[p. 25] Chapter 2
Influence of Carbon Dioxide Gas on Plant Growth

I would perhaps have followed a more methodical order if I had addressed the influence of oxygen gas on mature plants before proceeding to an examination of the effect of carbon dioxide gas, which is only secondary and which is exerted only in conjunction with oxygen gas, but a knowledge of the effects of oxygen gas assumes preliminary data that force me to invert the natural order.

2.1 Influence of Carbon Dioxide Gas on Germination

Seeds do not germinate in pure carbon dioxide gas. A small amount of this gas (such as one-twelfth), which, when mixed with atmospheric air, promotes the **[p. 26]** growth of developed plants in the sun, is detrimental to germination and retards it, both in the light and in the shade, more than does the same amount of hydrogen gas or nitrogen gas. If we introduce, under a receptacle in which seeds have been germinated in pure water and atmospheric air, some potash or a [*i.e., another*] substance capable of absorbing the carbon dioxide gas that the seeds form with the surrounding oxygen gas, their development is accelerated somewhat. It always seemed to me that germination occurs sooner in moist sand or between two wet sponges than in humus, and humus produces carbon dioxide gas. In general, this gas seems useful to plants only insofar as they can break it down, and seeds, at the earliest stage of their development, do not seem to carry out this decomposition appreciably. We note, however, that, as germinating seeds produce too much carbon dioxide gas for us to deprive them of it entirely, it is impossible to decide if its complete absence is harmful or helpful to them.

2.2 Influence of Carbon Dioxide Gas on Developed Plants [p. 27]

When recently sprouted seeds are nourished with water lightly impregnated with carbon dioxide gas, the water appears to be less advantageous to them than it is at later stages of their growth. In two jars, one of which was filled with distilled water

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and the other with acidulated water,[1] I floated two plates pierced with 24 holes, which were intended to support the same number of pea seeds germinated in distilled water. When the experiment began, their radicles were 6 millimeters (2 1/2 lines) long.

After 10 days, the roots in contact with the distilled water had elongated 1.3 decimeters (5 inches) more than had those **[p. 28]** in the gassed water. The stems and leaves had developed in the same proportion. But when, after a month, the plants nourished by the acidulated water were more developed, they no longer differed from those that had grown with the aid of pure water and that had attained their maximum growth several days previously. The latter, in turn, were even surpassed by the former, for, after 6 weeks, the pea plants in the gassed water had gained 46.4 grams (12 *gros* + 10 grains), [“*gros*” *is an obsolete French unit of measurement, equal to 1/8 French ounce; see Appendix 1*] whereas those grown in pure water had gained 45.5 grams (11 *gros* + 66 grains).[2] [*Note: De Saussure made an error in decimal placement here: He wrote 4.55 grams instead of 45.5. Also, he referred to footnote 1, when he clearly meant footnote* 2]. It is important to note that Senebier found that young leaves decompose, at equal volume and in the same time, less carbon dioxide than do adult leaves.

[p. 29] In the experiments just communicated, the stems of the plants grew in the open air and received almost entirely through the roots the extra carbon dioxide that was provided to them dissolved in water. It remains for me now to consider whether this gas is useful to plants when it serves as their atmosphere.

Percival (*Memoirs of the Manchester Society*, Vol. 2) observed that a mint plant nourished by water and exposed to a stream of atmospheric air mixed with carbon dioxide fared better than did a similar plant exposed to a stream of pure atmospheric air.

I tried to verify this initial observation and to determine the amount of carbon dioxide that, when mixed with atmospheric air, may promote plant growth.

I germinated peas with the aid of water, until each plant had reached about 1 decimeter (4 inches) in height and weighed 1 gram (20 grains). I then placed three plants for each experiment in a stemmed glass filled with water, such that the roots alone were immersed in this liquid, and I presented them with various mixtures of ordinary air and carbon dioxide in receptacles closed by water that was **[p. 30]** covered on the interior by a layer of oil if the receptacles contained more than half their volume of carbon dioxide. The three pea plants in each experiment had an atmosphere of 990 cubic centimeters (50 cubic inches) and they did not displace 1/400 part of it. Each day, for 5–6 hours, they received direct sunlight, which was moderated when

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[1] At first this water contained about a quarter of its volume of carbon dioxide, but as it was exposed to the open air in the sun, it retained only a much smaller amount during the general course of the experiment, which lasted 6 weeks. During this period, the gassed water was renewed four times.

