

whether they appear to afford or consume it, it is by drawing the coal of carbonic acid gas for food, and leaving its oxygen in the form of pure air.

I have the honor to be,

Dear Sir,



On the 10th of June, twelve measures of air were introduced into a glass vessel, in which was a small quantity of water. On the 15th, the can had vegetated, and was from two to five inches high. The air being examined at this time, by throwing up one measure of it, over lime water, in a glass vessel, the parts of carbonic acid air. Another measure, after being freed from the fixed air, and mixed with an equal measure of nitrogen air, produced an absorption of 1/20. On the 16th, the can having grown considerably, and the air being tried again, no carbonic

Experiments and Observations on the Vegetation of Plants, which shew that the common Opinion of the Amelioration of the Atmosphere, by Vegetation in Solar Light, is ill founded. By JAMES WOODHOUSE, M. D. Professor of Chemistry in the University of Pennsylvania, &c.

To Mr. NICHOLSON.

SIR,

Pater Noster Row, May 27, 1802.

I INCLOSE for the Philosophical Journal, the results of various experiments, made in Philadelphia in the year 1801, upon the seeds, leaves, &c. of a variety of plants, which seem to prove, that growing vegetables, contrary to an opinion almost universally adopted, do not purify atmospherical air; and that whenever



whenever they appear to afford oxigenous gas, it is by devouring the coal of carbonic acid gas for food, and leaving its oxigen in the form of pure air.

I have the honour to be,

Dear Sir,

With the greatest respect,

Your most obedient,

And very humble servant,

JAMES WOODHOUSE.

First. Of the Effects produced by the Germination of Seeds in atmospherical Air.

termination of
eds in atmo-
heric air.

On the 3d of June, twelve seeds of zea maiz were planted in earth, and confined over water in a glafs vessel, in seventy ounce measures of atmospherical air of the purity of 100, and often exposed to the light of the sun. On the 12th, the corn had vegetated, and was from two to five inches high. The air being examined at this time, by throwing up one measure of it, over lime water, in an eudiometer, gave $\frac{3}{100}$ parts of carbonic acid air. Another measure, after being freed from the fixed air, and mixed with an equal measure of nitrous air, produced an absorption of $\frac{3}{100}$. On the 19th, the corn having grown considerably, and the air being tried again, no carbonic acid gas appeared, and the purity was the same as at first. On the 23d, the plants died, and the airs were found to consist of $\frac{5}{100}$ fixed, and $\frac{95}{100}$ azotic gas.

Similar experiments were made with the feeds of apium peftrifelinum, lactuca fativa, cucurbita citrullus, phaseolus fativus, filymbrium, and raphanus fativus, and with the same result.

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The atmospherical air, in these experiments, appears to be reduced in purity, by its oxigen uniting to the coal of the cotyledons of the seed, or to that of some animal or vegetable matter contained in the earth in which the feeds are planted, or to that of some decayed portion of the living leaves.

Ingenhouz, Humbold, and Thomson, have observed, that soils have the property of absorbing oxigen; but as it cannot be proved that any pure earth, or mixture of earths, render atmospherical air impure, it is certainly more philosophical to ascribe the impurity of the air to the formation of the carbonic acid, the base of which generally exists in all soils.

II. Of the Effects produced by the Growth of Plants in atmospheric Air.

On the 27th of May, twelve plants of perficafia polygonum, two inches high, growing in earth, were confined in a glass vessel in fifty-two ounce measures of atmospheric air, of the purity of 100, and often exposed to the influence of solar light. On the 4th of June, they had increased about two inches in height. The air being examined at this time, was found to contain $\frac{3}{100}$ parts of carbonic acid gas, and to be reduced in purity to 80. Several young plants of raphanus fativus, lactuca stramonium, phytolacca decandra, zea maiz, phaseolus fativus, sidum telephium, amaranthus hyboidus, cucurbita citrullus, silybrium, and lactuca fativa, were also separately confined in from forty to eighty ounce measures of atmospheric air, which was examined at various times, from one hour to thirty days, after the plants had been placed in it. Carbonic acid gas was generally formed, and whenever this circumstance happened, the purity of the air was diminished.

Many of the same kind of vegetables were also confined in forty ounce measures of oxygenous gas, which had been well washed in lime water, and the purity of the air was very generally lessened, fixed air being generated. They turned of a white or yellow colour, and soon died, after being placed in atmospheric air.

