitted and prepared to play the part of useful Christian citizens.

I would now only gently remind even those who have so honourably come forward in support of this institution, that while they desire to promote the cause of a creditable and liberal education amongst those members of society for whom it is calculated, they must not forget, that in these times it is most indispensable to the welfare and even to the salvation of the country at large, that the benefits of education should not be confined to any particular class of persons; but that they should be extended to every species of occupation, and to every department of society. Given already to the nobles, to the merchants, to the master manufacturers, they ought not to be withheld from the mechanic, the labourer, and the cottager. You have made ample and splendid provision in order to meet the exigencies of those that are, comparatively speaking, in easier circumstances, and in so doing you have done most wisely, and most well. May those classes enjoy and appropriate the advantages thus held out to them; may we hear of your sons giving themselves up with ardour to all the studies of this place; may they delight in the sublime lay of Homer, and the faultless line of Virgil; may they obtain a proficiency in every polite and graceful accomplishment, or wing their adventurous flight through the highest realms of science! But while they do all this, be it our care also to provide that, if you will, a plainer, but still a sound and substantial, nourishment shall be afforded to the bulk of the nation, to those who make the pith and marrow of our people. See that it is put within their reach; see that it offers itself to their notice; see that it wooes their acceptance; even let it be pressed upon them, though they should at first sight seem unwilling to take advantage of it. While you support Academies and Colleges, give your assistance and your countenance also to working mens' classes, and to Mechanics' Institutes. While you amply uphold the credit of Huddersfield College, promote also the prosperity of the day-school, and the Sunday-school. Let education be provided for the heirs of poverty and the children of toil, as a genial relaxation from the weary hours of labour; let it be provided for them as a solid and sustaining nurture for the intellectual, the moral, and the spiritual cravings of their nature. And let me give this parting exhortation to you,—that within the whole range of your several spheres, according to the best of your abilities, you should promote the united cause of a free conscience and a universal education.

YORKSHIRE UNION OF MECHANICS' INSTITUTES.

(*Wakefield, May*, 1844.)

It has so happened, that although I have long been most fully alive to the great utility and advantage of the institutions which generally go by the name of Mechanics' Institutes, this is the very first time at which I have been able to attend the regular proceedings of a Mechanics' Institution within the county of York. To the members, indeed, of these Institutes, to the great body of the mechanics of the West Riding of Yorkshire, I may flatter myself that I am not wholly a stranger; many of us have met upon other occasions, and upon a different stage; but however important such occasions may have been, and however interesting or lofty the themes which belonged to those other theatres of action, a gathering like that of this evening has one evident superiority; it embraces no topics of difference, it marshals us into no opposite ranks of party or denomination, it has nothing to do with conflict; all it has to do with is co-operation. I look upon Mechanics' Institutes as both a creation and a type of the days in which we live; the influences of which they were born, and of which they breathe, are wholly of modern growth. The time was when, in the immediate neighbourhood of the place where we are now met, the opposing armies of the rival Roses were drawn up in menacing array, and soon mixed in murderous conflict; but now, gentlemen, instead of such a competition between us and our good brethren of Lancaster, the objects of our rivalry are, the number and excellence of our respective Mechanics' Institutes; this is, you will agree with me, a far better sight to exhibit in the eyes of heaven and the world than the brawls between the troopers of Warwick and the retainers of Clifford, when Baron was hewing at Baron, and Franklin hacking at Franklin. These revolting scenes, however, have left no other memorial than the exquisite little chapel on the bridge which spans your now peaceful Calder, raised to make propitiation for the souls of the slaughtered; and the days of the Barons have become the days of Mechanics' Institutes. Not that the one came in immediate succession to the other. After what may be especially called the feudal era, there came gradually the days of industry and enterprise, of the stout labourer, and ingenious artificer, and busy trader, and active merchant; nor can we say that their day is yet over, nor must we wish it to be over. No; by the activity of our enterprise and the energy of our industry we have raised a population so vast, and reared a dominion so mighty, that we cannot stop, even if we would; and the wealth which may have once been only considered as the glittering prize of ambition, has become a condition and a necessity even of our national existence. But within a period of almost the youngest life amongst us, new influences have been brought to bear, especially, on the working and industrious classes of the community; a new spirit has been breathed into the dry frame of trade and enterprise; and the education, and the accompanying knowledge, which formerly only graced, and that sometimes very superficially, the more privileged and opulent members of the community in the warehouse and counting-house, have now struck their kindly roots deeper down, and visited the mechanic at his workshop, and the weaver at his loom. Instead of merely impregnating the upper layers of the mass, they have penetrated, and warmed, and vivified the whole body beneath. In the process of this, I will not say, revolution, because the word sometimes conveys the idea of something violent, formidable, and convulsive; but of this great social recovery, this gradual and genial progress, Mechanics' Institutes and similar institutions have borne a conspicuous and most creditable part, and in the furtherance of Mechanics' Institutes, as in other good things, the men of Yorkshire may claim a very honourable share. Why, they produced from among them Dr. Birkbeck, who I believe may be justly considered their original founder; and they honoured, in the election of Lord Brougham, one of their most efficient patrons and supporters. I say nothing of those who are now prominently engaged in this good field of action. It is, therefore, with much pleasure that I witness such a meeting as this, which, to say nothing of its more ornamental portion, comprises not only so goodly an assembly of the members and mechanics of this fair city of Wakefield, but shows, by the number of representatives and delegates which it has brought together from other similar bodies within the Riding, that there is a sort of corporate life among you, not perhaps equally vivacious and mettlesome in all the limbs, but still ready to feel sympathy, and to communicate energy; to assist the struggles of the weak, and to applaud the success of the strong. May this wholesome and precious rivalry long continue, in which, while it will be an honour to be first, it will yet be a pleasure to be outstripped! In truth, the circumstances of this great district ought to command the general prevalence and hearty support of institutions of this character; you have here the large accumulation of great masses of people; you have a great diversity and keen competition of employments, exciting ingenuity, and stimulating discovery; the nature of your occupations is such as to call for all that can be procured in the way of refreshment and relaxation. In your busy and engrossing occupations, toiling at your daily task, and for your daily bread, you may certainly be without those opportunities and aids to advancement in study or in discovery which belong to studious ease, or to learned leisure; but it is not from these quarters that the most brilliant contributions to human advancement have been always made; it was not from these classes that Watt, or Brindley, or Fulton, or Burns, or Chantrey, came. In my travels on the great continent of North America, I chanced to fall in with a blacksmith in one of the interior States, who, while he most assiduously performed all the requirements of his calling, accomplished the mastery of, so as to be perfectly able to read, about fifty languages. I have just put down an extract which was made from the journal of this blacksmith linguist; it is a diary of his daily business for five days taken by chance in the course of the year. The extract is from the commonplace book of Elihu Burritt, in 1838. " June 5th. Read fifty lines of Hebrew, thirty-seven of Celtic; six hours of forging. June 6th. Read thirty-seven lines of Hebrew, forty of Celtic; six hours of forging. June 7th. Read sixty lines of Hebrew, sixty lines of Celtic, fifty-four pages of French, twenty names of stars; five hours of forging. June 8th. Read fifty-one lines of Hebrew, fifty lines of Celtic, forty pages of French, fifteen names of stars; eight hours of forging. June 10th (Sunday). 100 lines of Hebrew, eighty-five pages of French, four services at church, Bible-class at noon." For many days he was unwell, and sometimes worked twelve hours at the forge; so that it seems that he did not come within the Ten-hours bill. Now, lest you should be tempted to think that the concerns of his handicraft interfered with or were prejudicial to his course of study, I shall subjoin a remark which was made with respect to him by Mr. Combe, the eminent phrenologist, who travelled in America, and who gave the greatest attention to the developments of the human head, and to the conditions of human health. Mr. Combe says: " One thing is obvious, that the necessity for forging saved this student's life; if he had not been forced by necessity to labour, he would in all probability have devoted himself so incessantly to his books, that he would have ruined his health, and been carried to a premature grave." So you perceive that work may not only be no drawback but even an assistance to the most intense literary labour: the patient achievements of well-directed industry, and the heaven-kindled flame of genius, are confined to no order of our fellow-men, and are denied to none. The Mechanics' Institute is quite as likely as the country churchyard to produce,

> " Hands that the rod of empire might have swayed,
> Or waked to ecstacy the living lyre."

But then, if it does produce them, it is much more likely to discover them, develop them, and to give them to mankind; if we do produce them, we will not keep our Miltons "mute and inglorious," as they were in the churchyard. As for our "village Hampdens," I do not know what we can do with them. I hope I say it without offence to a very excellent and kind-hearted neighbour of yours, I do not know what else we can do with them than send them to protect Heath Common against its threatened inclosure. For these reasons, as well as for many more that have been often better said, I do hope that all whom I now address, and all whom my words may in any way reach, will continue and extend their support of all Mechanics' Institutes within their neighbourhood and influence. They will do well to attend to all suggestions respecting improved methods and enlarged means for instruction and enjoyment which the progress of time and the increased attention given to the whole subject will be continually supplying. I need not caution you not to make your proceedings too frivolous, or occasions either for idle dissipation or boisterous clamour; but neither would I have you make them too grave and stiff. You may generally mix the acquisition of sound knowledge and rational improvement with social enjoyment, with occasional merry-making, with all that lights a smile on the brow of care, throws a spell over the weariness of labour, or promotes mutual good will and neighbourly heartiness; nor need I add, that, although in the remarks which I have made I have confined myself to what seemed the direct object of these institutions, that is, the promotion of useful knowledge and the pursuit of rational enjoyment, I might remind you that, while all kinds of knowledge are useful, there is one, and perhaps only one, which is absolutely needful; and while of all knowledge we are told that it shall vanish away, of Christianity we know that it never faileth.

LEEDS MECHANICS' INSTITUTION.

(*February*, 1845.)

