important subject for study. After having given the plant a suitable dwelling-place, we must also supply it with suitable food; in this respect plants resemble animals. But, in order to understand what we are about, it may be advisable briefly to recapitulate the principles of vegetable physiology on which this doctrine is based.

If we call to mind the mechanism of vegetation, we find that water, containing various substances in solution, penetrates by endosmose into the roots, rises from thence by capillary attraction under the bark, where it is called *sap*. When it reaches the leaves a portion is removed by evaporation, and the solution, of course, becomes more condensed. Under the action of air and light, the free carbonic acid it contains is decomposed—carbon is fixed in the plant, and oxygen given off into the air. During the night, on the contrary, the oxygen of the air is absorbed by the leaves, combined with the carbonaceous elements of the sap, to be again decomposed at the return of light. The solid matters present in the sap are deposited, according to their special natures, round the cellular vessels, or on the surface of the leaves, or at certain determinate parts of the structure; the superfluous or injurious matter being carried off by the descending sap, and eliminated from the roots as excrement.

It is unnecessary to follow the sap through the various changes its elements undergo—the successive changes by which sugar, mucilage, gluten, albumen, and the various vegetable acids are formed; this part of the subject belongs to vegetable physiology.

All soluble matters within their reach being absorbed by plants (a fact well ascertained, even in the case of virulent poisons), which of these substances are so essential to vegetation that plants in general cannot be deprived of them without suffering? And, in the second place, do certain kinds require certain substances to be present in the soil, which are not absolutely necessary to others? In a word, is there in vegetables a universal food, so to speak, or does each plant require a special one? These are the questions which we have to examine.

1st. *The food necessary for all vegetables.*

The attempt has often been made to ascertain, by experiment, the substances essential to vegetation, or those by means of which the vegetable can live and grow, though deprived of all others. It has, at least, been ascertained that a plant cannot live without oxygen and carbonic acid. In an atmosphere deprived of moisture a plant will not live; water is, therefore, also indispensable, not only on account of its solvent powers, but also because its elements enter into the formation of many of the products of vegetation. As for carbonic acid, that which is absorbed by the leaves, though sufficient to support life, does not appear to be enough to secure the full development of plants, as the following experiment (which also goes to prove the importance of vegetable matter in the soil) will satisfactorily show.

Two boxes were taken, the one containing soil calcined, so as to destroy all organic matter; the second contained soil in its natural state. In both a few grains of peas were sown, and it was observed that the plants in the former were much less vigorous than those in the natural soil. Upon examination, the first contained 46 of its weight, and the second 57, or rather more than half its weight of carbon. This difference was, undoubtedly, owing to the carbon present in the second box.

In all the experiments which have been made, none have, as yet, been undertaken under such circumstances as to exclude nitrogen in its simple form, so that we cannot speak positively as to its importance. But as it is universally present in the form of ammonia, and as it enters largely into all the more important vegetable products, we may safely affirm that nitrogen is requisite for plants.

Thus oxygen, water, carbonic acid and nitrogen, are the primary and indispensable elements of vegetation. Their action is undoubtedly assisted by the important agents, heat and light, and in all probability by electricity.

Chemical analysis demonstrates the justice of this conclusion. Amongst a great number of substances, varying with the species, and climate, and the soil, these important ingredients are always present. They exist in the form of starch, gum, sugar, manisite, ulmic, gallic, acetic, malic, citric, and other acids, and neutral substances. In a word, they form the basis of the almost endless variety of organic compounds which modern chemistry has brought to light.

2nd. *The special food of vegetation.*

It might have been thought that the above mentioned substances would have sufficed to give stability and solidity to plants, especially as carbon forms such a large proportion of the vegetable tissues. If even this had been possible, the framework of a plant is not exclusively composed of carbon, certain alkaline and earthy matters being always found to be present along with the organic portion of vegetation. The difficulty exists in the varying proportion in which these alkaline and earthy substances are found, not only in different plants, but in even the same species when grown upon different soils. They are, to a certain extent, interchangeable amongst each other, so that it is difficult or impossible to say which of them are absolutely indispensable to vegetation. It is even possible to imagine a plant *existing* without any of them, in the same way as a mammiferous animal may live after all the solid portions of the bones have been removed. In both