The same effects are produced by the growth of plants as by the germination of seeds in common air, and by the same causes. If the leaves are confined a considerable time, part of them decay, and the coal of the dead portion, uniting with the oxygen of the atmospheric air, generates carbonic acid. This acid is decomposed by the living leaf. Its coal is abstracted, while its oxygen is left in the form of pure air.

When the oxygen unites to the coal of the animal or vegetable matter of the soil in which the plants vegetate, or to the coal of the decayed parts of the leaves, and makes fixed air quicker than the living parts can decompose it, the plants will speedily die.

When a plant in perfect health, growing in a soil which contains little vegetable or animal matter, is confined in atmospheric air, it will live a long time, without producing any change in it. Many of the vegetables which were the subjects of these experiments,

Growth of plant in atmoſ. air.

They produce carbonic acid gas, and diminished the purity of the air.

Growth of plant in oxygen diminish its purity carbonic acid.

In confined plants the decaying parts afford carbon and form acid, which the living plant decomposes.

But when the formation is quicker than decomposition the plant dies.

When the soil contains but little of organized remains, the included plant will live much longer.

experiments, did not affect the air in five days: one diminished its purity in three hours; and others altered it in a most slow and gradual manner, causing little change in it in twenty days.

III. *Of the Effects produced by the Leaves of Plants in atmospheric Air impregnated with Carbonic Acid Gas, and exposed to the Light of the Sun.*

Leaves exposed to solar light in a mixture of atmospheric and carbonic acid gas,

The carbonic acid disappeared, and the proportion of oxygen in the mixture was augmented. In the dark the leaves produced carbonic acid gas. Other leaves exposed to light, with the former result.

A handful of the leaves of mimosa virgata, euphorbia picta, digitalis purpurea, franklinia altamaha, asparagus officinalis, coryllus avellana, rhus glabrum, aristotochia siphoe, and periploca græca, were separately exposed seven hours to the light of the sun, in thirty-six ounce measures of atmospheric air, impregnated with four ounce measures of carbonic acid gas, from the carbonate of lime and sulphuric acid. The fixed air disappeared, and the atmospheric air was so much increased in purity, as to devour two measures of nitrous air.

The leaves of these plants, kept over night in the same air, gave carbonic acid gas in the morning; and its purity, in every instance, was considerably diminished.

The leaves of mimosa virgata and amygdalus perfica, were also separately exposed nine hours to the influence of solar light, in forty ounce measures of atmospheric air, in which fixed air had been formed by leaving a fungus to putrefy it. The carbonic acid gas disappeared, and the purity of the atmospheric air was increased from 30 to 80.

IV. *The following Tables will shew the Quantity and Purity of oxygenous Gas, obtained by exposing a small Handful of the Leaves of Plants to the Light of the Sun, in forty Ounce Measures of Pump Water.*

Table of experiments on leaves exposed to solar light under pump water.

This water was taken from a well sunk within a few yards of a necessary, from which it was impregnated with carbonic acid gas, as appeared from an analysis. The leaves were separately exposed in glasses arranged near each other, and from eight to thirteen comparative experiments were made at one time.

Leaves of	Carbonic Acid Gas, in 100 Parts.	Oxygenous Gas in Drachm Measures,	Purity with one Measure of Nitrous Air.	Do. with two Mea- sures.	Do. with three Measures.	State of the Ther- mometer.	Time when exposed.
Alcea rosea - - -	From 8 to 9 Parts.	19 $\frac{1}{2}$	122	146	96	105° to 110° of Fahrenheit.	July 2, 1802.
Zea maiz - - -		16	116	140	54		The day was very clear
Amaranthus spinosa -		15	120	140	68		
Melissa officinalis -		13	120	130	50		
Hyfopus - - -		16	120	138	70		
Convolvulus purpureus -		8	110	110	0		
Malva rotundifolia -		17	120	140	86		
Lavendula - - -		16	118	130	55		
Rosa centifolia - - -		15	112	130	46		
Mirabilis dichtoma -		16	110	130	40		
Convolvulus purpureis -	From 8 to 10 Parts.	13	110	120	40	100° to 115°.	July 3.
Anthemis nobilis - - -		12	114	120	32		Day clear.
Hibiscus Syriacus - - -		12	118	130	65		
Polygonum aviculare - -		18	114	130	50		
Amygdalus Perfica - - -		10	114	112	12		
Pyrus malus - - -		16	116	120	20		
Platanus occidentalis -		12	120	140	20		
Tilia Americana - - -	10	120	138	40			