MR. CHAIRMAN, LADIES, AND GENTLEMEN,

Even without the very friendly introduction of your chairman (Mr. E. Baines), I should have felt that I did not present myself before you as an absolute stranger. When I have come before you, it has generally been under the pressure of some exciting topics of the moment, and also at periods when I could not hope to chime in with the unanimous feeling of all who might hear me. On the occasion of our present meeting, though our topics are not deficient in interest or in dignity, yet I am happy to feel that they are calm, conciliating, and combining; and that not one person whom I have the pleasure to address, probably, will find any opinion of his ruffled by any counter-sentiment which I may have to offer. That the constitution and purpose of your society—the object and spirit which has brought together this intelligent and genial assembly—exactly falls in with all my sympathies, and stirs up all my warmest interest, it will be almost superfluous in me to declare. If I wanted testimony to the value of such institutions, I do not think that it could have been borne in a more interesting or striking manner than in the address which you have just heard from your late honorary secretary, Mr. Kitson, who, in addition to the happy and encouraging results which he has observed in others, tells you, with all the force and warmth of his own consciousness and his own gratitude, that if it had not been for the Mechanics' Institution, he probably would not have stood before you in the same honourable position, and in the same creditable sphere of society, which he now fills. I should feel the utility and importance of such an institution in any place whatsoever; but I feel them most abundantly in this busy city, in this populous district, in this stirring hive of industry and enterprise, amid these bristling stacks of chimneys, this roaring clatter of wheels, this ceaseless hum of tongues, this wear and tear of human life. Do not think that in any of the expressions that I have used I mean to depreciate the dignity of labour, or to rob it of any of its well-won honours. On the contrary, when your chairman was talking just now of temples erected by the pagan population of Rome to Virtue and to Honour, I cannot help feeling that if I had lived in the old times of mythology, almost the first power to which I should have been willing to pay divine honours would have been Labour. Indeed, of all the heathen gods and goddesses, by far the most creditable character seems to me to have been Vulcan, who went hammering on in his sooty forge, while the rest of them either indulged themselves in idle dissipation, or were engaged in slaughtering the unhappy mortals supposed to be subject to their caprice. If I wanted to cite a testimony and an evidence of the magic power of labour, and of the mode in which it can alter the whole surface, and transmute the entire substance, of the matter on which it acts, I think I might adduce as my proof the contrast of the times when your forefathers met to transact the business of the year under the old oak of Skyrack, or when the cloth market of Leeds was held upon the bridge, and the clothiers exposed their goods upon its battlements; and of these our own times, when every hill and valley teem with life and occupation; when the moorland is turned into hamlets, and every hamlet has become a town, large and important in itself; and the rustic lanes of olden times are transformed into crowded thoroughfares and busy markets, where the interchanges of a wide-spread commerce are being passed and repassed in their perpetual current; where the fleeces of the Elbe, or the Crimea, or Australia, are mixed up with our home-grown "noils and shorts;" and whence the products of your looms and your workshops are sent forth to clothe the freed inhabitants of the West India Islands, or the countless hordes of the farthest China. I am, indeed, far from belonging to that fond, and, as I think, rather foolish school, which is always looking wistfully back to the past, and thinking that our sires had a better job of it than ourselves. I am, indeed, far from questioning that this school comprises many very able and amiable men. At the same time, I own that "Young England" has rather too much of Old England for me. I cordially believe that, on the whole, this is the time, and this is the country, to live in. When I say this, I am far from meaning that all is just as it should be. I know that there is much which is amiss, and which needs to be set right. There are our dwellings,—sewerage,—the supply of water, of air, of light,—improvement in education, both in quantity and quality. Above all, there is a deep, stagnant mass of poverty, which needs to be moved, and sifted, and uplifted. But still, making all due allowance for these real and unquestionable drawbacks, I believe that there never was a community like that which an eminent and lamented writer, the late Dr. Arnold, termed "this kingly commonwealth of England,"—there never was a period like the present, which afforded more food for every appetite of manly intellect, and more scope for every exercise of active virtue. I believe there is scarcely anything which might not be attained, if we could only one and all of us determine to rise up to what we might be; if it could only be felt thoroughly by every one of us, no matter how humble his place, or how contracted his sphere, that each one has his own appointed work and mission,—not, assuredly, by indulging in any puffed-up opinion of his own capacity, and endeavouring to escape from his natural place or his allotted business, but by constant and conscientious perseverance, in which he might do much, very much, to smooth all the troubled elements of the daily life around him, and to aid the general welfare and advancement of his species. I believe that there is nothing at once so ambitious, and yet so humble, as duty; and it is the true, the practical, the Christian philosophy to endeavour rightly to apportion and attemper the ambition and the humility. It is because I believe that labour affords the main occasion and chief exercise-ground of duty, and because I see what labour has already done, and stretch my eyes forward to the yet greater things which it has to do in the world, that I said that if I had lived in the olden times, I should have been ready to build temples and altars in its name. But when I give this merited praise to labour, I believe, at the same time, that, with a view to the interests of labour itself, with a view to its vigorous, and permanent, and cheerful exercise, we ought not to exact too excessive and engrossing a service; but that breaks and relaxations are desirable, and salutary, and even necessary, to its own proper development and support. It is, therefore, that I love to read occasionally of the expeditions made by the Monster trains which convey large numbers far away from the smoke and confinement of their own streets and shops, to see whatever may be worthy of note, upon the many points of that great net-work of railways by which we are in the process of being surrounded,—to the crowded quays of Liverpool or the gothic aisles of York; and I should not repine—let me say it with the peace of Mr. Wordsworth—if a protracted line of railway should, on some sunny afternoon, carry a large bevy of the tradesmen of Leeds to the soft margin of Windermere or Ullswater. It is on the same ground that it has given me peculiar pleasure to have the privilege of witnessing and sharing the celebration of this evening, in the midst of such a community as I have already adverted to, and in the presence of such a company as that which I now see around me. It has, indeed, fallen to my lot often to be present at what are termed fashionable amusements in various quarters of the globe, and I have always found that they are pretty much the same thing wherever in the world it might be—whether amongst the courtier circles of St. Petersburgh, or the republican dandies of New York. I do not mean to assume any very severe or moralizing tone with respect to the attempts of people to amuse or enliven themselves, but I must say that I have generally found these very polished amusements to be rather listless, unmeaning, and unsatisfying things, where people seemed to come because they had nothing better to do, and to find it a great relief when it was time to go away. But an assembly like this, confined to no class or walk in life, comprising very many of what are termed the middle and labouring classes of society, those who keep the business of daily life really going, brought and kept together by no other tie than the love of knowledge, the wish to attain it and to communicate it, to acquire for themselves and to dispense to others the reciprocal benefits of instruction and advancement—this, to say nothing of its being more useful and more ennobling, seems to me a far fresher, livelier, heartier thing, than the high-flying entertainments I have adverted to,—the morning battue or the midnight polka. The constitution of your society seems to me to embrace all the objects which it must have been designed to accomplish. I am glad to hear from the lips of your respected chairman that it has lately been growing by hundreds, and I hope the time is coming when it is to increase by thousands. The purposes which it effects seem to me to supply a suitable and harmless relaxation to the strain of daily toil, and a pleasant variety and stimulus to what is, perhaps, even worse than the strain and severity of toil, the sameness of habitual routine. The mechanic or the operative, shut up during the day within the precincts of the shop, or with his ear dulled with the recurring sound of his shuttle, may here learn something of that Nature from the personal observation of which he is, in a great measure, debarred; and something of the past history of his country, to whose wealth and power his industry and enterprise make no mean contribution; or something of the links which attach him to higher and more enduring destinies. The delivery of oral lectures and the communication of original papers appear to me to be a most valuable supplement to the hoarded treasures of past wisdom and genius which are stored in the volumes of your libraries. On looking over your report, I was greatly struck with the interesting subjects which formed the materials of the lectures and papers which have been read and delivered during the last year; and I now rejoice to find that your chairman himself shortly meditates to give you a history of the invention of that art of printing, which, in its maturity, has been so honourably illustrated by the name he bears. If I had to choose one of the most encouraging and gratifying circumstances of the times in which we live,—if I were asked the feature in them upon which I should be inclined to dwell with most of complacency and hope, I should not select even the expansion of commerce, or the revival of trade, little as I should be disposed, anywhere, and least of all in this neighbourhood, or this society, to undervalue the numberless direct or indirect advantages connected with these considerations; nor yet the increase of our naval force, though I concur in the probable expediency of such a step; nor still the wisdom of any of the provisions of the recent budget, for which I trust I may be allowed to do justice even to a political opponent: but it would be the manifest increase and development of that kindly and considerate spirit, which in so many quarters and in so many directions seems to be guiding many of the wealthier and more educated classes to improve, cheer, and elevate the condition, to consult the present comfort—and the abiding welfare of their worse-provided and destitute brethren. I do not seek to attach an exaggerated or undue importance to any single measure or undertaking of the sort—public libraries in one place, public laundries in another, public walks and parks in a third. I know that wisdom is not always inseparably to be found even in a library, and that health cannot be commanded in every case, even by the Hydropathic establishment of Ben Rhydding. But I believe all these measures to be useful as auxiliaries; I believe them to be conceived in a right spirit, and to be directed with a proper aim. I know that the mass of penury and wretchedness which occasionally may fester in your streets and wound the eye of day, or else shrink to pine and perish in the shade—and I am sorry to observe that the recent experience of some of you bears witness to these dark truths—I know that this unsightly and gloomy mass cannot be raised by any single wrench of the lever, or be moved by the prowess of a single arm; but if a persevering, and discerning, and conscientious benevolence will keep itself fixed to the work,—if it will stretch out its many and far-reaching hands, loaded with the supplies for all the necessities of mankind—food for their hunger, medicine for their sickness, air and light for their dwellings, culture and instruction for their ignorance, relaxation for their long weary spells of toil, the vigour and buoyancy that wait upon that blessed thing called progress, there is nothing that I would despair of, from the efforts of the enlightened sagacity of our day, ministering the charity of the Gospel. I do not wish to arrogate too high or solemn a character for our present proceedings, or for the gathering of to-night, but I believe them to be subsidiary to the graver duties and sterner business of life. Looked upon in that light, I believe such meetings and such institutions to be conducive to sound information, to refined accomplishment, to social enjoyment, to mental and to moral progress; and thus esteeming them, I have no hesitation in giving, and in commending to your favourable acceptance, "Prosperity to the Leeds Mechanics' Institution and Literary Society."

SUNDAY SCHOOL JUBILEE.

Halifax, June, 1846.

Ladies and Gentlemen,

I am extremely obliged to you for the great kindness and warmth of your welcome to me. I must state to you, that I come before you, at present, in rather a chance or haphazard manner, and it was a very sudden thought my finding myself able to be here at all; so that I am by no means able to address you in anything like a prepared or premeditated harangue. But knowing that you were to meet this evening, and having been favoured with an invitation to be present on the occasion, I could not forego the sincere gratification which it gives me to find myself among such an assembly, upon such an occasion, and at the close of such an exhibition as we have beheld this morning. I was very sorry indeed to be prevented by an inevitable engagement from witnessing more of that interesting and elevating spectacle than I did, as I only came in at what may be called the tail of it; but I did see enough, and I did hear enough, to convey impressions which I feel assured will remain to the end of my life. I have, indeed before, had occasion to be present, and even to be a speaker, in that same noble area, the Piece-hall of this town; but then it was upon occasions which took place amidst the maddle of electioneering bustle and the din of political excitement. I confess, that it was a very pleasant and a very soothing contrast to be present in that same space, upon an occasion when all who are brought together seem to breathe the same atmosphere of good will, of harmony, and of love; and I felt sure that no more precious and acceptable offering could arise to the skies than the hymn which came from so many thousands of artless youthful lips, and the homage that I hope ascended to the same quarter from hearts upon which the passions and vices of the world have as yet been able to infix no stain. But, gentlemen, glad as I was to be present at the assembly of young children this morning, and amply as I participated in all the emotions which that exhibition was calculated to convey, I feel I pay a debt of still more strict justice and obligation by coming this evening among the instructors and teachers of those children,—among those who not only teach the infant notes to join in the hymn of praise, but those whose higher and still nobler endeavour it is to instruct the youthful mind and to improve the youthful heart. Such, my friends—whether men or women—such is your praiseworthy and noble endeavour; and I have long felt convinced, both from what I have observed, and still more from what I have been able to collect and learn from others, that it is scarcely possible to overrate the real solid and practical good which is conferred upon our common country by its Sabbath school teachers. There may be those who come forward more prominently and more noisily in the service of their species, in the busy and tumultuous scenes in which my lot is cast. When I resort to the great metropolis of this empire, I see crowds of people, some of them plunged in the giddy round of dissipation and the frivolous routine of fashion,—some of them striving, one after another, upon the ladder of ambition, and all engrossed in an absorbing course, whether of pleasure or of business. I will not deny, that it is the bounden duty and proper vocation of many to mix in those scenes, to bear their part in the strife of the political arena, and endeavour to do what good they can to their country and to their kind, in the various walks of public and political life: but those aims and those labours, however necessary in themselves, however laudable when properly pursued and duly superintended, are but too often mixed with the promptings of selfishness and vanity, and with the desire of personal aggrandisement. But no such drawback seems to me to present itself when we consider the exertions of the common Sunday school teachers, when we consider those exertions which it is your habit and your pleasure soberly, and quietly, and unostentatiously to carry on in your several districts and neighbourhoods, very often unmarked by society at large, very often without meeting the praise of your fellows, sometimes even encountering their obloquy, sometimes provoking their ridicule; sometimes being questioned how you can be weak and foolish enough to take so much pains about what does not concern you, and about what does not profit you; about that which does not actually put any money in the purse, which does not bring any grist, as they say, to the mill, — and with no other incitement but the sense of duty which you feel, in your own consciences, and the experience of the good, which, day by day, week by week, and year by year, is manifesting itself around you; for you best know— you, the instructresses and instructors of the Sabbath schools, best know, both what amount of real and practical good they are calculated to effect in this country, — and I will say in this county, situated and circumstanced as it is, and especially in so busy a manufacturing neighbourhood as this; or, rather, you best can feel what a void, what a cruel loss would be felt, if by any sudden calamity your ministrations could be closed, or the Sabbath schools of this active district shut up and abandoned. I know it must be often irksome to you; I am willing to suppose that you will not have been influenced by that weak and unprincipled scoffing to which I have just alluded; I know that you will think, when the path of duty is plain before you, it is your duty to tread it. But I feel that very often it is no common sacrifice you are called upon to make. I know what a life of toil, of exertion, and of watchfulness must be the lot of many of you. I know that many of you have to labour the whole week long in your warehouses, at your counters, in your shops, in your mills, in your factories, and in your quarries; and I can well conceive, that when the seventh day comes, especially after you have given its due portion to the services of the sanctuary,— I well know what a temptation there must be before you, either to enjoy those beauties of nature, and those pleasant walks with which this neighbourhood so eminently abounds, or to spend more time in the family circle and by the family fireside, and thus to rest in comparative inactivity altogether. But you forego these claims; you are willing to make the seventh day also, —I will not say a day of toil, but a day at least where love is labour; for you feel what an awful thing it would be to see the infant and young population of these crowded districts growing up, themselves subjected to wearing and harassing toil, often debarred from the opportunities of education, often destitute of a father's care and a mother's love, exposed to all the temptations of evil association and bad companionship,—you know what a desolating and awful thing it would be if this youthful population should grow up without any knowledge of the duty they owe to their neighbour, without any instruction in the faith which is to make them wise unto salvation and bring them to their God; and when I looked at that interesting crowd before us to-day, of those who, though now small in stature and weak in strength, are yet to furnish the skill and sinews which are to continue the wondrous processes of British manufacturing ingenuity and enterprise, and who are to bequeath the riches of English industry and augment the glories of the British name, when you, their teachers, are silent in your graves, I could not help breathing a fervent aspiration in my heart that when the time shall come for them to emerge into manhood, and they shall meet the crosses and be exposed to the temptations of this weary and wicked world—when for instance the invitation of the drunkard shall be sounding in their ears, or when the call to dissipation shall be spreading all its allurements before them,—the recollections and impression of the Piece Hall at Halifax might come upon their minds, that the infant hymn they had raised in the days of their youth might yet ring freshly in their ears, and that they might determine to abide by the better inspiration of their youth which you did so much to keep straight and active in the path of duty, in the ways of virtue, and in conformity to the will of God. It does not become one such as I am to offer anything in the way of advice or suggestion to such a meeting as the present, especially as I am quite ignorant whether there is the least occasion for it. But in considering the subject of Sabbath schools, it sometimes comes to my mind, that whereas the young people are themselves exposed to a great deal of toil and hard work during the week, and necessarily must undergo a considerable degree of lassitude, some degree of caution should be observed, lest the pleasing ideas which I should always wish to see attached to the Sabbath might be interfered with, and that too much confinement, too much keeping within doors, too much of what is called commonplace school work, should not be exacted from them. I know that the circumstances of their position in life, I know that the circumstances of this district, render it absolutely imperative, render it an unspeakable blessing, that Sunday schools should exist, should be encouraged, and should be increased; and it is because I wish them well, and it is because I wish you well in the charge you have so nobly undertaken of them, that I came here to-night. But still, one and all, I should wish you to remember that the string ought not to be strained too tight, that a proper degree of rest, relaxation, and of innocent amusements appropriate to the Sabbath should not be interfered with, and that the young should be enabled to associate it with ideas of enjoyment, and of calm and peaceful happiness. In what follows, I feel sure you have no need of being admonished by me or by anybody else; but I should be very sorry if in Sunday school teaching there was any of that degree of harshness or of crossness which sometimes will occur even among the most meritorious professors of week-day education. Let nothing occur on the Sunday which shall not convey an idea of love, and be connected with thoughts of peace and pleasantness. There was another most agreeable feature in the meeting of this morning, and that was the number and variety of the different denominations which it brought together. I always think religious differences — though I believe, at least in our day, they are likely to be inevitable — are among the most unpleasant and distressing features of the times, and anything to promote religious sympathy, religious concord, and religious harmony, I hail, even independently of its own recommendation and merits, with added cordiality. I do not say anything to tempt you to undervalue the respective differences which you have severally been led conscientiously to adopt. I know how much that is valuable depends upon a strict and steadfast and undeviating compliance with our own inborn sense of truth. But separate opinions may have separate spheres of action, just as in the concerns of that delightful art, which I believe you must have largely practised, from the proof and evidence I heard of it this day — I mean the art of music: one voice is a bass, another is a tenor, and there are various other learned names for them, all proving that separate voices have their distinct and separate offices. When parties are called upon to sing a solo or a duo, they make a distinction of parts, but then there is nothing to prevent all those united voices joining in that common chorus of praise and adoration with which the hymn concludes; and in that way I wish you to maintain your separate differences. Maintain them where you are bound to do so, in your own consciences, in your own chapels, in your own cottages, but not so as to refuse to join in that common hymn of praise and adoration which all people in this world are surely intended to send up together to their common Creator and their common Redeemer. Now I have only to renew the expression of the very sincere sympathy which I feel with your objects, the very unfeigned admiration I entertain of the zeal and activity and self-denying love with which you pursue them. I know that the common awards of fame are usually bestowed upon persons and pursuits I think far less deserving of them. They are often given, in the first place and principally, to reward the destroyers and desolators of mankind, — those who spread carnage through peaceful realms, and visit with slaughter unoffending tribes of our species. But, my friends, my sisters, and my brothers, if you will allow me to call you so, you may not have the votes of senators and of Parliaments bearing your names, they may not appear in newspapers or in gazettes, but still, trust me, your labour is not lost, your reward insures itself. It is written in the approving sense of your own consciences; it is written in the gratitude, and, still more, in the improvement of the rising generation who are springing up to life and strength, and I hope to usefulness and to virtue, around you; it is written, above all, in the records of those awards which are to fix our fate in eternity, for I need not remind you by whom it is said — "He that doeth this to the least of these little ones doeth it unto me." I can add nothing to such encouragements. I most gratefully thank you for the kind attention you have now bestowed upon me. I accept with pleasure the signs you gave that you received and did not reject the relationship which I claimed with you.

