SIMPLE SCIENTIFIC FOOD FOR THOUGHT.

"A LIVING BODY COMPARED WITH A STEAM ENGINE."*—We find ourselves on the outside of a large ball, which (carrying us with it) flies through space at the rate of about a thousand miles an hour. Below us we have the hard ground, around us and above us the thin air. On this ground we build our habitations with materials from within it ; out of the ground, the water, and the air, we get the materials for our food. But the physical power of man seems little qualified to enable him to become the governor of the world ; and we shall see that it is only by calling to his aid the forces already existing around him that he can control them.

Above the ground there is little but air and water ; but in the ground itself we have endless variety of material : thus in England, we have below the superficial accumulation of our own times clay and sand, below these chalk and greensand, below these again limestone, then red sand, then limestone, then the coal measures, below these still more red sand, and still lower we have slates, and lowest of all is granite. In these lower beds, almost exclusively, we find also a variety of substances differing from earths (such as clay, sand, and lime) in many respects. These melt at comparatively low temperatures, can be easily polished so as to reflect light, are good conductors of heat and electricity, have such considerable cohesive power that they may, in some cases, be drawn into threads finer than hairs. These are called metals, and differ from earths not only as just described, but also in being of more elementary chemical character. They are usually, indeed, said to be elementary substances—*i. e.*, incapable of further decomposition ; but this statement is probably a testimony to the imperfection rather than to the accuracy of our present knowledge.

On the surface of the ground, but attached to it by long fibres, is an immense variety of trees, shrubs, and grasses, which may be regarded as compounds of the materials of the earth, the sea, and the air. These are among the chief ministers to our wants—from them we get the chief of our food, our clothing, and in some cases our dwellings.

All these possess also the marvellous power of increasing in size, by absorbing additional materials from without. Commencing their lives as young leaves, they grow with time, apparently from within ; but really, as in the case of men, by the appropriation of additional materials from without. It is common to say that the seed becomes a twig, and the twig a tree ; but this is not the truth ; the seed does not become a twig, the twig does not become a tree. The materials which become the tree are in the ground, the rain, and the air. The office of the seed is to bring these materials together, to enable them to combine so as to form a tree. It would be as true to say that a wire is made of the hole through which it is drawn as that a tree comes from its seed. The seed is to the tree what the hole is to the wire, except that it does the work itself, and does not require to be set going.

The whole world, then, consists of a vast variety of constituent substances ; metals, earths, woods, are three groups that contain nearly the whole of the substances usually met with in the solid form : water, usually a liquid, and air as a gas, make up, with these metals, earths, and wood, nearly the whole of the world.

Yet all the varieties of earths and woods, together with water and air, may be treated as compounds of a very limited number of elementary substances some fifty or sixty in number, among which primary substances the metals themselves may be placed. Thus chalk is a compound of carbon, lime, and oxygen ; lime is a mixture of calcium and oxygen ; soda of sodium and oxygen ; water of hydrogen and oxygen ; flint of silicon and oxygen ; copperas is a complicated mixture of iron, sulphur, hydrogen, and oxygen ; vitriol a compound of sulphur, hydrogen, and oxygen.

It will be noticed in this list how frequently oxygen occurs. It is indeed a constituent in a vast number of the compounds found in the world. One fifth of the entire atmosphere is oxygen, one-third of all the water is the same. Indeed, it has been stated that oxygen forms nearly a fourth part of the entire contents of the globe. It has a wonderful power of combination with nearly all other substances ; and while this gives much trouble when it is necessary to obtain any substance in a state of purity, it also frequently offers a means of this purification.

The whole world, then, being but a number of more or less complex substances, all acting and reacting, with differences of degree, upon each other, it becomes necessary to know something of the nature of their elementary substances, of the manner in which they affect each other, and of the circumstances which modify the mutual action. For it should be clearly borne in mind that all that is called work, and sometimes dignified with the title of man's power over external nature, is but the use of these properties. As has been clearly pointed out by one of our greatest writers, all that man can do is to move things from one place to another, that beyond this he can do nothing whatever.