[2] Rückert (*Annales de Crell*) found that favas and violets planted in pots full of garden humus fared better when they were sprinkled with water containing a third of its volume of carbon dioxide than when they were sprinkled with distilled water. I did not find a detectable difference, in performing the same experiment on wheat [*blé*]. It is possible that my humus, which was richer in manure, provided the plants excess carbon dioxide.

too intense. At the same time and in the same place, I set up similar apparati exposed to a weak and diffuse light. I call the latter manner of placement *exposure to shade.*

2.2.1 Results in Sunlight

The mean weight gain of the plants exposed to sunlight for 10 days in pure atmospheric air was 425 milligrams (8 grains) per pea.[3]

[p. 31] These plants, at the same exposure, wilted as soon as they were in contact with pure carbon dioxide.

They met the same fate in the atmospheres containing 3/4 and 2/3 of their volume of carbon dioxide.

They grew for 7 days in the vessel containing 1/2 its volume of carbon dioxide. After this period, they stopped growing.

The plants whose atmosphere contained 1/4 of its volume of carbon dioxide survived for the 10 days devoted to the experiment but they did not thrive. Each pea gained only 265 milligrams (5 grains).

With 1/8 carbon dioxide, the mean gain was 371 milligrams (7 grains).

Finally, the mean gain of each plant in an atmosphere of ordinary air in which carbon dioxide occupied 1/12 part was 583 milligrams (11 grains). I repeated this experiment several times, and **[p. 32]** the plants consistently fared better than in pure atmospheric air. The plants that grew in pure atmospheric air did not change it perceptibly, either in purity or in volume, but those that grew in the artificial mixture changed nearly all the carbon dioxide gas into oxygen gas.

I performed another experiment, which confirms this one and shows directly that humus is useful to plants, not only through the nutrients that the plants may draw from it through their roots, but also through the influence that humus has on the atmosphere (influence that, as we know, consists largely of forming carbon dioxide). I suspended, at the upper part of a receptacle containing about 3 liters (150 cubic inches) of atmospheric air, 61 grams (2 ounces) of moistened humus. With this receptacle, closed by water, I covered some partially developed pea plants, whose roots were immersed in pure water during the experiment. After 10 days in the sunlight, these plants, which did not touch the humus at all, had grown one-third more than other, similar plants placed at the same time, without humus, under a receptacle similar to the preceding one. **[p. 33]** But I must note that I renewed the air of the receptacles twice in 24 hours, for without this precaution the plants growing with the humus would have fared less well, either because the humus releases too much carbon dioxide or because it produces vapors or miasmas that, in an unrenewed air and through an unknown cause, are highly detrimental to plant growth.

[3] This weight gain was due largely, and maybe even entirely, to the introduction of liquid water, that is, water of vegetation, into the leaves that developed during the experiment and that drew their solid substance from the cotyledons, which were still large and attached to the plant. These cotyledons contained three or four times less water of vegetation than the leaves to whose development they contributed. I will return elsewhere to this subject, which is unrelated to what occupies me here.

2.2.2 Results in the Shade

In the apparatus exposed to shade, the smallest amount of carbon dioxide added to ordinary air was detrimental to plant growth. In the atmosphere containing 1/4 of its volume of carbon dioxide, the plants were dead after the sixth day. They survived, at the same exposure, for 10 days in an atmosphere in which carbon dioxide occupied 1/12 part, but their gain there was only 159 milligrams (3 grains), whereas it was 265 milligrams (5 grains) in pure atmospheric air.

We have just seen that carbon dioxide added artificially in very small proportions to the atmosphere of plants **[p. 34]** is useful to their growth in the sun, but it exerts this beneficial effect only insofar as this atmosphere contains free oxygen gas. Thus, plants that can maintain their growth in nitrogen gas die in it even in the sun when it is combined with the proportion of carbon dioxide gas that would have promoted their development in atmospheric air.

2.3 Elaboration of Carbon Dioxide Gas by Leaves is Necessary to Their Growth in the Sun

The experiments that I have detailed on the growth of peas in pure atmospheric air yielded the same results when I washed this air in limewater and thus removed the very small amount of carbon dioxide that this air contains naturally. But the results were very different when I introduced into the atmosphere of the plants a substance that absorbs the carbon dioxide that the plants contribute to forming. I suspended, at the top of the receptacles covering the peas, 7 or 8 grams (2 or 3 *gros*) of lime slaked with water **[p. 35]** and then dried quickly by the heat of boiling water. I rested the openings of these receptacles on saucers filled with limewater.

