especially in the bark of plants. Hence it appears, that de­cayed vegetable matter, and the same may be said of ani­mal remains, is not only conveyed into plants, but, being formed of the same elements as the living plant, may be conceived to furnish materials necessary to its growth.

But in all soils adapted to vegetation, water is a neces­sary ingredient, whether it be regarded merely as a vehicle for the conveyance of other substances, or as itself forming a portion of the food of plants. To the experiments of Van Helmont, Boyle, Bonnet, Du Hamel, and Braconnot, tending to prove that water alone affords nutriment to plants. It has been objected, that the water which they employed, though apparently pure, held in solution both earthy and saline matters; but, unless we suppose these matters convertible into oxygen, hydrogen, and carbon—the only essential ele­ments of vegetables—the presence of these earths and salts in the water could not supply the elements required for the pro­duction of vegetable matter. If, on the other hand, with Du Hamel and De Saussure, we suppose water, though not decomposed, to lose its fluidity, and become fixed in vege­tables, then we have at once two of the elements of woody fibre, combined in that proportion which the experiments of Gay Lussac and Thenard exhibit them as holding in the composition of vegetable substance.

Of the source of the other element, carbon. It is not less difficult to speak. It is an ingredient of vegetable mould, and of the carbonic acid carried into plants with the sap, either in a free state, or in combination with alkaline mat­ter ; so that, by these means. It is pretty largely supplied to plants. On the other hand, M. Hassenfratz endeavoured to show, that plants which vegetated in the open air by the aid of pure water, yielded, on analysis, less carbon than the seeds or bulbs from which they had sprung. M. de Saus­sure obtained similar results when he analysed plants that had grown in pure water, and in a place weakly illuminat­ed ; but when they grew under the direct influence of light, then the proportion of carbon in the plant nearly doubled that in the seed. This carbon he supposes to be de­rived from that decomposition of carbonic acid which is carried on by the leaves of plants growing in sunshine. Admitting this to be the fact, we may perhaps regard the carbon thus deposited in the leaf as contributing rather to the formation of the inflammable products of the plant, than as undergoing *assimilation,* and being applied to the pro­duction of new vegetable substance. And hence, as will afterwards be shown, plants which grow in darkness not only contain less carbon than those which grow in light, but are at the same time destitute of those inflammable ingre­dients which plants growing in light possess.

Beside the earth and water, the air also lias been sup­posed to furnish food to plants. That plants obtain mois­ture from the air will not be denied ; and in as far as water is concerned in vegetable nutrition, the moisture thus ob­tained may contribute to vegetable growth. But they have also been supposed to derive carbon from the atmosphere, by decomposing its carbonic acid. Since, however, the at­mosphere contains less than 1/1000th part of carbonic acid gas, the portion of that gas decomposed by plants in the open air must, even in sunshine, be necessarily very small, and the quantity of carbon thus obtained is probably much exceeded by that continually given off by plants to unite with the oxygen *gas* of the atmosphere, through every pe­riod of active vegetation. M. de Crell, indeed, deeming the carbon that could be afforded by the atmosphere insuf­ficient to account for the addition of that substance which plants receive during their growth, was led to suppose they possessed the power of forming carbon by the aid of water, air, and light; and M. Braconnot has maintained that vege­tables find in pure water every thing necessary for them to assimlate; that mould and manures yield no nutriment; and that earths, alkalis, metals, sulphur, phosphorus, and charcoal, are developed from water, by the organic powers of plants assisted by solar light.

“ But the experiments,” says Sir Humphry Davy, “ in which it is said that alkalies, metallic oxides, and earths, may be formed from air and water alone in processes of ve­getation, have been always made in an inconclusive man­ner ; for distilled water may contain both saline and metal­lic impregnations; and the free atmosphere almost constantly holds in mechanical suspension solid substances of various kinds. The conclusions of Μ. Braconnot,” he adds, “ are rendered of little avail in consequence of these circum­stances. In the only case of vegetation in which the free atmosphere, in his experiments, was excluded, the seeds grew in white sand, which is stated to have been purified by washing in muriatic acid ; but such a process was insuf­ficient to deprive it of substances which might afford carbon, or various inflammable matters.”

Art. II.—*Of the course of the Sap, and the causes of its Morion.*

In the warmer regions of the earth, the sap flows, in cer­tain plants, through the whole year ; but in more tempe­rate climes the functions of vegetables are suspended dur­ing the winter season. Early in spring, however. It begins to rise in trees, and continues daily to ascend till it reaches the extremities of the branches. This sap is absorbed from the soil by the extremities of the capillary rootlets, or the spongioles, as they are called, and conveyed upwards through the vessels of the root to the trunk. In its ascent it rises only through the wood ; for, at this early period, no sap is found in the bark, nor between it and the wood, nor in the pith. This rise of the sap occurs *before* the buds have shot forth into leaves ; and as no outlet for its escape by tran­spiration then exists. It rises or falls in the vessels in which it is contained according to the temperature of the atmos­phere. If at this period of its flow. Its course, in certain trees, be intercepted, by piercing the vessels of the trunk in any part. It issues forth, and may be collected for exami­nation. In this way the vine, the birch, and sugar-maple, yield sap, or *bleed,* as it is called, very abundantly. They bleed also from the extremity of a cut branch, if the expe­riment be made sufficiently late in the season, but still *be­fore* the appearance of the leaves.

Early in February, before the sap began to flow, Dr. Wal­ker made several incisions, at different heights, in a birch tree, in order to observe its motion. No sap was visible at the lowest incision in the trunk till the temperature of the atmosphere rose to 46° in the shade ; after which, as the temperature augmented, the sap continued daily to rise. When the highest incision in the trunk, at the height of thirty feet, bled, the thermometer was at 52°; and when the tree bled, not only from the incisions in its trunk, but from every cut extremity of its branches. It was at 56°. During the whole experiment, when the temperature was nearly the same, the sap continued nearly stationary,—rising again, as the temperature rose, just like the fluid in a thermome­ter. To the cut extremity of a vine branch, Dr. Hales, in the bleeding season, cemented long glass tubes, so that he could readily observe the movements of the sap. Into these tubes it would rise many feet through the morning after the sun was up ; but while in this rising state, if there was a cold wind, or the sun was clouded, the sap would imme­diately subside, at the rate of an inch in a minute, for seve­ral inches ; but as soon as the sunbeams broke out again, the sap would immediately return to its rising state, just as any liquor in a thermometer rises and fails with the alterna­tions of heat and cold.

To ascertain the force and velocity of the sap’s motion at this season, Dr. Hales made many experiments. He found it to rise in glass tubes, at the rate, sometimes, of an inch in three minutes, and to attain the height of more than