

and only by the green parts that oxygen is given off, that this is quite distinct from another (respiratory) process in which carbonic acid gas is liberated, and that the chief if not the only source of the carbon in plants is in the carbonic acid gas of the atmosphere.

In 1800 Senebier (1742-1809) corroborated Ingen-Houss's discovery of the decomposition of carbon dioxide. Much more important, however, was the work of Théodore de Saussure (1767-1845), son of the famous explorer of the Alps, who introduced the quantitative method of estimating a plant's income and expenditure, and thereby showed that the elements of water are fixed in the plant as well as the carbon of the carbon dioxide, that respiration is essential to growth and is related to the internal heat (measurable in flowers), that plants are unable to use the nitrogen of the atmosphere, and that there is no normal nutrition apart from nitrates and similar salts in the soil.

The chief representatives of vegetable physiology about 1840 were De Candolle (better known as a systematist), Treviranus, and Meyen, but none of them made any new step of importance. Two impeding theories had to be got rid of, the theory of vital force and the theory of humus. The former could only die hard, but the latter was cut short by Liebig. According to the "humus-theory" it was believed that plants feed upon prepared organic matter (or humus) in the soil, and this was regarded as a source of both carbon and nitrogen. Liebig showed, however, that (Fungi apart) plants derive from the soil only water, ammonia, and inorganic salts, and corroborated the already established conclusion that all the carbon supplies are in the CO_2 of the air. As plants die down they necessarily enrich the soil with humus, but this humus as such forms no part of the food-supply. There is no doubt that 1840, when Liebig published the first edition of his *Organic Chemistry in application to Agriculture and Physiology*, is one of the red-letter dates in the history of biology. It marks the first concrete realization of the "circulation of matter".

What Liebig had shown in a general way was con-