YORKSHIRE UNION OF MECHANICS' INSTITUTES.

Huddersfield, June, 1846.

Ladies and Gentlemen,

Having been promoted by you to the honours of the chair, I have, in the first instance, to return my thanks to you for the invitation and permission to fill it, and to express to you the very lively pleasure which it gives me to meet you upon so agreeable and auspicious an occasion as the present. This, indeed, is not the first time at which I have had the gratification of occupying a similar post at a meeting of the Yorkshire Union of Mechanics' Institutes. I think it is now two years ago since I discharged the same office at the anniversary meeting then held in Wakefield. Then, gentlemen, I occupied what might be termed a private position; I was not then connected as a representative with the large constituency of the Riding in which we are now met. Since that occasion, I hope you will allow me to say, that I feel I have been regularly and legitimately qualified to fill the office which I now hold. I wish I could consider myself qualified in all respects, for I fear, as often happens to the chairmen of public meetings, that I am perhaps less accurately acquainted with the subject matter of which I have to speak than almost any of those by whom I am surrounded. I have not been able, from want of opportunity, perhaps from want of proper industry, to make myself so well acquainted as I should have wished to have been with the various operations and transactions of the separate Mechanics' Institutions in this Riding and in this county; and, therefore, I can only hope that those who will have to follow me will be able, as, indeed, I am confident they will, to supply all the deficiencies which must necessarily be found in my method of discharging the duties of the place I now fill. I had not even the privilege of attending the meeting of this morning. Therefore your chairman feels himself in the scarcely dignified position of having but little to say to you about the proper business of the meeting. But I know enough of Mechanics' Institutes, — I know enough of the good they are calculated to effect,—I know enough of the good they have effected, — I know enough of the encouragement which has been given them in this county, — and nowhere, perhaps, in a more marked degree than in the town of Huddersfield, in which we are now met, — to be able to express my full sympathy in the success of the cause which has brought us together this evening, and to join my exhortation to all the others that will be addressed to you, to give to these institutions every encouragement and support in your power. It is a rule most properly laid down at these anniversary meetings, that topics of a nature which might excite difference of opinion, and which divide the community into separate demarcations — such as questions of political interest — should be excluded from our consideration; and I am sure, for one, I heartily wish that many of those who may be considered my political opponents may be numbered among those now present, in order to join their efforts with those of my political friends in promoting an object destined to secure the common good of all. There is, however, one matter which has much occupied public attention of late, to which I cannot help briefly adverting — not for the sake of considering its political bearing, not for the sake of eliciting any opinion respecting it from any person who may be now present — but only in so far as I think it is properly and naturally connected with the specific business of the evening. The subject to which I allude is the question of the Corn Laws. And why do I make mention of that? Because, without adverting more at length to what is now passing around us, I trust that if we are justified in considering that this large question is settled — that this great controversy is cleared off, and has left an open stage, I trust I am then justified in recalling to your recollection, that there may be other questions eminently deserving of your attention, lying beyond it, and that even this question of the food of the people ought not to absorb all the legitimate benevolence — all the manly effort which may be stirring among you. I am sure that I shall be the very last person to underrate the importance of that great subject to which I have thus briefly ventured to allude. But it must be confessed, that, important as it is, it primarily at least is a question which refers to our material wants — to the body's food — to the body's growth — to the body's being. Now, bear in mind that the body, though it is much, — though it is that without which there can be nothing else, yet still it is not all — it is not the most important — it is not the most enduring—it is not the most divine part of man's nature. We may be right in our opinion that a repeal of the Corn Laws would not only bring more wheat for the food of man, but that it would bring more oats for horses, more maize for cattle, more provender for pigs. Well, that would be enough for them — the body's food would be enough for them. But men who think and reason — men who speak and argue — men who can form themselves into societies, and can receive and impart instruction, and can enrol themselves as members of Mechanics' Institutes, know that they require more than the bread that groweth stale, and more than the meat that perisheth. What may not be effected by the physical skill and ingenuity of man? His lips may utter, and his ears may drink in, all the modulations of sound and of melody; his eye may dispose the most ingenious intricacies of the most delicate patterns, and regulate the assortments of the most striking and splendid colours; his hand may mould the breathing brass or the speaking marble; and, above all, his mind may apply the wisdom of the past for the instruction of the future; it may solve the highest questions of science and philosophy; it may unfold the countless mysteries, the peerless beauties of nature, or it may people time and space with the most radiant creations of the fancy. Well, then, after we have provided for the body its coarser, though indispensable nourishment, I hope that additional care and additional knowledge will be brought into play to provide for those higher requirements to which I have just adverted. When Leagues and Legislatures have done all that in them lies to provide the body's food, I hope you will feel that your next great object is more completely to educate the mind, more thoroughly to elevate the soul. We shall then expect Lord John Russell to write one of his pithy letters against the evils of ignorance, which are still more mischievous, and still more fatal, than those evils of destitution, of fever, and of mortality, which he so feelingly denounced. We shall expect Sir Robert Peel to bring in his Bills, and to carry them too, with the same stout will which has lately signalised him, for the introduction of a system for the general education of the people. And we shall expect our Cobdens and our Brights to do battle for free trade in slates and primers, for cheap arithmetic, cheap chemistry, cheap geography, cheap astronomy, for learning for the many, and literature for the millions. Now, among the undertakings and institutions which have been most successful in promoting the instruction and enlightenment of the mass of the people, Mechanics' Institutes have occupied a prominent and distinguished place. I believe it was a Yorkshireman, the late Dr. Birkbeck, who was the first pioneer in introducing Mechanics' Institutes; and I think it must be confessed that, in Yorkshire, these noble and praiseworthy institutions, to this day, have found a congenial soil. I find, from the official records which have been presented at the regular meeting of the union, that twenty-nine institutions in this county were, before this day, connected with the union; and that twenty of these institutions contained an aggregate of 5594 members. I find that twenty-three other institutions applied, and I am happy to say, what is better than applying, they have to-day been admitted into the Union.

These twenty-three institutes number 3440 members. The aggregate of the number of members of Mechanics' Institutes in Yorkshire, connected with the Union, now amounts to above 9000 persons. There is a further gratifying circumstance, that the increase of members has, in the short space of two years, been one-fourth. Comparing the number of members with the number of the gross population of the districts in which the institutions are founded, it appears that one in every fifty-four persons is a member of one of the Mechanics' Institutes, while in some of the smaller towns — I may mention Pateley bridge and Ackworth — one in every seventeen of the inhabitants is a member of a Mechanics' Institute. Why should the larger towns not take a lesson from their smaller contemporaries? Then I find that various methods are adopted in these institutions. One locality finds that one system suits its operations better, while another seems better suited to a different atmosphere. But one great benefit and advantage of this union, and of this annual gathering, is, that it admits the several members to compare notes with each other, — to find what has succeeded in one place, and what has failed in another, — what is attracting members in one district, and what is repelling them in another, — what tends, in one place, to give a serious and practical character to the operations of the institutes, while, in another, anything which may be looked upon as of a more frivolous or derogatory character may, in its turn, be avoided. I am happy to find that, in all these institutions, several schemes most advantageous and most profitable have been established. In some of them there are all the varieties, while in others one or two obtained a greater vogue. I find that, in thirty-eight institutions, there are libraries which have 38,000 volumes, with an issue, in one year, of 173,000 volumes, made to 7900 members. With respect to evening classes, they seem to me to be one of the most profitable, and one of the most unobjectionable modes of operation which these institutes can assume. One third of the members of the associated institutes are, in the evening classes, receiving instruction in the various branches of knowledge. Eighteen of the institutions have given 235 lectures during the past year; twenty others have given 150; and the whole thirty-eight institutions have given nearly four hundred lectures during that period. In some towns and cities there are young and kindred institutions which go under the names of "Youths' Guardian Societies," "Mutual Instruction Associations," and "Mutual Improvement Societies;" and I would respectfully advise the members of Mechanics' Institutions not to feel any jealousy or grudge of these kindred societies, if they should exist in any town, and should, on the first sight, be thought to detract from the apparent numbers of the Institute itself. Depend upon it, that in this. as in higher matters, all that are not against us are with us; all that are seeking the same object — that are seeking to refine and elevate the taste, the intellect, and the soul, are most useful adjuncts and allies to Mechanics' Institutes, whatever name they may bear. Then I think that the members of these Institutes have exercised much wise discretion in not confining their branches of occupation to the severer sciences — to the drier, if they are the loftier, branches of learning, but have included within their range the domain of the fine arts, and some of the more polite accomplishments. I find that in many of these institutes there are drawing classes. At Halifax, there is an Art-Union for the pupils of the drawing classes, which is thrown open to the town; and in Huddersfield and Leeds, Schools of Design have been established in connection with the Mechanics' Institutes. Now, I rejoice extremely that this should be the case; and I would hold out this example to general imitation, because it seems to me that the delightful arts of drawing and of painting, provided they do not withdraw those who pursue them from those occupations which are necessary for them to follow, are pursuits which not only contribute to enlarge and exalt the taste, but it seems to me that an improved and inventive facility of design must tend greatly to promote the special pursuits of which such districts and such towns as these are the theatre. Where is it so much called for to make yourselves instructed in all the witcheries of design and in all the wonders of colour, as for the use of those looms, the products of which must arrest the giddy caprice of fashion, and captivate the fastidious glance of beauty? Where is it so proper to elicit all the combinations and inventions of the fancy as in that town which is the mart of the fancy trade? I do not mean that you ought to attempt to transfer to your tweeds, to your lastings, to your cassimeres, to your waistcoats, and to your trousers, the matchless outlines of a Raphael, or the glowing tints of a Titian, any more than I should expect that lectures given on the art of poetry should turn out so many ready-made Miltons and

Shakespeares, or lectures on astronomy so many Newtons and Herschels. But I entertain the conviction that a sound knowledge and appreciation of the principles of science will make you appreciate more rightly the real force of truth and reason, and also that a sound knowledge and appreciation of art will tend to fix in your mind, and to bring out in the products of your hands, the indelible stamps of proportion and of beauty. Then I find that in some of the Institutes there are classes for acquiring a competent knowledge of modern languages: and this seems to me to be a pursuit highly desirable in this age, in this country, and in this district. Why, the carriers and agents in the highways of commerce are, in some sense, the citizens of every clime, and are free of every community; and why should not our young men be able to drive their bargains, whether it be for the fleeces of Spain or for the oils of Italy, in the harmonious and soft tongues of those regions? I do not know whether my excellent friend, your worthy President, Mr. Schwann, would expect me to apply the same epithets precisely to his native tongue, but I am sure you all must be alive to the importance of rivetting, as closely as possible, the ties between the people of this country and the great German family. I also observe that in other of the Institutes there are classes set apart for acquiring a knowledge of the principle and practice of singing; and this, I think, in its place, is a very good pursuit too. I believe that the West Riding of Yorkshire has long been famous for its warblers. You will recollect that it is said that

"The man that hath not music in his soul
Is fit for treasons, stratagems, and spoils."