Thus, if I wish to light a lamp, I move a lighted match to the wick ; to light the match I moved it rapidly along some roughened surface. I can do no more. The nature of the oil in the lamp, and of the phosphorus and potassic chlorate on the end of the match, does the rest. A sculptor wishes to make a statue ; he simply moves away the pieces that do not belong to the figure ; and the difference between a good artist and a bad one consists in the degree of knowledge as to what pieces should be moved. A pudding is made by removing all the requisite materials into a cloth, the cloth into a saucepan, and the saucepan to the fire. To write a letter I move some ink from the inkstand on to some paper, and the postman moves the paper from me to the person to whom it is addressed. And so on through all the multifarious concerns of our life, whether of business or of pleasure, of work or of rest. The greatest orator, in his highest flights of eloquence, but moves his tongue and his mouth, beating the air that moves from him to our ears. The artilleryman, who deals out death to hundreds from his gaping cannon, but moves powder and ball into it, and then evokes the force of burning gunpowder to move them out again. The greatest painter but moves various colours on to his canvas ; to walk we but move the muscles of our legs, and to work we but move the muscles of our arms. The carpenter moves a few pieces of wood together, and behold a table or a chair, a bookcase or a window-frame. The builder moves from place to place a certain number of bricks, pieces of wood, and of stone, together with sundry pieces of glass, iron, and pottery, and a house has risen under his hand.

This does not degrade man's work ; on the contrary, it dignifies it. For out of this single power of moving things, and the possession of judgment to govern the moving, see what mighty results have been attained ! One will delight the soul with music by moving a few ivory keys ; another by moving a few roughened hairs over a few strings ; a third by moving air through a brass tube. Think of the mighty power of so appealing to mankind, and of the woundrous power that enables us to understand and to delight in the appeal.

If, however, man can only move things from one place to another, there must be some power inherent in the things themselves, or no result would follow from the moving. I place a small piece of coal—say, two ounces—as fuel for a steam engine ; if I can collect and utilise all the force so developed (without any loss in moving the machinery), I have power sufficient to raise a hundredweight through a distance of three miles—to lift it bodily from the foot of Mont Blanc to its summit. It becomes then a very important question to ask, Whence can coal derive this power of exerting force when burnt ? Wood possesses the same power of giving out force when burnt ; but wood and coal are practically the same.

It is a familiar fact that wood and coal burn because they contain carbon, that this carbon unites with oxygen in burning, that the union of the two forms carbonic acid. Therefore, since carbon unites with oxygen, when the two are placed in contact, it becomes necessary to ask, Whence is this power derived ?

We cannot carry ourselves back through ages of time so as to see the trees of which our coal has been made ; but trees are now as they were then ; and we have but to go a few miles away from London to be in every circumstance, but that of actual time, among the sources of coal. The trees, the ground, the sun, the air, are the same in kind now as they ever were ; and, standing under the old beeches of Epping Forest, let us ask them how they live ? what food nourishes them ? and how they obtain it ?

Carbon is the combustible part of wood—that which burns and gives out force in burning ; so that our chief concern is to know whence it derives this. Not from the ground, which usually contains but little ; not from the rain, which contains none. Driven from land and from water, we have but the air to take refuge in ; and here we find the true source of the carbon contained in our trees and our coal.

When I burn coal or wood, the carbon unites with oxygen to form carbonic acid ; this floats about in the air, and forms an appreciable portion of its bulk. From this carbonic acid the trees derive their carbon. In some wonderful way, aided by sunlight, they separate these again into oxygen, which goes away, and carbon, which remains. Thus, the same carbon is burnt over and over again, giving out at each successive burning a certain amount of heat or force.

* Introduction to a small work, "Applied Mechanics," by W. Rossiter, F. R. A. S., &c.