Leaves of	Carbonic Acid Gas, in 100 Parts,	Oxygenous Gas in Drachm Measures,	Purity with one Measure of Nitrogenous Air.	Do. with two Mea- sures.	Do. with three Measures.	State of the Ther- mometer.	Time when exposed.	
Siriodendron tulipifera	-	14	112	120	25	105° to 110°.	July 4, 1801.	
Populus dilatata	-	14	110	132	60		Day generally clear.	
Æsculus pavia	-	13	110	130	60			
Apium petroselinum	-	12	115	132	55			
Convolvulus purpureus	-	5	120	120	30			
Helianthus annuus	-	8.	13	112	132		62	
Ruta graveolens	-	-	10	120	130		40	
Trifolium palustri	-	-	13	120	140		55	
Datura stramonium	-	-	14	112	130		80	
Hyfopus	-	-	7	112	132		65	
Blattari verbascum	-	-	12	112	130	45	July 5.	
Chelidonium majus	-	-	18	112	136	80	Day clear and cloudy.	
Chrysanthimum Indicum	-	-	14	120	142	63	Twelve ounce mea- sures of this oxygenous air, after being washed in lime water, to free it from the carbonic acid gas, being exposed to a mixture of iron filings and fulphur, were found to confist of eight ounce measures of oxygenous, and four of azotic gas.	
Acer glaucum	-	-	14	120	139	63		
Phytolacca decandra	-	-	14	120	140	80		
Antirrhinum linaria	-	-	18	120	140	65		
Arctum cappa	-	8 & 9.	12	120	140	53		
Syringa vulgaris	-	-	8	120	132	40		
Helianthus altissimus	-	-	12	120	140	55		
Polygonum Persicana	-	-	12	120	140	80		
Cercis Canadensis	-	-	12	120	140	60		
Sonicera caprifolium	-	-	12	120	140	60		
Diospyros Virginiana	-	-	10	120	120	30	July 6.	
Franklinia altamaha	-	-	10	120	102	0	Day clear and cloudy.	
Chionanthus Virginica	-	-	8	120	100	0		
Arundo gigantia	-	-	10	120	130	32		
Asclepias Syriaca	-	-	9	120	80	0	These leaves were ga- thered in the evening, and kept until morning, in a cool place.	
Annona triloba	-	-	10	120	130	40		
Magnolia glauca	-	-	10	110	102	0		
— tripetala	-	-	16	116	130	40		
Xanthoriza tinctoria	-	8 to 10.	8	120	130	50		
Conferva cicularis	-	-	10	120	120	30		
Alcea rosea	-	-	5	110	70	0		
Sophora indica	-	-	7	110	80	0		
Laurus sassafras	-	-	10	120	92	0		

Leaves of	Carbonic Acid Gas, in 100 Parts.	Quantity of Gas in Drachm Measures.	Purity with one Measure of Nitrogenous Air.	Do. with two Measures.	Do. with three Measures.	State of the Thermometer.	Time when exposed.
<i>Aspidodendron tulipifera</i> -	None.	From half a Drachm to one Drachm.	55			110°.	July 7, 1801. Day very clear. The leaves were exposed in the water of the river Schuyltrill.
<i>Cercis Canadensis</i> -			70				
<i>Filia Americana</i> -			50				
<i>Salix Babylonica</i> -			32				
<i>Polygonum Perficaria</i> -			30				
<i>Phytolacca decandra</i> -			94				
<i>Platanus occidentalis</i> -			90				
<i>Alcea rosea</i> -			84				
<i>Helianthus annuus</i> -			83				
<i>Amygdalus Perfica</i> -			82				
<i>Conferva fontinalis</i> -			80				
<i>Zea maiz</i> -			75				
<i>Acer glaucum</i> -			90				
<i>Aspidodendra tulipifera</i> -	In some of the vessels none, in others, from 5 to 10 Parts.	6	120	130	40	110°.	July 8, 1801. Day a little hazy, although the sun shone constantly. The leaves of the same plants, in the same river water, impregnated with four quarts of the water, saturated with carbonic acid gas, from carbonate of lime and the sulphuric acid.
<i>Cercis Canadensis</i> -			116	124	30		
<i>Filia Americana</i> -			110	160	0		
<i>Salix Babylonica</i> -			120	100	0		
<i>Polygonum Perficaria</i> -			120	140	70		
<i>Phytolacca decandra</i> -			120	140	42		
<i>Platanus occidentalis</i> -			110	60	0		
<i>Alcea rosea</i> -			120	132	40		
<i>Helianthus annuus</i> -			120	110	50		
<i>Amygdalus Perfica</i> -			120	138	40		
<i>Conferva fontinalis</i> -			120	134	50		
<i>Zea maiz</i> -			115	125	20		
<i>Acer glaucum</i> -			120	140	50		