And so I believe that to sing gaily, cheerily, and in tune from the heart, it is almost necessary to have a good conscience. The graver pursuits, the severer walks of knowledge, carry their own recommendation with them. They must recommend themselves to all intelligent and inquiring minds; and, believe me, those who have pursued them in earnest—those who have dived most deeply into them, find that they bring with them their own reward. I do not feel it necessary, in addition to what I have said, to guard myself against attaching to knowledge, to science, to art, to fancy, and to genius, any undue or exaggerated value; I know that good and acceptable as they all are, yet there are better things even than these — things more important for man's happiness, and for man's virtue. I know that all you can ever read, and all you can ever learn, must fall short of a good temper and a good conscience. By a good temper I mean such a temper as will make you willing workmen, kind husbands, and affectionate fathers; and I will add — for I learn with great pleasure that some of the institutes have adopted the valuable and powerful aid of female association and help, — such a temper as will make you considerate wives and conscientious mothers; and by a good conscience, I mean such a conscience as will make you and keep you good Christians and good citizens. Well, gentlemen, by the side and in comparison with such attributes and qualities as these, I willingly admit to you, that the loftiest soarings of the intellect, and the brightest imaginations of the fancy, are poor and valueless. But surely it is a very vulgar and a very stupid error, to neglect or to repel anything that is good, because there may be something better. We are not apt to refuse a shilling, because we should think it still better to have a sovereign. We know that a shilling added to a sovereign will make a guinea; and so will knowledge enhance even the true value of virtue; and knowledge, like the shilling, very often tends to make up the whole sum of man's real sovereign virtue. And so, Ladies and Gentlemen, whom I am happy to look upon as the combined friends, and patrons, and members of Mechanics' Institutes, I trust that you will add to your knowledge, virtue; and that, in fostering and extending the range of these institutions, you will do what in you lies to make the toiling, heaving, straining mass of the population — too likely to be led astray, — too likely to be corrupted by evil associations and bad companionship, if left without the softening and elevating influences of taste and knowledge, — a cultivated, an educated, and if so, all the more probably, a contented and a virtuous people.

BRADFORD MECHANICS' INSTITUTION.

October 6th, 1846.

Ladies and Gentlemen,

I believe that it now becomes part of my pleasing duty to open the proceedings of this evening, and in doing so I cannot refrain from observing at the commencement that I believe, though I have in-several instances been in the town of Bradford, upon occasions of political excitement and upon the eve of contested elections, yet that it has never fallen to my lot before to visit Bradford on what I may be allowed to call a purely social occasion. And I have felt, that considering what the importance of this town and district is, and the conspicuous place which it fills in the manufacturing history of our country, its being in fact the seat and capital of one of the principal branches of our manufactures, the worsted manufacture of the country, and its having exhibited, perhaps, a more striking and prodigious growth than any other town whatever within the limits of the kingdom,— having, as I am told, from the beginning of the century, when it scarcely amounted to 5000 inhabitants, now risen to the ample dimensions of 100,000,—and, remembering further that it has been my agreeable duty to attend in other towns in your neighbourhood, having been at Huddersfield, at Halifax, at Leeds, and at Wakefield, upon occasions not in any way connected with politics, — I did feel glad that the time was at last come when Bradford was no longer to be an exception to that rule. In a town circumstanced as this is, among all the toiling, struggling, panting hives of men, women, and children which it includes, where so much of time and thought must necessarily be engrossed by the strain of the daily task, and by the care for the daily meal, I do think it most desirable and most salutary to have some common neutral ground, restricted to no condition, limited to no class, sacred to no denomination, but where all alike equally, and at all times, can meet together, without any restraint save that of mutual self-respect — without any laws save those of good manners, for the salutary and noble purpose of acquiring in the first place useful information; in the next place, of gaining some proficiency in any elegant accomplishment; or, in the last place, of partaking in innocent recreation. I think that in a community so situated it is most desirable not only to furnish facilities for your becoming proficients in study, and in the acquisition of useful knowledge, but also to provide means of enlarging the sum of human cheerfulness and contentment. I am glad, therefore, that you should come to the Bradford Mechanics' Institute, that you should come to its libraries, that you should come to its lecture rooms. I wish that all those who feel so proper and honourable an ambition should come here at one time with the view of acquiring some knowledge of the wonderful workings of nature, such as they are developed to us by the processes of inquiry and by the conclusions of science. I am happy to find that some of your lectures are set apart to these high and ennobling pursuits. I am happy, above all, to find that one of your number, a gentleman connected officially with the highest duties of this town, I allude to your Rev. Vicar,* not only makes presents of his works to you, but is himself the writer of works worthy to be presented. I am glad that at other times you should come here to gain a competent knowledge of the history of bygone ages, not only as that history concerns itself with the details of wars, which have too often been both bloody and unfruitful, with the mere annals of courts, with the intrigues of statesmen, and with the policy of sovereigns who perhaps may be only aiming at their own personal aggrandisement, but of that history which penetrates into the deeper causes that enter inwardly into the life of nations, that decide the laws by which states flourish and by which states decay, that affect the real condition, the average happiness, the daily comfort of the great bulk of the people. I am glad that at other times you should come to make yourselves adequately instructed in what is called the study of biography, in the histories and fortunes of those more remarkable men who have been the lights and models of the ages in which they lived — not only of distinguished generals and mighty warriors, who, though we may regret the effects on human happiness which have too frequently resulted from the bare pursuit of military glory, yet still in the details of their individual lives may often furnish very high and inspiriting lessons of difficulties subdued and hardships encountered, — but that you should augment your knowledge of those who have been the more real benefactors of the ages in which they lived, and who are therefore at least as fully entitled to the gratitude of nations, while they may divide with the others their admiration ; — I mean the inventors of useful arts, the discoverers of lofty truths, the martyrs to the sense of right and to the call of duty. And it is pleasing to think that our own times will be able to furnish many splendid contributions to the list of Worthies which I have thus characterised as proper subjects for Biography to concern herself with, and that she will be able to hand down to the latest posterity, together with the unconquered sword of Wellington, the equally enduring record of names such as that, for instance, of Thomas Clarkson, the man who

* The Rev. Mr. Scoresby.

gave the first impulse to the movement which led to the final extinction of the African slave trade, over whose honoured, but not immature grave, all who are best and most philanthropic in the land are now joining together in respectful sympathy. Well, then, I wish that those who feel the due ambition should come to your lectures and to your libraries, to advance and to improve themselves by such studies as those of history and biography; but I think, also, that after the tear and wear of daily labour in your workshops and factories, it would be very captious to object to a man, at the close of a well-spent day, if he felt disinclined at the time to give his attention to any of those severer pursuits, relaxing his mind either with the perusal of good poetry or of graceful fiction. With respect to poetry, I need hardly tell you that, in its proper sphere, lessons as thrilling and as exalting may be derived from the pen of gifted poets as from the most prosaic writings to which we could turn our attention; and, perhaps you will allow me to say, upon this head, at least, that your library, which seems upon the whole to be very well and prudently selected, hardly contains as yet such an assortment of good poets as I think ought to be found in it. And with respect to fiction too, though I would not recommend it as giving the same healthy tone and nourishment to the mind as other more practical pursuits, yet I am pleased to think, especially in later times, that writers of fiction have treated it both with so much refinement and so much enlargement of view, that lessons may be derived from the pages of the best writers of fiction, be they male or female, scarcely inferior to what can be derived from the study of facts. But then, ladies and gentlemen, are you ever too tired even to attend to reading of any sort, or have you no fancy, after a hard day's work, to take up the pages of any book? Well, then, occasionally, I certainly am not sorry to find that you have been in the habit, in this large apartment, of seeking further relaxation in good music and in occasional concerts. Still I know that good concerts and good music cannot be had without some considerable cost, and I think it would not be difficult to devise even less expensive pleasures with which occasionally to vary the long evenings of the winter. Now, why should not any of you, accustomed to come here after a day's work, meeting in the reading room or the library, occasionally prevail upon some one of your number who may be a good reader — and I am sure such are likely to be found among you — to read from one valuable work or other; or even why could you no enlist some one amongst those who are looked up to as moving in the more opulent classes amongst you, who would be good enough to give his time for such a purpose, and to read to any that may be gathered together in the evening, one of the best plays of Shakspeare, or a piece of Milton's Paradise Lost? And if you should find that the taste grows upon you, you might even take up Pope's Homer's Iliad. However, I leave all that to your own taste and discretion. Respecting those topics which relate more to the accomplishments and to the fine arts, I think it is very gratifying to find that you have established a school for drawing, and that it excites considerable interest among you. I hope you will carry that delightful pursuit still farther; and besides, it cannot be looked upon as a mere idle accomplishment, or as a mere delightful recreation — it will even stand the test of this utilitarian age. This town is largely engaged in manufactures. As I have said, it is busied with one of the principal branches of the manufactures of this country, and it is a branch of those manufactures in which the art of making suitable patterns and designs must find a place. Now, it is a well-known fact that in many respects the manufactures of this country defy all competition, and that in the adaptation of our machinery and in the intelligence of our operatives we are not afraid to confront the whole of the Old world and the New. But it is not less acknowledged by those who take an impartial view on such subjects, that we are inferior to many nations on the Continent as yet in the arts of design and colour, and that we have not arrived quite at that happy delicacy in making out those beautiful combinations in patterns at which some of our neighbours, especially the French, have arrived. Now, I believe there is nothing in the natural composition or genius of Englishmen which unfits them from excelling here as well as in other respects; but they have not yet made it part of their practical, positive business to attend to it; and with this view schools for drawing are most eminently useful. It may be that in drawing schools, where you have models put before you of the human form and other objects of that sort, you cannot see at first sight of what good they can be to you in making out a pretty and delicate pattern; but depend upon it that the eye which has been trained to all the true doctrines of proportion and beauty, will attain comparative excellence in every branch of labour to which it applies itself. And I do most earnestly hope that not only the working classes, the operative men, those who have to carry on the handiwork of the manufacturers, will attend to this suggestion, but that the great employers of labour will take it into their earnest consideration, too. I hope on all accounts that they will give an enlightened and liberal support to the general purposes of this institution. I feel it to be eminently their duty, but not more their duty than their interest, to take every means of surrounding themselves with an orderly, a refined, an intellectual, and an educated population, and I believe they will find this to be the case in every respect. It will return upon them in a thousand ways, however little immediately concerned the subject-matter of the studies may appear with the daily business with which they are connected; but as the poet Pope, whom I have once mentioned before, and whom I may specify, perhaps not as the first, perhaps not as the greatest, but as the most perfect of our poets, says—

"True self-love and social are the same;"

by promoting the good of others, you are sure in the end to promote your own; and so upon the most sordid calculations of interest, upon what concerns your pockets, you may depend upon it, that if in the long run the patterns and manufactures of other countries exhibit a decided superiority over your own, you will lose your hold of the market of the world. And, therefore, besides encouraging good order, besides encouraging general knowledge, besides encouraging useful information amongst those by whom you are surrounded, also promote that taste for beauty, that true conception of the loveliness of nature of which art is but another embodiment, and you will find it the best means, not only of advancing and elevating the population in which you live, but of rendering yourselves superior to all the competition of the world's rivalry. I am glad with this view to find that it is in the contemplation of the committee to found, I believe, a new condition of admission, by which, if a person subscribe a guinea a year to the funds of this Institution, he shall not only be entitled to share in all its privileges and advantages himself, but shall have the privilege of introducing two pupils gratuitously to all its benefits. And most gratified I should be to learn that the great manufacturers and employers of labour in Bradford avail themselves of this condition not only to associate themselves with this Institution, which I think would reflect such just credit upon them, but to give the means to those least able to afford it, of reaping the benefit which it holds out to its members. I am glad, also, to find another contemplated condition, which I think is conceived in the true spirit of Yorkshire liberality and hospitality, — that condition is, that when any member of any other Mechanics' Institution in the West Riding of Yorkshire shall be resident for a time within this town, he shall be entitled to free admission to the benefits of this Institution. I think this is an admirable rule, calculated not only to extend the benefits of your Institution, but to promote the advantages of communication and feelings of good fellowship among all those who are brought together by kindred tastes and by kindred pursuits. It would be in vain for me to dissemble, ladies and gentlemen, now that I have offered the few practical remarks which have occurred to me — it would be in vain for me to dissemble what interest I feel in all that concerns the real interests, and what pride I take in all that advances the real character of the inhabitants of this Riding. This important district comprises a vast number of large towns and communities which are themselves the seats and centres of kindred and analogous, though, I believe, in many respects, of somewhat different branches of manufacture. Well, what I want you to do is, not to vie with each other alone in the skill of your handicraft, or in the ingenuity of your machinery, or in the accumulation of your capital, but in the nobler growth of the mind, the intellect, and the character. Be careful to show that upon this generous and splendid field of competition, while you do not grudge being outstripped by any other town, you will not be content yourselves, if there be any danger, to remain the hindmost. You are now, most of you, and have been for some time, busily employed in connecting your several towns with each other by means of railways. Well, be equally careful to speed the intercourse of the mind as well as of the body. Do not let your "West Riding Unions" be confined merely to the railway world, but let them include in your care and in your liberality the Union of the West Riding Mechanics' Institutes, and all other institutions devoted to the like noble and improving purposes. Cut your first sod in the dense crust which has too long overlaid the genial capacities of the soil beneath — open the waste lands of selfishness, of ignorance, of prejudice, and of error, in order that you may call forth the full development of mental progress and moral culture; and let the free communication of knowledge, and the improving intercourse of thought, ply incessantly along those new highways which, in their advancing progress, are to bring together the wants and the attainments of the united human family.