From the second day, the atmosphere of the plants exposed *to the sun* in this apparatus decreased in volume. The third day, the lower leaves began to turn yellow, and between the fifth and sixth days, the stems died or were completely defoliated. The atmosphere of the plants, examined at this time, was found to be corrupted [*"vitiated"*]. It contained no more than 16/100 oxygen gas. [*Ordinary air is approximately 21 % oxygen, 79 % nitrogen, by volume*]. Peas that had grown at the same time without lime, under receptacles filled with ordinary air, had changed the air neither in purity nor in volume, and all their parts were healthy and vigorous. We see by the experiment with lime that there was absorption [*by the lime*], and consequently formation of carbon dioxide gas, for the absorbing substance acted only on this gas. We see, further, that the presence, or rather, the elaboration, of carbon dioxide is necessary to plant growth in the sun.[4] Finally, we **[p. 36]** find that when we do not

[4] One might think that the withdrawal of the part of the atmospheric oxygen gas retained by the carbon dioxide in the lime was the reason why growth ceased, but developed pea plants can survive in pure nitrogen gas. Lime and potash exert their full deleterious influence on marsh plants, which thrive as well in pure nitrogen gas as in atmospheric air.

see carbon dioxide production by plants growing without lime in ordinary air, it is because they decompose it as they form it with the surrounding oxygen.

In the shade I obtained a different result. Not only did the plants not die in the receptacle containing the lime and limewater, but they fared better there than in a similar receptacle lacking these substances.

The mean weight gain of each plant growing with the lime was 371 milligrams (7 grains) in the period of 10 days. The air of the receptacle contained 3/100 carbon dioxide after the experiment. But in the ordinary air without **[p. 37]** lime, each pea acquired [*on average*] only 212 milligrams (5 grains). Limewater showed 11/100 carbon dioxide in this atmosphere.

It is evident from these results that one cannot judge the effect of the complete deprivation of carbon dioxide on plant growth in the shade because too much of this gas is produced in this case for the lime to absorb it all as it is formed, but that the effect of a partial deprivation is to promote growth.

For the same reason, lime does not cause plants that are growing in the sun in an atmosphere of pure oxygen gas to lose their leaves. This atmosphere has a superabundance of carbon dioxide gas that the alkaline earth did not have time to absorb as quickly as it was formed.

The above observations were made only on plants growing in pure water, and it was important to make sure that the same results would be obtained with plants rooted in plant mold. But this earth could not be placed under a receptacle because the earth produces too much carbon dioxide for the lime, which acts only at a distance, to be able to remove it before its elaboration by the plant.

I put 31 grams (1 ounce) of the same lime that I used in the preceding experiments into a glass globe. **[p. 38]** I moistened the lime slightly to remove any doubt as to its dehydrating properties. Into the globe, which had a capacity of about 4 liters (200 cubic inches), I then placed a woody branch,[5] covered with leaves, that was exposed to the sun and whose roots were in plant mold. I took care that the leaves touched neither the lime nor the walls of the globe, whose neck was carefully luted [*cemented*] to the branch. I fitted a similar apparatus, but without lime in the globe, to a branch located next to the preceding one. This branch retained its freshness for more than 2 months, but it was not so for the branch growing with the lime. Its leaves remained green for 12 days, then began to dry and, after 3 weeks, they had all fallen. The branch was not dead. A month later, it sprouted new leaves in the globe, which **[p. 39]** had not been unsealed. But at this time, the lime no longer had an effect on the surrounding air. Its surface was saturated with carbon dioxide. I withdrew it and found that it effervesced with acids.

I must note that quicklime and potash have no very noticeable effect on the growth of succulent plants, because, with their very thick parenchyma and their epidermis that is less porous than that of other plants, they retain carbon dioxide more tenaciously. For the same reason, the stems of all plants are much less affected than are the leaves in these experiments.

[5] The plants on which I performed these experiments were honeysuckle (*Lonicera caprifolium*), plum (*Prunus domestica*), privet (*Ligustrum vulgare*), and peach (*Amygdalus persica*).

