Agricultural Chemistry.

Water.

Water is a substance which is so common and so important, and which, at the same time, in its chemical relations is so remarkable, that we cannot do better than begin our study of chemistry, in its relation to agriculture, by a consideration of its composition and properties.

A plate of copper and a plate of zinc, the upper edges of which are in contact, or are united by a copper wire, and which are then partially immersed in a vessel containing dilute acid, constitute a *galvanic battery* in a simple form. By using a number of such batteries, and connecting the copper of one with the zinc of the next, and then the zinc of the first with the copper of the last, a compound battery of great power may be constructed. Platinum is often advantageously substituted for copper in such a battery. So long as the first and last plates of the battery are unconnected no galvanic action takes place; but if a copper wire connected with the copper plate of the first cell is made to dip into a vessel of water to which a little acid has been added, and a similar wire connected with the zinc plate of the last cell is made to touch the same liquid, a current is immediately established. The action is much facilitated by making the wires terminate in platinum plates which dip beneath the surface of the acidulated water. The termination of the wire connected with the copper of the battery is called the *positive pole*; that of the wire attached to the zinc, the *negative pole*.

No sooner is the connection in this way complete, than numbers of little bubbles arise from the water round each of the platinum plates which constitute the poles of the battery. These bubbles are caused by the escape of a colorless invisible gas at these points, which may be collected in glass cylinders inverted over the platinum plates from the surface of which the bubbles are arising. If the gases in the two cylinders are then compared together, they will present no difference to the eye except that the quantity of that collected over the negative pole is twice as great as that of the gas which was given off at the positive pole. If, however, a lighted match be applied successively to the mouths of the two cylinders, very different results will be observed. The gas which was obtained over the wire connected with the zinc of the battery will take fire, and burn with a pale yellowish flame; the match itself will be extinguished if immersed in the gas. A lighted match thrust into the other cylinder will burn with very greatly increased brilliancy; and if blown out so as to leave the extremity still red hot, it will, if again plunged into the gas, burst at once into flame.

To the gas which arises from the positive pole the name *Oxygen* has been given; that which is evolved at the negative pole has been called *Hydrogen*. These two gases, united chemically in the proportion of two measures of hydrogen to one of oxygen, constitute water. This may be shewn by passing an electric spark through a mixture of the gases in these proportions. They explode with great violence, and form *steam*, which rapidly condenses into a few drops of water resembling dew, and the two gases are found to have entirely disappeared.

It will be well, then, to study these gases, which together constitute water, a little more closely.

Oxygen.—Oxygen may be obtained by decomposing water by means of the galvanic current, as just described. It is more easily procured, however, in another way. Chlorate of potash is a substance sold by druggists in the form of white or colorless crystals; it consists of oxygen in combination with another gas known as *chlorine*, and a metal called *potassium*. When this substance is heated, it gives off all its oxygen, leaving the chlorine in combination with the potassium. The addition of *black oxide of manganese*, or *peroxide of iron*, greatly facilitates the decomposition. From such a mixture oxygen may be obtained by heating it in a Florence flask, in the neck of which is fastened a cork perforated by a bent tube, which dips beneath the surface of water contained in a good sized basin. A glass jar is filled with water, and inverted over the end of the tube with its mouth under the water. The pressure of the atmosphere on the surface of the water in the basin will, of course, retain the water in the jar. On the application of heat the gas is given off in large quantities, and bubbles up into the jar, displacing the water which it previously contained. The jar may be kept inverted over a shallow dish of water, which will prevent the escape of any of the oxygen.

Oxygen is a colorless gas, with neither taste nor smell. In appearance, it cannot be distinguished from common air; it is a little more than one-tenth heavier than air. We have already seen that a piece of lighted wood will burn in oxygen more vividly than in air; the same is true as regards other combustible bodies.

A piece of charcoal will, if ignited and plunged into a jar of oxygen, glow intensely, throwing out sparks in all directions, and being in a short time entirely consumed. Phosphorus burns in oxygen with a light that is almost insupportable. But this is not all. Substances which are not usually regarded as combustible will readily burn in oxygen. If a bit of iron wire or a steel watch-spring be tipped with a little ignited sulphur, and then placed in a jar of the gas, it will burn most brilliantly, throwing off beautiful scintillations.

All these experiments are illustrative of *chemical combination*. Charcoal consists almost entirely of *carbon*, and carbon and oxygen have, at certain temperatures, an attraction for each other which causes them to unite together, with the production of great heat and light, to form a gas called *carbon dioxide*, which contains both oxygen and carbon. So, too, the iron wire or the watch-spring unites with the oxygen to form *iron oxide*; and in this instance, as in the case of the charcoal, heat and light are evolved in the act of union between the two substances. The atmosphere contains twenty-one measures of oxygen in every hundred, and all ordinary combustion is nothing more than the chemical combination of the burning body with oxygen. The heat and light of combustion are the effects of this chemical action. The reason why bodies burn with so much more energy in oxygen than in the air is now apparent, for air is only diluted oxygen. Chemical combination is always attended by heat, but not always by such intense heat as in the instances that have been given. In the air, charcoal will smoulder away until it is consumed; that is, until it has all united with oxygen from the atmosphere to form carbon dioxide. The effect is the same; and the same *quantity* of heat is generated as in its rapid combustion in oxygen, but it takes a longer time to accomplish the result. When iron *rusts*, it is slowly combining with the oxygen of the air—a process known as *oxidation*.