MANCHESTER ATHENÆUM.

October, 1846.

I trust I shall be believed, when I say I appreciate my situation. Whatever may be the incidents of distinction, or responsibility, with which I am elsewhere invested—honoured as I am by the choice of no mean Constituency on the other side of the hills which bound your prospects—permitted as I am to bear a part in the highest councils of the State—I can in all truth assure you, that I find something very new, fresh, and large in the honour of being called upon to preside at this annual jubilee of the Manchester Athenæum. The sense of honour, and let me add with as much truth, of difficulty also, is certainly not lessened, when I call those to mind who have preceded me in the same post, upon these brilliant occasions. The last echoes of this assembly, which I now feel it is a hardihood in me to rouse again, answered to the accents, deep, gentle, and earnest as his own spirit, of Mr. Serjeant Talfourd—why, there is something in the very name of an Athenæum which bespeaks it to be a fitting theatre for all the utterances of the bard of *Ion* and the *Athenian* captive. Next before him, I well know that your souls must have thrilled under the spell of so potent a magician as Mr. D'israeli; even in the very hottest conflicts of party, from which we are here happily sheltered, I think it was impossible even for his most exposed victim to have been blind to the point, the brilliancy, the genius, which played about the wounds they made—but here, on this gorgeous stage, amidst this apt and congenial auditory, on the themes so familiar to him of literature, of art, of imagination, I, who could only read in cold print what he said, without all the kindling accessories of time and place, can yet easily believe how the admiration, which could not be withheld even on the barren ground of political controversy, must have here been heightened almost into enchantment. And it was at the first, I believe, of these assemblies, the first at least held upon this scale of size and splendour, that its chair was filled—better it can never again be filled—by Charles Dickens—that bright and genial nature, the master of our sunniest smiles and our most unselfish tears, whom, as it is impossible to read without the most ready and pliant sympathy, it is impossible to know (I at least have found it so) without a depth of respect, and a warmth of affection, which a singular union of rare qualities alike command. I have made it my business, too, to look at what they said when they were here; but this, while it certainly has ministered very highly to my gratification, has also only added to my embarrassment; for it would indeed be an endeavour irksome to you, and hopeless for me, to revive in feebler expression, and fainter colouring, what was pourtrayed by them with so much richness and exuberance. I therefore feel that at this time of day, and above all in this place, it would be an impertinence in me to inculcate that learning in any community will not prove "a dangerous thing"—that commerce, which has formed, and which now ennobles a community like this, is the natural ally of literature and art—that the tastes which may be here encouraged, the habits which may be here fostered, are those which give a grace and glory to the lives and characters of men. Yes, I do rejoice with the most gifted and ardent of those who have preceded me, of those who now surround me,—I do rejoice over the impulses and associations which are impressed upon the times we live in, and which institutions like this, and assemblies like these, serve to rivet and transmit; I rejoice that English commerce is rising up to the height of its position, and feeling the real dignity of its calling; but this the Tuscan, this the Genoese, this the Venetian did; the worthies of our English commerce are content to be merchants, without being princes; if we have Medicis, they are not intent on seeking alliances with the thrones of Europe; their best aim will be now to raise to the same level of knowledge, of happiness, of virtue, the whole body of the people. I rejoice that here, in Manchester, beyond all dispute the first city in the ancient or modern world for manufacturing enterprise and mechanical skill, you have not been content with that display of wealth which jostles in your streets and is piled in your warehouses; you do not think it enough to raise factories tier upon tier, and magazines that will accommodate the traffic of the world, but you have thought it part of your proper business, too, to build and to set apart a haunt for innocent enjoyment, for useful instruction, for graceful accomplishment, for lofty thought, the shrine of Pallas Athene in a Christian land. May this long be the resort, together with those kindred and neighbouring institutions, which this does not aim to eclipse or overlay, but to encourage and excite, where all who are engaged in the business and the labours of this unparalleled hive of industry may find rest for their flagging spirits, a neutral ground for their manifold differences, invigorating food for their reason, and an impulse, onward and upward, to all the higher tendencies of our nature. I am glad to perceive that, as the benefits of the establishment are confined to no condition, no class, no denomination, so they are not exclusively appropriated even to one sex. Women have always played an important, perhaps not uniformly a beneficial part in this world's history. I believe as civilisation advances, they will play both a more recognised and a more elevated part than they have ever yet done; and I trust that among the many currents upon which the restless activity of our age is eddying along, a prominent one will be devoted to making female education sound, substantial, and enlightened; all it ought to be for training those who themselves must in any case be the real trainers, as they may be the best trainers, of our citizens and our workmen. From all I can gather, the wholesome effects of your association have, by no means, been confined to its own walls or its own operations; it not only walks its own round, but is suggestive of many kindred processes; or, if I may borrow an illustration from one of the disputed problems of the upper skies, in its career of light and progress, it throws off from itself separate bodies, which harden into distinct masses, and glow with independent lustre. Has it not been very much under the impulse of ideas struck out and caught up here, in your lecture rooms, in your social gatherings, in the more earnest friction of your discussions, by the agency mainly of your members, your officers, your founders, that the public parks, which have added so much, both of material and of real beauty to your great city, that the public baths and wash-houses, which have still deeper effects than on the mere linen and the skin, that the attention given to sanitary regulations of every description, have owed their rise? Can you look to other sources for industrial schools, for the weekly half-holiday in warehouses, for the early closing of shops?

You will perceive that I have not refrained from some of those obvious topics in connection with the institution, which the part assigned to me of opening the proceedings of the night necessarily almost imposed upon me. Let me turn for a little time from the institution to yourselves,—you who constitute it, who are its essence and its life. I perceive that one of the orators by whose eloquence you have heretofore been so much delighted, addressing himself to the youth of Manchester before him, told them with emphasis to aspire. Far be it from me to tell them otherwise; all who feel within them the sacred flame, who are strung for the high endeavour, who have girded themselves for the immortal race, I would address in the same terms, even the terms of the great moralist poet, Dr. Johnson:—

"Proceed, illustrious youth,
And virtue guard thee to the throne of Truth!
Let all thy soul indulge the generous heat,
Till captive Science yield her last retreat;
Let Reason guide thee with her brightest ray,
And pour on misty Doubt resistless day!"

It is, indeed, by such means, by patient inquiry, by diligent study, by humble-minded searching after truth, that all real knowledge is to be wooed by man, equally removed from the shallow presumption which sets up its own speculations and sophistries in the place of a conscientious reason and a disciplined faith, and from the blind bigotry which bawls down fair argument, decides against proof, and condemns without hearing. But I was saying that I did not wish, I could not wish, to damp or discountenance the purpose of your young men to aspire; for well I know that genius is the property of no condition, the apanage of no class of men: it will often be seen to rise, like the Goddess of old, out of the ocean billow. from those surfaces of society where you would least expect to find it, break through all the surrounding uniformity, and shed sudden radiance round the new horizon. But, while I am ready to track its shining course, and bask in its genial warmth, in whatever orbit it may be moving, I would yet venture to remind you that there is something more admirable than genius, and that is virtue; there is something more valuable than success, and that is duty. The hope of succeeding in the world, and of playing a shining part, may sometimes operate powerfully as an incentive, but it is too apt to engross both the efforts and the admiration of mankind. I was struck with the import of an expression I once heard from a friend, though you will at once perceive that it is not to be understood quite in its literal acceptation: the expression was, that Heaven was made for those who had failed in the world. Now, all sorts of unbecoming and unamiable feelings may undoubtedly accompany and embitter failure, just as every bright and blessed quality of the heart and mind may enhance and adorn success; but to aim at success, to meet with failure, and not to grudge it, to be outstripped by a rival and yet

"To hear
A rival's praises with unwounded ear,"

this is an effort and a triumph besides which all the ordinary successes of life are mean and trivial. Success, after all, in nearly every walk of life, from the aspiring statesman to the ambitious parish beadle, unless very carefully watched, very anxiously chastened, is apt to be made up of very coarse, obtrusive, vulgar ingredients, certainly not of heavenly temperament; while there is hardly a grace of character, a spring of self-reliance, an element of progress, with which failure, not caused by our own acts, and sustained with an even and brave spirit, may not ally itself. Depend upon it, in a great many instances, the world does not discover, does not recognise its best; there are diamonds in Golconda more precious than any, the Pitt, or the Pigott, or the Kohinoor, which ever blazed in the diadem of sovereigns; there are pearls in unopened shells more lustrous than any that ever shone upon the neck of beauty; the ages as they pass have known their Homer, their Raphael, their Newton, their Shakspeare; but there are prodigalities among the human creation as well as among all besides, that have never yet been fathomed; yet there has never been any thing which, except by its own fault, has been lost or thrown away. Which is the material point,—to be Raphael or Shakspeare, or only to be thought a transcendant poet, or an unequalled painter; to have conceived in the inmost soul the lineaments of the Holy Mother and Divine Babe, the idea of *Lear* on the heath, or *Macbeth* at the banquet, or to have would-be amateurs commending the picture, and crowded audiences shouting bravo in the pit? Only impress upon your minds this great truth — and bear it about with you both to your daily task and to your evening leisure, both to the privacy of your homes, and to your social musters, that it matters comparatively little what we may seem to be — it even matters proportionately little what we may do: what we are matters every thing; what we may seem, is subject to a thousand accidents and misapprehensions; what we may do, is under the control of circumstances; what we are, is entirely under our own. We may be all we should be; and no matter how humble the situation may be of any one among you, no matter how obscure the business which engrosses every precious hour, how insignificant the whole life's drudgery, still in that obscure and unenvied situation, amidst that wearing and numbing drudgery, you may mould for yourselves the qualities, you may build up for yourselves the character which princes, if they knew it, would trust, which multitudes, if they could discern it, would adore. I know that in venturing to speak upon these high topics of morality and conduct, with lips scarcely authorised, I run the risk of imperfect explanation, as well as of much misconstruction. I know it is thought that addresses delivered on such occasions are rather apt to minister too much to the pride of man — to undue adulation of the intellect. I disclaim such tendencies; when I say you may be all you should be, I do not mean to exclude from the method those aids and sanctions which are too high to be here dwelt upon, and no one feels more convinced that reason as well as Christianity makes humility almost its most prominent grace. Who would not be humble who felt, as he ought, the loveliness of virtue, and the magnificence of knowledge? I should like to ask the men who have just added another planet to our system, or, as has been beautifully said, on an earlier occasion, "who lent the lyre of heaven another string," whether their spirit does not recoil with modest awe, instead of swelling with self-sufficient pride, before the secrets of that space into which they have been permitted to throw a more far-seeing gaze than any of their fellows; and when the time shall come which to our enlarged and perfected vision shall unfold the whole bright mechanism of stars, and suns, and systems, shall we not find in the laws which fix their stations, or which guide their mazes, fresh reasons to be reverent, acquiescent, and lowly? It is time, however, for me to come down from the clouds, and indeed from everything else; I could hardly, however, have lighted on a more radiant resting-place on this earth than the present assembly. I only hope that all those who have partaken in its excitements will not merely carry away the transitory emotions to which it may easily give birth, but a settled determination, followed up by a corresponding practice, to give fair play and full scope to all the best and highest purposes of which the Institution is capable; they must be attained by associated effort, but you will hardly fail to remark, at least it is generally the case in institutions of this character, how very much of the work is done by a very few out of the whole number. Now, what we want is more of individual energy in the whole body; each of you make the work his own; and let no member of the Manchester Athenæum think that he has done his duty without having done something, according to his opportunities, to give encouragement, efficacy, and credit to an establishment he ought to be so proud to serve. On my own part I have only further to say, that if, when the gay glitter of the scene has passed away,—when the strains of music are hushed, and silence has fallen on the voice of the speaker,—any one of you, in the stillness of the quiet home, or amid the clang of the daily occupation, shall have derived a single encouragement to ennobling reflections or to worthy pursuits,—still more if any, under the sting of disappointment, or a sense of the world's coldness and alienation, shall have been reminded how little it really signifies, and that failure is one of the appointed accesses to Heaven, —if any word that has fallen from me shall have contributed to such encouragement or such alleviation, I shall then feel that I have not come to Manchester quite in vain.