This new growth shows that the leaf shedding was due not to deprivation of oxygen gas, which could be retained in the lime by the absorption of carbon dioxide gas, but only to the absence of carbon dioxide. If the effects occurred more slowly in these experiments than in the previous ones, it is partly because the plants rooted in soil were not deprived of the effects of the carbon dioxide that they received from the plant mold through the roots, but only of the external effects of this gas on the leaves. [*Although de Saussure says here that plants obtain some carbon via carbon dioxide in the soil, he generally considers the main source of plant carbon to be atmospheric carbon dioxide*.]

2.4 Of the Decomposition of Carbon Dioxide Gas by the Green Parts of Plants

Priestley was the first to recognize that leaves have the property of improving air corrupted by combustion or respiration, but he did not trace the cause of this phenomenon. Senebier discovered that leaves **[p. 40]** decompose carbon dioxide by appropriating its carbon and eliminating its oxygen. He noted that fresh leaves exposed to the sun, in spring water or water lightly impregnated with carbon dioxide gas, produced oxygen gas as long as some carbon dioxide remained in the water. He saw that when this gas was used up, and when leaves in distilled water were exposed [*to the sun*], they did not produce more air than could be interposed in their own volume. But no one has yet analyzed the effects of the decomposition of carbon dioxide, or seen if the amount of oxygen gas eliminated is greater than, less than, or equal to the amount in the carbon dioxide gas. The following experiments were intended to answer this question. I will go into this subject in long and minute detail, but without it the results would be almost meaningless.

2.4.1 First Experiment

2.4.1.1 On Periwinkle (*Vinca minor* L.)

I composed, from carbon dioxide gas and ordinary air that **[p. 41]** the phosphoeudiometer [*see "eudiometer" in Glossary and discussion in footnote 9 of Introduction to the translation*] showed to be 21 hundredths oxygen, an artificial atmosphere occupying 5.746 liters (290 cubic inches [*original text erroneously says 290 cubic centimeters*]). Limewater showed it to be 7-1/2 hundredths carbon dioxide. [*Note: The amount of carbon dioxide in ordinary air is so small that virtually all the carbon dioxide de Saussure measured in these experiments is the added gas*.] The gaseous mixture was confined in a receptacle closed by mercury that was wetted, or covered with a very thin layer of water, to prevent contact of this metal with the air surrounding the plants, for I have observed that such contact, as reported by the Dutch chemists, is harmful to plant growth in prolonged experiments.

Under this receptacle I placed seven periwinkle plants, each 2 decimeters (8 inches) tall. They displaced a total of 10 cubic centimeters (1/2 cubic inch). Their roots were immersed in a separate vessel containing 15 cubic centimeters (3/4 cubic inch) of water. The amount of this liquid under the receptacle was insufficient to absorb appreciable carbon dioxide, especially at the ambient temperature, which was never less than + 17° Réaumur [*about 21 °C, or room temperature*].

This apparatus was exposed to direct sunlight for 6 consecutive days, from 5 to 11 o'clock in the morning, and shaded whenever the light became too intense. On the seventh day, I removed the plants, **[p. 42]** which had not deteriorated in the least. Their atmosphere, all corrections made [*presumably for temperature and pressure*], had not changed in volume, at least as far as one could judge in a receptacle of 1.3 decimeters (5 inches) diameter, in which a difference of 20 cubic centimeters (1 cubic inch) is almost imperceptible; but the error can be no greater than this.

Limewater showed no remaining carbon dioxide gas. The eudiometer indicated 24-1/2 hundredths oxygen gas. I set up a similar apparatus with pure atmospheric air and the same number of plants at the same exposure. This atmosphere changed neither in purity nor in volume.

From the eudiometric observations noted above, it follows that, before the experiment, the mixture of ordinary air and carbon dioxide contained:

4199 cubic centimeters (211.92 cubic inches) of nitrogen gas
1116 cubic centimeters (56.33 cubic inches) of oxygen gas
431 cubic centimeters (21.75 cubic inches) of carbon dioxide gas
5746 cubic centimeters (*290 cubic inches*)

After the experiment, the same air contained:

4338 cubic centimeters (218.95 cubic inches) of nitrogen gas
1408 cubic centimeters (71.05 cubic inches) of oxygen gas
0 cubic centimeters (0 cubic inches) of carbon dioxide gas
5746 cubic centimeters [*290 cubic inches—but de Saussure omitted this figure*]

[p. 43] The periwinkles therefore elaborated, or removed, 431 cubic centimeters (21-3/4 cubic inches) of carbon dioxide gas. Had the plants eliminated all of the oxygen gas from it, they would have produced a volume of oxygen equal to that of the carbon dioxide that disappeared. But they released only 292 cubic centimeters (14-3/4 cubic inches) of oxygen. Therefore they assimilated 139 cubic centimeters (7 cubic inches) of oxygen in decomposing the carbon dioxide, and produced 139 cubic centimeters (7 cubic inches) of nitrogen gas [*an error; plants do not release nitrogen gas*.]

