

THE AWAKENING OF SPRING.

With sudden impulse Nature wakes from sleep,
And throws aside her coverlet of white,
The morning air is fragrant, fair and bright,
As from her couch she laughing doth upleap;
The robe she now unfastens that did keep
Secure her growing beauty from the sight
Of her lord-lover in the silent night,
Who yet lies buried in a slumber deep;
A lightsome drapery of verdant hue
She now throws o'er her, as she trips along,
Humming the burden of an old love-song;
Where'er she steps all things she doth endue
With cheerful grace, and as she moves about
The whole world welcomes her with one glad shout.

AMARANTH.

EDUCATION:

INTELLECTUAL, MORAL, AND PHYSICAL.

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CHAPTER I.

WHAT KNOWLEDGE IS OF MOST WORTH?

Still more numerous are the bearings of chemistry on those activities by which men obtain means of living. The bleacher, the dyer, the calico-printer, are severally occupied in processes that are well or ill done according as they do or do not conform to chemical laws. The economical reduction from their ores of copper, tin, zinc, lead, silver, iron, are in a great measure questions of chemistry. Sugar-refining, gas-making, soap-boiling, gunpowder manufacture, are operations all partly chemical; as are also those by which are produced glass and porcelain. Whether the distiller's wort stops at the alcoholic fermentation or passes into the acetous is a chemical question on which hangs his profit or loss; and the brewer, if his business is sufficiently large, finds it pay to keep a chemist on his premises. Glance through a work on technology, and it becomes at once apparent that there is now scarcely any process in the arts or manufactures over some part of which chemistry does not preside. And then, lastly, we come to the fact that in these times, agriculture, to be profitably carried on, must have like guidance. The analysis of manures and soils; their adaptations to each other; the use of gypsum or other substance for fixing ammonia; the utilization of coprolites; the production of artificial manures—all these are boons of chemistry which it behooves the farmer to acquaint himself with. Be it in the lucifer match, or in disinfected sewage, or in photographs; in bread made without fermentation, or perfumes extracted from refuse, we may perceive that chemistry affects all our industries, and that, by consequence, knowledge of it concerns every one who is directly or indirectly connected with our industries.

And then the science of life—biology: does not this, too, bear fundamentally upon these processes of indirect self-preservation? With what we ordinarily call manufactures, it has, indeed, little connection; but with the all-essential manufacture—that of food—it is inseparably connected. As agriculture must conform its methods to the phenomena of vegetable and animal life, it follows necessarily

that the science of these phenomena is the rational basis of agriculture. Various biological truths have indeed been empirically established and acted upon by farmers while yet there has been no conception of them as science: such as that particular manures are suited to particular plants; that crops of certain kinds unfit the soil for other crops; that horses cannot do good work on poor food; that such and such diseases of cattle and sheep are caused by such and such conditions. These, and the every-day knowledge which the agriculturist gains by experience respecting the right management of plants and animals, constitute his stock of biological facts, on the largeness of which greatly depends his success. And as these biological facts, scanty, indefinite, rudimentary though they are, aid him so essentially, judge what must be the value to him of such facts when they become positive, definite, and exhaustive. Indeed, even now we may see the benefits that rational biology is conferring on him. The truth that the production of animal heat implies waste of substance, and that, therefore, preventing loss of heat prevents the need for extra food—a purely theoretical conclusion—now guides the fattening of cattle: it is found that by keeping cattle warm fodder is saved. Similarly with respect to variety of food. The experiments of physiologists have shown that not only is change of diet beneficial, but that digestion is facilitated by a mixture of ingredients in each meal: both which truths are now influencing cattle-feeding. The discovery that a disorder known as "the staggers," of which many thousands of sheep have died annually, is caused by an entozoon which presses on the brain, and that if the creature is extracted through the softened place in the skull which marks its position the sheep usually recovers, is another debt which agriculture owes to biology. When we observe the marked contrast between our farming and farming on the Continent, and remember that this contrast is mainly due to the far greater influence science has had upon farming here than there; and when we see how, daily, competition is making the adoption of scientific methods more general and necessary; we shall rightly infer, that very soon agricultural success in England will be impossible without a competent knowledge of animal and vegetable physiology.

Yet one more science have we to note as bearing directly on industrial success—the Science of Society. Without knowing it, men who daily look at the state of the moneymarket, glance over prices current, discuss the probable crops of corn, cotton, sugar, wool, silk, weigh the chances of war, and from all those data decide on their mercantile operations, are students of social science: empirical and blundering students it may be, but still students who gain the prizes or are plucked of their profits according as they do or do not reach the right conclusion. Not only the manufacturer and the merchant must guide their transactions by calculations of supply and demand, based on numerous facts, and tacitly recognizing sundry general

principles of social action, but even the retailer must do the like: his prosperity very greatly depending upon the correctness of his judgments respecting the future wholesale prices and the future rates of consumption. Manifestly all who take part in the entangled commercial activities of a community are vitally interested in, understanding the laws according to which those activities vary.

Thus, to all such as are occupied in the production, exchange, or distribution of commodities, acquaintance with science in some of its departments is of fundamental importance. Whoever is immediately or remotely implicated in any form of industry (and few are not) has a direct interest in understanding something of the mathematical, physical, and chemical properties of things; perhaps, also, has a direct interest in biology; and certainly has in sociology. Whether he does or does not succeed well in that indirect self-preservation which we call getting a good livelihood depends in a great degree on his knowledge of one or more of these sciences: not, it may be, a rational knowledge, but still a knowledge, though empirical. For what we call learning a business really implies learning the science involved in it, though not perhaps under the name of science. And hence a grounding in science is of great importance, both because it prepares for all this, and because rational knowledge has an immense superiority over empirical knowledge. Moreover not only is it that scientific culture is requisite for each, that he may understand the *how* and, the *why* of the things and processes with which he is concerned as maker or distributor, but it is often of much moment that he should understand the *how* and the *why* of various other things and processes. In this age of joint stock undertakings, nearly every man above the laborer is interested as capitalist in some other occupation than his own; and, as thus interested his profit or loss depends on his knowledge of the sciences bearing on this other occupation. Here is a mine, in the sinking of which many shareholders ruined themselves, from not knowing that a certain fossil belonged to the old red sandstone, below which no coal is found. Not many years ago 20,000*l* was lost in the prosecution of a scheme for collecting the alcohol that distils from bread in baking, all which would have been saved to the subscribers had they known that less than a hundredth part by weight of the flour is changed in fermentation. Numerous attempts have been made to construct electro-magnetic engines, in the hope of superseding steam; but had those who supplied the money understood the general law of the correlation and equivalence of forces they might have had better balances at their bankers. Daily are men induced to aid in carrying out inventions which a mere tyro in science could show to be futile. Scarcely a locality but has its history of fortunes thrown away over some impossible project.

And if already the loss from want of science is so frequent and so great, still greater and more frequent will it be to those who hereafter