SHEFFIELD ATHENÆUM.

September, 1847.

MY LORDS, LADIES, AND GENTLEMEN,

I could not resist the gratification, when it was proposed to me, of attending the meeting of this evening, brought together for the purpose of promoting the interests of the Sheffield Athenæum and Mechanics' Institution, and of encouraging its friends in the good work they have undertaken. I feel, indeed, that having now been called upon to attend some half-dozen meetings within this Riding, for the same purpose and with the same objects, that it would be quite useless for me to endeavour to bring any new illustration, or to offer any new suggestion, even upon a subject so important and interesting as that which engages our attention. You do well, ladies and gentlemen, to promote the objects of such an Institution as that which has now been founded for thirteen years within your town; and to which, I trust, a fresh impulse and encouragement have been given this day by the ceremony of the morning, in laying a first stone for a new and extensive building under the happy auspices by which you are distinguished upon the present occasion. I hope that the building is destined largely to extend the advantages which have already been derived from the establishment of a Mechanics' Institution within your town. I hope it is destined to associate with it several kindred objects, connected with the education generally of the youthful classes, and the promotion of a taste for the Fine Arts, which I can assure you will be found one of the most useful auxiliaries to the peculiar pursuits of this place, as well as highly conducive to the general improvement and elevation of all who can participate in those benefits. I am not, necessarily, intimately well acquainted with the peculiar processes and objects to which the attention of the Members of the Sheffield Mechanics' Institution has of late been directed. I think it is always desirable that the pursuits and studies should not be confined to any one branch of acquirement, inasmuch as the same food does not suit all palates, nor the same food at all times suit the same palates. I certainly hope that your foremost attention, and your most anxious patronage, will always be directed to those studies and objects which are most important for advancing the real, moral, political, and social improvement of your population—which tend to make the mind rational, sober, and manly, and which most fit them for battling in that great conflict of existence in which we must all bear a part, and enlisting under the banner of progress which is unfurled above us. But with those more serious, and solemn, and business-like pursuits, which ought to occupy your foremost attention, I think the promoters of this Institution have done well to mix some attention to the lighter walks of elegant accomplishments and polite literature, and to the cultivation of a taste for art, poetry, or music, which tend so much not only to relax, but to refine the human mind. While I recommend those who are inclined to such studies, to give their foremost attention to the severer walks of history and philosophy, I do not wish to exclude the graceful pages of poetry and fiction, and I will borrow an illustration from those pages, of the truth which I think worthy to be impressed upon your minds. Those of you who have had the opportunity of consulting the old legends of classical mythology, are aware that among the fancied deities with which they peopled the world, there was one who was more especially regarded as the God of labour, and of handicraft, Vulcan by name, who was always represented as being employed in huge smithies and workshops, hammering at heavy anvils, and blowing vast bellows, heating vast furnaces, and begrimed with soot and dirt. Well, for this hard working and swarthy-looking divinity, they wished to pick out a wife. And they did not select for him a mere drab—not a person, taken herself from the scullery or kitchen-dresser; but they chose for him Venus, the Goddess of love and beauty. Now, ladies and gentlemen, pick out for me the moral of this tale, for I believe that nothing ever was invented,—certainly nothing by the polished and brilliant imagination of the Grecian intellect, which has not its own meaning, and its moral. I have no doubt that all the legends of our own country—that the one even of your own neighbourhood, the Dragon of Wantley itself has its appropriate allegory and meaning, if we only knew how to find them out. But what is the special meaning of the marriage of Vulcan with Venus—of the hard-working artificer with the laughter-loving queen—of labour with beauty? What is it but this, that even in a busy hive of industry and toil like this, even here, upon a spot which is in many respects no inapt representative of the fabled workshop of Vulcan, even here, amid the clang of anvils, the noise of furnaces, and the sputtering of forges—even here, amid stunning sounds, and sooty blackness, the mind—the untrammelled mind—may go forth, may pierce the dim atmosphere which is poised all around us, may wing its way to the freer air and purer light which dwell beyond, and may ally itself with all that is most fair, genial, and lovely in creation. So, gentlemen, I say, your labour, your downright, hard, swarthy labour may make itself the companion, the helpmate, and the husband of beauty—of physical beauty, as I have reason to believe, from the inspection which I am able even now to command, and I have no doubt that a more intimate acquaintance with your wives, sisters, and daughters, would enable me to prove that I was not here wrong in my illustration:—but besides this beauty, I say, your labour may ally itself with intellectual beauty—the beauty which is connected with the play of fancy, with the achievements of art, and with the creations of genius; beauty, such as painting fixes upon the glowing canvass, such as the sculptor embodies in the breathing marble, such as architecture developes in her stately and harmonious proportions, such as music dresses with the enchantment of sound. Now it is to the perception and cultivation of the beautiful in these departments that I look upon your Schools of Design, and your concerts, and many of the lectures which you hear from able and gifted men, as intended to be subservient; and I strongly advise the members of this Mechanics' Institution to show a discriminating and generous support of these tasteful and humanizing pursuits. Above all, I advise you to cultivate a love of reading—that which makes you almost independent of any other aids and appliances, and puts, with very moderate help, the whole domain of philosophy, history, and poetry, within your individual command. Why, gentlemen, a man is almost above the world, who possesses two books. I do not mean to put the two books which I am about to mention upon the same level, far from it, nor am I wishing to intimate to you that two books are sufficient for your study and perusal. I am only mentioning them as representatives of what is most excellent, though different in degree. But I say that a man is almost above the world who possesses his Bible and his Shakspeare — his Shakspeare for his leisure — his Bible for all time. I said some time ago, that labour, even the labour of this district, may unite itself with intellectual beauty. But there is a beauty of a still higher order with which I feel even more assured it is still more open to it to unite itself: I mean with moral beauty — the beauty connected with the affections, the conscience, the heart, and the life. It is indeed most true that in the very busiest and darkest of your workshops — in the most wearying and monotonous tasks of your daily drudgery, as also in the very humblest of your own homes — by the very smallest of your fire-places — one and each of you, in the zealous and cheerful discharge of the daily duty — in respect for the just rights and in consideration for the feelings of others — in the spirit of meekness, and in the thousand charities and kindnesses of social and domestic intercourse, — one and each of you may attain to and exhibit that moral beauty of which I have spoken — that beauty which is beyond all others in degree, because, when it is attained to, it is the perfection of man's nature here below, and is the most faithful reflection of the will and image of his Creator. And thus, ladies and gentlemen, I close my explanation of the marriage of Vulcan with Venus — of Labour with Beauty, and with it I close the remarks which I have risen to offer you this evening. It has been a real pleasure to me to meet you here. I feel that this is neither the time nor the place fitting for me to enter upon any topics connected with local circumstances which are not properly connected with the business or occasion of our meeting. I have spoken of a just regard for the rights of others, and I feel quite disposed to believe that all who come within these walls are always willing to be actuated by a spirit of harmony and by a just regard to the rights and privileges of others. I have told you that labour — your labour — the labour of this district — may be most properly mated with beauty, but labour certainly loses its dignity and value if it is divorced from liberty. And it is by the aid of this and similar institutions — it is by the honest and genial influence which they have a tendency to spread around them, that I trust the intelligence and conscience of the times in which we live may be so fostered and so united, that every form and kind of tyranny may be effectually put down and banished;—the tyranny of opinion, the tyranny of classes; the tyranny of the few, the tyranny of the many. And it is by the salutary control which an instructed and enlightened public will be competent to exercise over the conduct and march of affairs that you will be best able to guard yourselves, on the one hand, against undue and vexatious interference on the part of governments and rulers, and on the other hand against the abuses and neglect of local and individual interests; and that you will be able to attain that which ought to be the true aim of a nation's management, the pursuit of the best ends by the most efficient methods.

YORKSHIRE UNION OF MECHANICS' INSTITUTES.

Hull, June, 1848.

Ladies and Gentlemen,

I have to assure you that it is with very great pleasure that I find myself associated with you on this occasion. Though I am not so able as are many of those by whom I am surrounded to give you an account of the recent proceedings of the Yorkshire Union of Mechanics' Institutions; though I am still less competent, from any actual experience, to enter into the concerns of the Athenæum of Hull; yet I trust that you will consider that I am not out of place on this occasion. For I will beg to remind my East Riding friends among you, that I have the honour to be an office-holder in this riding. But we do not, on this occasion, consider ourselves to be limited by the boundaries of ridings, or even of counties; and it is with no small pleasure that I see, upon this occasion, associated with us, my friend the Earl of Yarborough, and any coadjutors he may have brought with him from the county of Lincoln. I know that he and his tenantry, to say the very least, are prepared to compete with the whole world in the science and the practice of farming; and it is gratifying to find that there is no field of improvement, no branch of progress, in which they are not willing to lend a helping hand. It was said of old, by the great French king, when he put his grandson upon the throne of Spain, that there were thenceforth to be no Pyrenees; so we, when any object of rational import, or any opportunity of social intercourse is to be imparted, may henceforth say, "There shall be no Humber." Now, with respect to this special occasion which has brought us together, I always must feel, that a person who wishes to recommend any institution or undertaking to general support and acceptance, ought to be careful lest he should seem unadvisedly to exaggerate its pretensions, or to put them in a false light. So I do not, on this occasion, — though I think the advantages to be derived from Mechanics' Institutes, and other similar enterprises, are very great and very various, — yet I do not affect to place them upon the same level as the observance of industry and honesty in the course of business; or, in the daily habit of our life, as the cultivation of domestic virtues, or household charities, or the all-comprehensive relations which subsist between man and his Creator. I should also think that person a very injudicious friend to Mechanics' Institutes who should pretend that, in your reading-rooms and lecture-rooms, the means were afforded of turning out your members as finished scholars, or ready-made philosophers, or of conferring those distinctions which must always be the reward of the midnight oil of the student, or the life-long researches of the experimentalist. But, if it be the object how to raise the toiling masses of our countrymen above the range of sordid cares and low desires — to enliven the weary toil and drudgery of life with the countless graces of literature, and the sparkling play of fancy, — to clothe the lessons of duty and of prudence in the most instructive as well as the most inviting forms, — to throw open to eyes, dull and bleared with the irksome monotony of their daily task-work, the rich resources and bountiful prodigalities of nature, — to dignify the present with the lessons of the past and the visions of the future, — to make the artisans of our crowded workshops and the inhabitants of our most sequestered villages alive to all that is going on in the big universe around them, and, amidst all the startling and repelling distinctions of our country, to place all upon the equal domain of intellect and of genius; — if these objects — and they are neither slight nor trivial — are worthy of acceptance and approval, I think that they can be satisfactorily attained by the means which Mechanics' Institutes place at your disposal; and it is upon grounds like these that I urge you to tender them your encouragement and support. Then, if

Mechanics' Institutes are entitled to general favour, — if institutions such as the Athenæum and the Mechanics' Institute of this place are a credit and an ornament to the district in which they are placed, it does not require any expression of argument to prove to you that such an institution as the Yorkshire Union of Mechanics' Institutes must have a tendency to increase and diffuse the practical benefits for which the separate branches are designed; for it is the means of spreading, on every side, the most useful information, — of pointing out the best models, — of conducting to what are the most praiseworthy objects, and the most ready means of successfully prosecuting them. It enables the inhabitants of our smaller manufacturing villages to know what has been successfully effected in the great commercial emporiums of Sheffield and Leeds; it enables the farmers and yeomen of the Wolds to know what is achieved under the graceful towers of Beverley or around the crowded quays of Hull. I believe I am correct in the assertion that Yorkshire alone — that the district comprised in the Yorkshire Union of Mechanics' Institutes, contains a greater number of those institutions than any other, with respect to its area and population, in the whole kingdom. I find that the total number of Mechanics' Institutions in the Yorkshire Union is 86, and the aggregate number of members 15,860. As might be expected, these institutions present to us a variety of features.