A comparative experiment showed me that the seven periwinkle plants that I used had a dry weight of 2.707 grams (51 grains) before the decomposition of the carbon dioxide, and yielded, through carbonization by fire in a closed vessel, 528 milligrams (9.95 grains) of charcoal. The plants that decomposed the carbon dioxide were dried and carbonized by the same technique and yielded 649 milligrams (12.23 grains) of charcoal. The decomposition of the carbon dioxide therefore caused a gain of 120 milligrams (2.28 grains) of charcoal.

I similarly carbonized periwinkles that had grown in atmospheric air freed of carbon dioxide, and I found that the **[p. 44]** proportion of their carbon had decreased rather than increased during their stay under the receptacle.

2.4.2 Second Experiment

2.4.2.1 On Aquatic Mint (*Mentha aquatica* L.)

The mixture of ordinary air and carbon dioxide that served as atmosphere for two mint plants, each 3.5 decimeters (13 inches) tall, and together displacing 10 cubic centimeters (1/2 cubic inch), occupied 6.5 liters (328 cubic inches). Limewater indicated 7-1/4 hundredths carbon dioxide. Before the addition of this gas, the ordinary air contained 21 hundredths oxygen gas. The arrangement of the apparatus was the same as in the previous experiment.

After 10 days the plants had elongated by 1 decimeter (4 inches) and had sprouted long roots, but the volume of their atmosphere had not changed. Limewater indicated no more than 2-1/2 hundredths carbon dioxide gas in the artificial mixture at this time. After removal of the carbon dioxide, this atmosphere contained 23-1/2 hundredths oxygen gas.

[p. 45] Ordinary air without mixture, in which two mint plants were grown at the same time, did not change, either in purity or in volume.

The mints in the preceding experiment therefore removed 309 cubic centimeters (15.6 cubic inches) of carbon dioxide gas. They eliminated 224 cubic centimeters (11.26 cubic inches) of oxygen gas from it. They retained 86 cubic centimeters (4.34 cubic inches) of oxygen gas in elaborating the carbon dioxide gas, and replaced the oxygen gas absorbed by a nearly equal amount of nitrogen gas.

Through carbonization, I found that these plants had increased their charcoal content in this experiment, and that this increase was no greater in those that had grown under a receptacle filled with pure atmospheric air.

2.4.3 Third Experiment

2.4.3.1 On Loosestrife (*Lythrum salicaria*)

The mixture of atmospheric air and carbon dioxide gas used for this experiment occupied 1.486 liters (75 cubic inches). Limewater indicated 10/100 carbon dioxide in it. Before the addition **[p. 46]** of the carbon dioxide, the ordinary air contained 21/100 oxygen gas. The loosestrife displaced 2.8 cubic centimeters (1/7 cubic inch). The arrangement was the same as in the previous experiments. The receptacle that I used here was 9 centimeters (3.5 inches) in diameter, and I could not be mistaken by more than 5 cubic centimeters (1/4 cubic inch) in the estimation of volumes.

After 7 days devoted to this experiment, not a single leaf of the loosestrife had turned yellow. The atmosphere had decreased by 10 cubic centimeters (1/2 cubic inch). It then no longer contained any carbon dioxide gas, and the eudiometer indicated 27-1/4 hundredths oxygen gas in it.

Another loosestrife, grown at the same time under the same conditions, in pure atmospheric air, changed the air neither in purity nor in volume.

Based on the eudiometric results reported above, the plant that stayed in the artificial mixture removed 149 cubic centimeters (7-1/2 cubic inches) of carbon dioxide gas, and eliminated from it 121 cubic centimeters (6.13 cubic inches) of oxygen gas. It assimilated 27 cubic centimeters (1.37 cubic inches) of oxygen gas from the carbon dioxide gas, **[p. 47]** and it produced 21 cubic centimeters (1.1 cubic inches) of nitrogen gas.