If a small animal be placed in a jar of oxygen, its heart beats rapidly, its breathing is hurried, its temperature rises; it is in exactly the same condition that the lighted carbon was in when it was plunged into the oxygen—it is being consumed more quickly. In respiration, the carbon of the blood unites with the oxygen of the air to form carbon dioxide; it consists, in fact, of a slow combustion of this carbon, and in pure oxygen this process of oxidation takes place more rapidly, and the animal soon dies, exhausted.

Animals are continually absorbing oxygen from the air. Plants, on the other hand, are, during daylight, always giving it out. If a bunch of freshly gathered leaves be put into a basin of water, and a glass jar filled with water and inverted, over them, bubbles of gas will rise into the jar, which may be shewn to consist of oxygen. During the night plants cease giving off oxygen.

Oxygen is an *elementary substance*: it has never been decomposed into any other simpler substances. Hydrogen, carbon, phosphorus and iron are also elementary substances, or chemical *elements*. Water, carbon dioxide, and iron oxide, on the other hand, are examples of chemical compounds. A chemical compound is quite different from a mechanical mixture. It exhibits properties which are usually quite different from those of either of the elements of which it is composed. Its formation is always attended by more or less heat, and, as we shall see hereafter, it always contains the same elements in certain definite proportions, which are never altered.

FERTILIZERS.

Guano Deposit of Peru.

Harry Meiggs the great railroad operator of South America, has discovered, on the main-land of the west coast of Peru, the most immense deposit of guano ever seen anywhere. This deposit is said to extend for many miles along the coast, and reached far inland. The Chincha Islands have heretofore been considered the richest in guano production, but this last discovery shows conclusively that it is of much better quality and much easier to handle than the former. Millions upon millions of tons can be dug cheaply, and transported to all parts of the world at a much lower figure than heretofore. This valuable fertilizer will no doubt be used much more extensively in America, as well as Europe, as the price at which it can be furnished will place it within the reach of all.

Mineral Phosphate.

The business of phosphate mining seems to be very prosperous in South Carolina. One company mined 15,000, tons last year, and the production from river deposits alone amounted to 40,000 tons during 1872. It is expected that the entire product of the State will be increased not less than 40 per cent. during 1873. Mineral phosphates have been discovered recently in Siberia, Austria and France, but they are beyond the reach of immediate development, and are not favorably situated for the transportation of the products to a market. In these respects the South Carolina deposits enjoy great advantage.

Compost.

Below find rule for preparing my "Domestic Concentrated Manure," which I have used for three years for corn; take two parts of decomposed sheep manure, (or fine cattle manure,) one part of hen manure, one part unleached ashes, one part of plaster, all incorporated together, and thoroughly worked over twice or more; keep under cover ten days. All ingredients are at the command of all farmers without much expense. I have experimented with it the past three years; spreading on stable manure, and thoroughly incorporating it into the soil with an ox cultivator, working the land with a corn-worker, marking the rows regularly both ways. Apply a handful to each hill. My crops of corn have been twenty-five per cent. better than before I went into the use of the composition. In 1871, York County Fair gave me the highest premium on corn.—*Correspondence Boston Cultivator.*

Lime and Salt Mixtures.

Prof. Johnson recommends for fertilizing purposes to mix one bushel of salt and two bushels of dry lime under cover, and allow the mixture to decompose gradually, thus forming an intimate chemical union of the two materials. For this purpose the mixture should be made at least six weeks before use, or still better, two or three months, the heap mentioned being turned over occasionally. This salt and lime mixture, when applied at the rate of twenty or thirty bushels per acre, forms an excellent top-dressing for many crops. It acts powerfully on the vegetable matter of soils; fifty-six bushels applied to a turnip crop have produced as large a crop as barn-yard manure. It is also very destructive to grubs and insects in the soil. Like salt, it attracts moisture from the air, and is useful against drought. Its decomposing power is remarkable, and if three or four bushels of it are mixed with a load of swamp muck, the latter will be reduced to a powder.

What Greeley thought of Plaster.

In one of his last agricultural addresses, Horace Greeley spoke as follows:—"As a fertilizer, I place gypsum or plaster first on the list, without supposing it to be of equal value everywhere, or even of any value under all conceivable circumstances. And yet I doubt that a hill or dry plain can be found ten miles inland on which a first application of plaster, to the extent of 200 pounds per acre, would not be repaid in the very next crop, more especially if that crop were clover. Wherever ground plaster may be had for less than $20 per ton (as it can be in some parts of the Union,) I hold that each farmer who has not yet tried it should buy at least one ton, apply it to ten acres in strips of two rods' width, alternating with a like breadth left unsown, and carefully watch the result. If no benefit is realized, he may safely conclude—not the plaster is a humbug—but that his land does not need it, or that he has not known how and when to apply it. In my own case, I judge that I have bought no other fertilizer that paid so amply and speedily as plaster.

Potash as a Fertilizer.

Coleman's *Rural World* is credited as saying that potash forms one of the most essential constituents of a fertile soil, and one of the most important of all the fertilizing agents within reach of the agriculturist. In many plants it constitutes more than one-half of their ash, and in most at least one-third. In neutralizing acids in the soil and in the liberation of ammonia, it acts in the same manner as lime; but when it is desired to simply effect these last mentioned objects, the latter should be used, as being cheaper; and potash, generally available in the form of ashes, should be applied as a manure, using the word in its strictest sense, to indicate a substance that contributes directly to the building up of the structure of the plants. But considerable care should be exercised in the use of ashes, and they should never, as is the practice with some in manuring corn in the hill, be mixed with guano or the refuse of the hen-roost, inasmuch as the first rain that dissolves them will cause the potash to displace the ammonia in the same manner that lime displaces it from barnyard manure and similar manures, as we have just mentioned.