I think it almost unnecessary to explain the advantages of good lectures; but I may state that the accession of Howden to the Union is attributable to Mr. Child's lectures in that place. In the same manner, the exertions of Mr. Dunning have led to the accession of Market Weighton. I believe that the East Riding sub-union, in the most public-spirited manner, has seen the advantages of this method of providing instruction and amusement, and has hired a lecturer of its own. I am informed that in consequence of the facility and arrangements of the Yorkshire Union, the sum of 113*l.* has been saved by the respective institutions of which it is composed, by uniting in the engagement of well-qualified public lecturers, above what would have been paid by the separate institutions had they all separately engaged those lecturers. As might be expected, different modes of attraction have been resorted to. At Leeds, I believe, no money whatever is taken at the door for the lectures, but they find that good lectures so increase the members, that they have no need to resort to extraneous means of support. I believe I may congratulate this institution — at whose special invitation we are met in this place — upon mixing wholesome recreation with the severer studies of literature. The Hull Athenæum has a cricket club of its own. At Saddleworth, the ladies enter so much into the spirit of the institution that, I am informed, they write essays which are read by their friends, the members of the institute. Leeds and Wakefield add to the attractions of the library and the lecture-room others of the Muses, and give monthly concerts. Most important benefits have been found in some places to result from the classes formed for adults, who are immersed in various occupations during the entire day, but meet together in the evening for the acquisition of those elements of education which they have not, perhaps, had the opportunity of acquiring in their youth. In this way at Huddersfield, an institution has met with much success, and working men may command great facilities for education, for sixpence a fortnight. I believe at Leeds the same facilities were given; the same price was required, and, soon after the promulgation of the arrangement, there was an addition of two hundred members to the ranks of the institution. And I may now remark, which I do with sincere pleasure, that the London School of Design has consented to give elementary drawing-books to all the Mechanics' Institutes which enter into the arrangements they have prescribed for the same. Already, I understand, there are drawing-classes established in twenty-seven institutions, and that the number of pupils therein is 682; and I cannot close the list of these various efforts and attractions which are displayed in the last year's labours of the Union, without being reminded that the Mechanics' Institute at Ripon has opened a commodious building for the purpose of carrying on, with increased facility, the various operations of that society. I am happy to find that my friend, the Very Reverend the Dean of Ripon, is here with us to-night, to give us an account of the spirit in which it is supported by those people who are happy enough to live under his presidency. In bringing before you these various details, I must enjoin upon all those who are here present, and may represent their several localities, to do all that in them lies to foster this wholesome spirit of competition and generous rivalry. Let us do what we can to communicate this electric impulse over all the varied features of our county's geography; let us speed it from mountain to valley; from forge and factory to meadow and to plough-land; from the manufacturing village that just lines the moor to the watering-place that enlivens the sea-board; from Scarborough to Saddleworth, from Wensleydale to the Spurn; and in inviting your contemplations to these wholesome exercises of effort and of progress, I cannot help asking you just to contrast these emulations and this success — not in the spirit of undue conceit or self-sufficiency, but to contrast them on account of the gratitude they ought to inspire for the benefits which they have brought upon this land, with the evils which now prevail over too great a portion of the Continent of Europe. I say this, not with the idea of infringing the wholesome rule which excludes any party politics from our festivities and public celebrations, but with reference to those more general politics which decide the destinies of our species: let me ask you just to consider, in contrast with your own condition, the general aspect of affairs as presented to us among so many tribes and kindreds of the great European Continent. Why you yourselves, at Hull, probably, can only bear but too faithful witness to the embarrassments, the inconveniences, and the losses, which result from the blockade of friendly seas, fitted and purposed to receive and to interchange the commerce of the world; you yourselves can tell by the return of disconsolate vessels, how much harm is being inflicted by the blockade of the Elbe; by shutting the Sound; by the insensate hostilities between Germany and Denmark. But there is hardly a community which is not too disastrously suffering from the heavings of these revolutionary whirlwinds and storms. The Russians are on the Danube, the French are on the Tiber. It really seems as if the nations of Europe, in some species of wild bacchanal, were seizing the torches of civil discord and of foreign war, and throwing them, in their furious glee, from frontier to frontier, from river to river, from rampart to rampart, and scaring all the peaceful haunts of industry with their uncouth dissonance and hideous glare. While such are the appalling sights and sounds of which we catch the reflection, and hear the echo, here in Yorkshire, here in England, while we abide in our accustomed occupations, and move on in our allotted spheres, under the broad and equal light of freedom, let it be our care to kindle the genial lamp of knowledge, and to transmit it from hand to hand, from institute to institute, from wold to plain, from class to class, from the workshop to the cottage, over every portion of our land, till there shall be no dark corner unilluminated, till there shall be no haunt of obscene revelry unrebuked, till there shall be no abode of ignorance unenlightened, till there shall be no haunt of happy industry uncheered; and so, while we judge with all lowliness and humility of ourselves, we may become, in the judgment of the observing nations around us, and perhaps in the judgment of Him who judgeth not as man judgeth, a wise and understanding people.

YORKSHIRE UNION OF MECHANICS' INSTITUTES.

Leeds, June, 1851.

I HAVE sometimes felt inclined to remonstrate with my friends here for having led me to produce myself so frequently on these occasions, and, I may add, in this place. I might have thought that I had already inflicted enough in the way of lecture on the good people of Leeds, at least for some time to come; but I may be reminded that whatever may be my respect for them, this is not merely a town, or borough, or municipal meeting, but that it represents and constitutes an association which does not even confine itself to the boundaries of our wide West Riding, but enlarges its borders and stretches its stakes to the furthest limits of our entire county of York, and, I believe, even beyond it. With respect, too, to the time of our holding this assembly, it has been felt that this year of 1851, the first of this half-century, has, in many respects, been made a sort of Jubilee year, and that it behoves all good and laudable undertakings, and among them the Yorkshire Union of Mechanics' Institutes, to put on their best countenances, and summon the greatest number of their friends, and in all ways make much of themselves, not, I trust, for the purposes of a braggart and garish vanity, but for the sake of recommending what we really look upon as commendable in itself, and as calculated for extensive usefulness, to the widest possible amount of support and of imitation. All reasons these, however, the more why an old stager like myself should seek to make no undue trespass on your attention, but bear in his mind that we happily have to-night some new faces, as well as old to encourage; some new voices, as well as old, to instruct us. The Yorkshire Mechanics' Union can, indeed, no longer be regarded as an experiment; it is no sickly plant, no doubtful shoot, no fragile stem we have to rear, but it shows a robust and hardy trunk, and justly prides itself in its multitude of branches; comprising as it does, I believe, 117 institutions, and including within its branches, 20,000 members. No doubt the various delegates from the separate branches who have met to-day will have had the means of comparing the different methods and processes which have answered the best in the respective localities ; this I take to be a principal advantage of these annual concourses; they afford an opportunity for comparison; they supply a whet-stone for emulation, not for envy; at the same time, I think it would be a mistake for each institution to consider itself bound to tread servilely in the track of every other; it is with these bodies as it is with nations at large; there will be a difference of circumstances, a difference of capabilities, a difference of humours. There are, of course, some broad rules and some obvious methods applicable to all; but, in the adaptation of them, the convenience, and the tastes, and the wants of the respective communities may be taken into consideration. There can be no better rule, (you must excuse me if I still find the echoes of Pope lingering about this room,) —

"Consult the genius of the place in all."

I naturally do not presume to enlarge upon details, which must have formed the subject of conference among the delegates this morning. A letter has been brought under my notice, written by Mr. Sikes, of Huddersfield, strongly urging the annexing of Savings' Banks to these institutions. Any step that would promote prudence and self-reliance is most deserving of consideration, but, as I have intimated, I consider any suggestion of this nature had better be left in the hands of those who have the practical management of the institutions. I have already adverted to the year 1851, and as there is extremely little I can say upon the general subject of Mechanics' Institutes which I have not, I fear but too often, before had opportunities of addressing to you, you will, I feel persuaded, make allowance for me, if, during the few minutes more I shall occupy of your time, I seek a variety from the ordinary topics of observation within that great Building, which some of you, I doubt not, have already seen, and all will have heard of, which gives to this year, 1851, now while it is gliding past us, and will probably give to it through all future time, its most distinguishing characteristic. Not that I am at all travelling out of the domain of Mechanics' Institutions when I refer to the Exhibition of 1851. Why say I this? Oh, enter for a moment with me through one of its many portals; stand under that lucid arch of glass, at the part where the broad transept intersects the far-stretching nave, while the summer sun glistens, first on the fresh young green of our forest elms, then on the tapering foliage of the tropics, then on the pale marble of the statuary, then on the thousand changing hues of the world's merchandise. I most truly believe that, as a mere spectacle, it surpasses any which the labour, and art, and power of man ever yet displayed in any one spot. Look at that long alley of plate, the stalls of goldsmiths and silversmiths; such a bright profusion was not spread out by Belshazzar when, amid the spoils of the Old Asia, he feasted his thousand lords. Examine the jewels and tissues of India, of Tunis, of Turkey; so dazzling an array was never piled behind the chariot of the Roman conqueror, when he led the long triumph up the hill of the Capitoline Jove;—observe the lustrous variety of porcelain, and tapestry, and silk, and bronze, and carving, which enters into the composition of furniture;—why Louis XIV. himself, could he be summoned from his grave, would confess that, although the French people had dethroned his dynasty, exiled his race, and obliterated that monarchy of which he was the special impersonation, they had carried all the arts of embellishment farther even than when he held his gorgeous court at Versailles. But I should not have obtruded these topics on an assembly like this, had I nothing to remark upon but the jewelled diadem, or the breathing brass, or the glistening marble, or the spangled brocade; these might only be fit adornments for the palaces of the great, or for the toilets of luxurious beauty; the title which the Crystal Palace of London has upon the suffrage of the judgment as well as the admiration of the eye, is, that it is the formal recognition of the value and dignity of labour—it is the throne and temple of industry;—industry and labour, in all their forms, as well as in all their climes, whether they are employed on the cheap gingham that makes up the wardrobe of the humblest cottager, or the richest lace that forms aprons for Queen or Cardinal—on the rude block from the quarry, and the hollow brick for model cottages, or the biggest diamond of the mine, the Mountain of Light itself; industry and labour, alike necessary to furnish their daily bread to the masses and the millions, and to embody in palpable form the brightest visions of poetry and art. Said I then wrong that this undertaking. thus intended and calculated to recognise and represent labour and industry, was not removed from the domain of Mechanics' Institutes? And when, further, I mark the space which is covered in this show-room of the world by the special industry of the West Riding of Yorkshire; when I recognise the banners which are suspended above the productions of your principal towns, with their, to me, most familiar devices—when I pass by, not without a sort of feeling of joint ownership—the woollens of Leeds, and stuffs of Bradford, and fancy goods of Huddersfield, and carpets of Halifax—(is their excellent and spirited manufacturer, Mr. Crossley, now among us?); and the hardware of Sheffield, and many other things from many other places, which I necessarily omit, to say nothing of all that wondrous, whirring machinery to which, among others, this town has contributed so conspicuously, I need offer no excuse for having connected the mechanics of Yorkshire with the Industrial Temple of 1851. One word of counsel to those who visit the Exhibition. It is divided, as you are probably aware, into two great sections, one belonging to our own empire, the other to the rest of the world. It had been anticipated, and it so turns out, that the British section shines most in what is solid, useful, practical, durable; in what is of most importance to the greatest numbers; while the Foreign section excels in brilliancy, in taste, in all that relates to decorative art; not that this line should be too rigidly drawn, for the Foreign division contains very much that is useful, and the British very much that is ornamental. What I would then earnestly advise every one, in his own branch of employment and skill, is, diligently to observe how, without foregoing what is valuable in his own workmanship, he can graft upon it whatever is attractive in that of others, and how, to the sterling home-bred qualities of use and durability, he may add the subtle charms of grace and beauty. This I would specially point out as an object of laudable ambition to your Schools of Design. And if I have ventured to offer one word of counsel to those who visit the Exhibition, let me conclude with one word of comfort to those whom circumstances may prevent from going there. Though I have described it justly as the most magnificent temple of industry, remember yet that the only worthy worship of industry must be carried on in the daily life and by the domestic hearth; this worship all have the power of rendering, and I can answer for it, there are two things more precious and bright even than any thing which is now displayed in the Crystal Palace,—the persevering energy of contented toil—the sunny smile of an approving conscience.

MECHANICS' INSTITUTION.

Lincoln, October, 1851.

You have heard, ladies and gentlemen, that I have been named to move the first resolution, which I find runs thus: — "That Mechanics' Institutions, having for their object the advancement of the people in solid and useful education, deserve the support of all classes interested in the welfare of their common country." I find everything in the terms of that resolution to justify my recommending it to your cordial acceptance.

But, in offering a few brief observations in support of it, I feel that I ought to set out by making some sort of excuse to you for appearing here at all. It always seems to me upon such occasions as the present, that, except indeed in the neighbouring county of York, where I have got into the habit of doing as I am bid, I have no business to meddle with the concerns of other people. But, after all, it is not such a very long way across the Humber, and, on this occasion, I have acted under the special command of your excellent neighbour, the Earl of Yarborough. I know that he has performed the same good turn for the towns, I believe, both of Hull and of Sheffield; and I should be sorry to appear wanting in reciprocating any such neighbourly disposition. I feel, over and above all those local considerations, that the cause of Mechanics' Institutions is such as to justify any co-operation, no matter, however inefficient the person, or however remote his dwelling.