2.4.4 Fourth Experiment

2.4.4.1 On Pine (*Pinus genevensis*)

The mixture of ordinary air and carbon dioxide occupied 5.549 liters (280 cubic inches). Limewater indicated 7/100 carbon dioxide. For 18 days, I left in it a young pine, 2.4 decimeters (9 inches) tall and 10 cubic centimeters (1/2 cubic inch) in volume. After this period, the atmosphere had decreased by 39 cubic centimeters (2 cubic inches), as far as I could estimate in a receptacle that was 1.6 decimeters (6 inches) in diameter.

The eudiometers indicated 1-1/2 hundredths carbon dioxide gas there, and after this was removed, 24-1/4 hundredths oxygen gas.

Another pine, grown for the same time under a receptacle filled with pure atmospheric air, made no detectable change in it.

The plant in the artificial mixture removed 306 cubic centimeters (15-1/2 cubic inches) of carbon dioxide gas. The plant disengaged **[p. 48]** 246 cubic centimeters (12-1/2 cubic inches) of oxygen gas and retained 60 cubic centimeters (3 cubic inches) of oxygen in the decomposition of the carbon dioxide. Finally, the plant produced 20 cubic centimeters (1 cubic inch) of nitrogen gas.

2.4.5 Fifth Experiment

2.4.5.1 On Raquette (*Cactus opuntia*)

The mixture of ordinary air and carbon dioxide gas occupied 3.012 liters (155 cubic inches), and limewater indicated 10/100 carbon dioxide gas. The cactus displaced 22 cubic centimeters (1-1/10 cubic inches). It remained for 8 days under the receptacle, exposed to the sun's full intensity. I had moderated this effect for the other plants, which would have been harmed without this precaution, but here there was not the same risk, and without strong light, the carbon dioxide would have decomposed too slowly.

When I withdrew the plant, the volume of its atmosphere had not changed detectably. The eudiometers indicated 4/100 carbon dioxide gas in it, and after the removal of this gas, 24/100 oxygen gas. A cactus identical to the **[p. 49]** preceding, grown for the same time in an equal volume of pure atmospheric air containing 21/100 oxygen gas, made no detectable change.

The plant therefore removed 184 cubic centimeters (9.3 cubic inches) of carbon dioxide gas from the artificial mixture. It eliminated from this gas 126 cubic centimeters (6.4 cubic inches) of oxygen gas. The plant assimilated 57 cubic centimeters (2.9 cubic inches) of oxygen gas in decomposing the carbon dioxide and replaced the oxygen gas absorbed by a nearly equal amount of nitrogen gas.

It follows from all these experiments that plants, in decomposing carbon dioxide gas, assimilate a part of the oxygen that it contains.

2.5 Plants Grown with Pure Water in the Open Air Take Carbon from the Small Amount of Carbon Dioxide Gas that Occurs Naturally in Our Atmosphere

The previous observations show that plants in closed vessels decompose **[p. 50]** carbon dioxide gas when it is mixed with atmospheric air in much larger proportions than occur naturally.

It is now appropriate to see whether plants carry out this decomposition in the open air, which contains hardly more than 1/500 carbon dioxide by volume. Hassenfratz, in a memoir on plant nutrition (*Annales de Chimie*, Vol. 13), sought to establish that plants growing in pure water and the open air increase in volume with the aid of the water alone, and that after they develop they contain an absolute amount of carbon less than that which was present in the seed. On this subject, I did several experiments, which yielded results contrary to those of this author. I will report two examples.

First Experiment I immersed the roots of several peppermint plants (*Mentha piperita*) in bottles filled with distilled water, and I grew these plants in the sun, on an exterior window sill protected from the rain. By drying some similar plants that had been uprooted at the same time and place, **[p. 51]** I ascertained[6] that 100 parts by weight of those that I grew in distilled water contained 40.29 parts of dry plant substance, from which 10.96 parts of charcoal were withdrawn by carbonization.[7]

The 100 parts of mint, after 2-1/2 months of growth in the open air, had a green weight of 216 parts, but this weight gain revealed nothing at that point, since it

[6] The absolute weight of the plants grown in distilled water was 7.6 grams (3 *gros*).

[7] For the procedure followed in this operation, see the note at the end of Chap. 5.

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