I must not forget, too, that I am a member of the Yorkshire Union of Mechanics' Institutions, an association which we think, in that county, has been of very considerable use in fostering the success of the institutions which are scattered within its borders. We understand that now for three or four years past the midland districts of our fair England have been desirous of being put under a system of equal efficiency and energy, and I feel that I may appear here once more as the representative of my old Yorkshire friends, to assure you that they heartily wish you success; and, if I know aright the feelings of those who have interested themselves in this cause, I am sure that they would hear of your complete success, even of your surpassing their own, with no other feeling but that of unalloyed satisfaction. And why should they not? England is no longer under the Heptarchy. The Humber, to which I have already referred, and "the smug and silvery Trent," as the world-wide poet (Shakspeare) calls it, no longer divides hostile and jealous regions. We may, it is true, some of us have our favourite boasts of what is to be found among ourselves. The Lincolnshire and Yorkshire wolds may contend with each other as to which are the best cultivated, without any great danger of being surpassed by any other portion of the kingdom. Young Grimsby may flatter itself that it may one day beat old Hull, and the palm of beauty may reasonably be contended for between the imposing masses of York Minster and the aspiring pinnacles of Lincoln Cathedral. But, as I have already hinted, the object which brings us together to-night is not a local one; it is scarcely a national one; it is a cosmopolitan one; for it aims at the progress of mankind and the advance of our species. Therefore, addressing you Midlanders, I say you are quite welcome to beat us of Yorkshire, if you can. If you fall short of us, we shall be willing to teach; and if you excel us, we shall be, I trust, docile to learn. There is no place from which one ought not to be content to pick up what is laudable and good. Why, when we look at the aspect of the midnight heavens, we are not so much struck with them when it is only a single star that twinkles athwart the gloom, but we most feel the beauty and the brightness, when all their boundless spaces are crowded with light, and when the stars, which may singly exceed each other in glory, collectively serve to show and set forth each other.

And this, I feel that I do not vainly flatter myself, will be the spirit of mankind at large when the civilisation of our race has attained its full developement. It may not be the era of a city like Athens, which absorbed into a single community an amount of poetry, of eloquence, of philosophy, and of art, unparalleled before or since; it may not be the era of an empire like Rome, which rolled up into itself all the eminence of the world; it may not be an era merely of splendid patronage or of surpassing discovery. No Shakspeare then may string the lyre, no Newton may measure the heavens; but it will be rather an era, when judicious enlightenment will pervade almost every community, and when liberal and refined accomplishments will distinguish almost every family. What I want you to feel, what I want you all, if any of you here have not joined it, to join such an institution as this for, is to make you feel how much each of you singly may do to aid this great consummation.

I know that the enemies of Mechanics' Institutes, and of popular institutions generally, have been apt to say that they have a tendency to make the mechanics and working men, whom especially they are intended to benefit, puffed up, presumptuous, conceited, and discontented. All I can say is, that if they do so, they fail singularly in their purpose, and fall far short of their aim. It appears to me that there are two principles upon which we must mainly rely for success in any attempts to raise and regenerate mankind. The one is to have a very high opinion of what we can do, the height to which we can soar, the advance in knowledge and in virtue which we may make,—that is, ambition as concerns our capacities. The other is to have a mean opinion of what we at any time know, or at any time have already done,—that is, humility as concerns our attainments. The ambition should be ever stirring us up to the even and steady development of righteous principles, and, where the opportunity presents itself, to the performance of noble, meritorious, and unselfish actions. The humility should ever keep in view that there is no sphere of life, however humble, no round of duties, however unexciting, which any of you may not enrich and elevate with qualities beside which the successes of statesmen and the triumphs of conquerors are but poor and vulgar. I believe there is no eminence to which man may not reach, but he must reach it by subordinating all unlawful impulses, and by subduing all mean ambitions. There is a general craving in the human mind for greatness and distinction. That greatness and distinction, I am thankful to think, is within the reach of any one to obtain ; but the greatness and distinction must not be without you, but within you.

I should be sorry to appear to take this opportunity of preaching what might be called a sermon, but I feel so fervid an interest in the welfare and progress of the great body of my countrymen, that I cannot refrain from enjoining them, even while I would invite them to a full enjoyment of all the rich resources and all the innocent pleasures of this our variegated world, never to lose hold of religion. I do not mean that you should necessarily confine it within those stiff and narrow grooves in which some would imprison its ethereal spirit; but I feel assured that it is the source among mankind of all that is large and all that is lovely, and that without it all would be dark and joyless. Under her sacred wing you may securely resign yourselves to all that is improving in knowledge, or instructing in science, or captivating in art, or beautiful in nature. The Architect of the Universe, the Author of Being, such as Christianity represents Him, cannot but approve of every creature that He has made developing to the utmost extent the faculties He has given him, and examining, in all its depth and mystery, every work of His hand. Shut up the page of knowledge and the sources of enjoyment from the multitude, because some have occasionally abused the blessed privilege! Why, the very same argument would consign every man and woman to a cloister, because the world and active life are full of traps and pitfalls. No. Pre-eminent and supreme as I am convinced religion is, yet to make her so in the convictions and hearts of men, I feel she must discard all timidity, must front every truth in the full blaze of light, and sympathise with every pursuit and every impulse of our race.

I have thus briefly shadowed forth the reasons why no person ought to frown upon Mechanics' Institutions. I do not wish to attribute to them any exaggerated or imaginary value; I do not hold them forth as singly containing the elements with which we should hope to regenerate modern society; but it is because I believe them calculated happily to chime in with the existing wants and prevailing dispositions of the times, to afford opportunities for improvement and development in quarters where they would not otherwise be found, to promote innocent recreation and blameless amusements, and generally to assist the progress of mankind, that I thus venture to recommend them to your cordial sympathy and your active assistance.

BURNLEY MECHANICS' INSTITUTE.

November, 1851.

LADIES AND GENTLEMEN—

I thank you from my heart for the very generous reception which you have given to one who has yet certainly been a stranger to the town of Burnley. But you, sir, have just carried me back into Yorkshire, and it is certainly true that, across the hills which rise just above your town, I have had many opportunities of addressing audiences upon similar occasions in some of those valleys which, like your own, are distinguished alike by the beauties of their natural scenery and by the busy hum of human industry. And I feel that in coming before a Lancashire audience we are no longer living in the times, so eloquently adverted to by a late speaker, when the names of York and Lancaster signified different factions and parties; but now, on the contrary, we are in a happier era, when either your red rose has paled, or our white rose has blushed, into one common colour, and instead of contending for rival causes or for opposing dynasties, we may now only try to boast among each other which has the most or the best supported and best conducted Mechanics' Institutions. I have had many occasions heretofore, and very recent ones, of remarking upon the singular elasticity of these Mechanics' Institutions, I mean their adaptation to the varied aspects of our society. Scarcely a month ago, I attended at a similar meeting in the city of Lincoln, an old and picturesquely built town, the capital of the most agricultural district in England; the towers of whose majestic cathedral look down from their lofty perch upon a wide expanse of reclaimed fens and level corn fields: and among that agricultural population, under the shade of that old cathedral, a thriving Mechanics' Institution has been established. And now I find myself in Burnley, one of that cluster of busy manufacturing towns and communities, which stud this district of England, like the broad brazen knobs upon some old belt. It may be true that their names are not surrounded with the halo of classical or romantic associations. The names of Bolton, and Blackburn, and Bury, and Bacup, and Burnley, have not the imposing and picturesque sound either of Thebes, or Corinth, or Argos, in ancient Greece; or of Padua, or Mantua, or Verona, in modern Italy. But they have at least this comparative advantage, they are not marching their inhabitants in trained bands to batter down each other's walls and assault each other's citizens; their contention, if contention there is among them, is in the pursuits of a peaceful industry, and if they are at strife with each other, it is upon the equal field of honourable enterprise, where all the laurels which are won serve both to crown themselves and to enrich the whole population. Now in a place and district like this, I consider a Mechanics' Institution to be a most appropriate appendage; and therefore it is with great pleasure that I found myself enabled to take part in the auspicious proceedings of this morning. And when I say it is an appropriate appendage, I feel that I understate the truth; it is a most desirable and almost indispensable one. I have just referred to the nature of the pursuits which are followed here as being peaceful and useful and honourable, but at the same time we must not forget that primarily and in themselves they are conversant only with what is material and with the ways (to use a homely phrase) of making money; and that they might have a tendency, if unchecked and unbalanced by anything in an opposite direction, to engross and enchain some of the more delicate tastes, or the loftier aspirations of the human mind. Far be it from me, in Lancashire or anywhere else, to speak slightingly of cotton; but you must feel that cotton and calico, though they make admirable stockings and other equally indispensable articles of clothing, yet do not in themselves furnish out the whole man. Now, I have observed that a most accomplished and able person, whom I may call a fellow lecturer of my own, Dr. Lyon Playfair, in an address he recently delivered, gave it as his opinion with respect to the modes of education pursued in this country, that in our schools and colleges enough attention has not been given to scientific instruction and regular industrial training. He complains that too much labour may have been bestowed on classical studies, on dead authors, on by-gone poets, and that the faculties have not been enough exercised on the open page of nature and the living wonders which are around and about and above and beneath us. Now, I think that he is probably in the right in this, but at the same time I am convinced that almost every prevailing direction, both of the individual mind and of society at large, ought occasionally to have administered to it something in the way of reaction and of corrective. It may be very well, in the quiet of academic bowers, that the dim cloisters of Oxford and the still shades of Cambridge, retaining, as I hope they ever will do, their old appropriate sources of learning, not ignoring (to use a modern phrase, which I might probably be told in those classic precincts was a barbarous one) the accustomed voices of their own Muses, should yet reflect more, as I believe they have begun to do, of the aspect of the century and the society in which they are placed. But on the other hand, in a district like this, where the pursuit of wealth is the habitual rule, where the recurring routine of labour is the daily life, where the steam engine and the power loom and mechanism and machinery seem to be the lords of time and space, of the body and of the mind, it is well too, that without neglecting, on the contrary while you are directly encouraging, those subjects of inquiry which are congenial to the place, while you are

the study of the law of nature and inquiring into the properties of matter, at the same time the means of access should be given, and opportunities for a hearing at least, afforded, to the claims of general literature, the sober muse of history, the fervid accents of oratory, and the sublime inspirations of song. And just as it is the boast of our country, England, that it is the self-same country which produced her Newton, who has laid down the positive and ascertained laws of other worlds and other systems, and her Shakspeare, whose imagination peopled worlds almost as numerous, and quite as bright; just as those mingling characteristics still in some sort distinguish our countrymen, at once the most sober-minded and adventurous race which the world has known; so let it be the aim and glory of our own times, on the one hand, to make the study of the recluse and the vigil of the student still more available for the wants of the present day, and for obtaining a mastery over nature, still more useful, still more practical, than they have yet been; so, on the other hand, we should aim to throw around the dreary monotony of toil, and the plodding perseverance of labour, charms and graces which are not their own. And for these reasons I rejoice, again, that such an institution as has already existed here, it is now proposed to extend, to diffuse, to embody in a more worthy home; I rejoice to hear that it is proposed to combine with it lecture-rooms, classes for drawing and for music and for languages, together with a well assorted library; and that it is purposed not to be wanting in the graces of external architecture; and I trust that you will show yourselves alive to the occasion which opens itself thus before you, and that when the effort has been made, and the brick and mortar, — I beg your pardon, for I believe you have excellent stone of your own in Burnley, — when all this is brought together, and a goodly edifice is raised, you will show that it has the support of the inhabitants, and that the intelligence and mind which have to be developed within it will make the real glory of that building. I know that when I address you in Lancashire, I am among a community which has shown a great and growing interest in the cause of popular education in all its directions. Into the merits of any particular direction which that interest may assume, this is not the place or opportunity to enter. But I feel it a real triumph to think that the time has come when the education of the people must spread wide and strike deep, and I have faith that the wisdom and the public spirit of all classes in this country will be guided to large and expansive in the bodies of men which in this portion of the country are brought together upon an occasion like the present. Why, in the very place * in which we are assembled, in the very person † who laid the first stone of your new building, we have living and patent proof that there is nothing exclusive or repelling in the assistance and energy which are brought to bear upon it. And as I have referred to Mechanics' Institutions as comprising in their range the cathedral towers of Lincoln and the factories of Burnley, so I have seen to-day that they may unite in their service the oldest and most ancestral modes of faith, and the least fettered and least hierarchical forms. From my heart I join in the wish, which I feel sure will be entertained by all who have now been brought together, and which has already found an expression in the mouths of preceding speakers, that the Institution of which, amid so many demonstrations of good will and concord, the first stone has been laid this day, and of which we are now holding this commemorative assembly, may in its future development, never suffer those whom it may bring within its walls, or who may be partakers of its benefits, to derive any influence that is inconsistent with their duties as good citizens, good subjects, good men, good Christians — that they may under its roof find much to instruct, much to amuse, much to refine, much to elevate; — nothing to corrupt, nothing to sully, nothing to sap the wholesome foundation of morals or impair the sacred principles of religion; but that while they may continue to enjoy the opportunities it affords for useful instruction and for rational recreation, they may at the same time be imbibing lessons which shall stimulate and sweeten their daily toil, and make their own homes and firesides honest and happy.

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THE END.

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