It appears from this table, that the leaves of thirteen different plants, separately exposed in forty ounce measures of the water of the river Schuyltrill, produced about ten drachm measures of air, the principal part of which was azotic gas; whereas the same kind of leaves, exposed in the same quantity of the same water, impregnated with carbonic acid, yielded seventy-seven drachm measures of oxygenous air, of a very high degree of purity.

Count Rumford made an attempt, in the year 1787, to overthrow the doctrine of the purification of the air by plants. His arguments were, that leaves confined in water were in unnatural circumstances, and that pure air could be obtained from other bodies, as fine spun glass, raw silk, common cotton, and that of the poplar tree, exposed in water to the light of the sun *.

Count Rumford's experiments to obtain oxygen from water by solar light.

The ingenious author of *Phytologia* also says, it may be suspected that, in many of the experiments of Priestley and Ingenhousz, the production of vital air might be simply owing to the action of the sun's light on the water in which the vegetables were immersed, like that from the silk in the experiments of Count Rumford; and that the fine points or sharp edges of these bodies, contributed only to facilitate the liberation of it when exposed to the sun shine, which thus disoxygenated the water by their united effect.

Remarks on Priestley's

The experiments of Count Rumford are far from being satisfactory. Thirty grains of raw silk, at the end of three days, yielded him but $3\frac{3}{4}$ cubic inches of air, and sometimes four days elapsed before a sufficient quantity could be collected for an experiment.

and Count Rumford's experiments.

In order to find how much air could be obtained from the "fine points or sharp edges" of certain bodies acting upon water, the following substances were exposed one day to the action of solar light, in forty ounce measures of pump water.

Direct experiments

Filaments of asbestos, baked horse-hair, common cotton, and that of the *asclepias Syriaca*, the flower panicles of *rhus cotinus*, the fine hairy plumes of *climatis crispa*, the spikes of *panicum glaucum*, and charcoal in powder. From each of these substances, from two to four drachm measures of pure air were obtained, which devoured nearly two measures of nitrous air; consequently it was less pure than that procured from leaves exposed in the same water. There was also a much smaller quantity of it; for from eight to nineteen drachm measures may be obtained in a few hours, by immersing the leaves of any plant in the same water, and exposing them to solar light.

with fibrous bodies, which give air less in quantity and purity than leaves.

Some water, without any mixture, will yield oxygenous gas by the combined action of light and heat; and many substances placed in water, appear to act merely by raising its temperature.

Other sources of air.

* Transactions of the Royal Society for 1787.

The green vegetable matter, which forms on all bodies, immersed a considerable time in water, might also have been one of the sources of pure air, in some of the experiments of Count Rumford.

Plants do not decompose water; for they do not operate in pure water.

Secondly. Many philosophers suppose, that vegetables yield oxygenous gas by the decomposition of water. Its hydrogen is said to enter into plants, while its oxygen is set at liberty in the form of pure air.

If this opinion was true, oxygenous gas should be obtained by exposing leaves in boiled, rain, distilled, river, or lime water, but this cannot be done.

Plants do not (as has been supposed) emit oxygen and absorb azote;

Thirdly. Some suppose that vegetables give oxygenous air to animals, and that the latter yield them azotic gas in return, which they devour for food.

If this hypothesis were just, atmospheric air would be increased in purity by confining leaves in it when it contained no fixed air; and its purity might also be increased, after being previously diminished, by an additional quantity of azotic air, in the same manner.

for fresh leaves do not affect atmospheric air,

A handful of the leaves of *euphorbia picta*, *nicotiana tobacco*, *buxus vulgaris*, *cinna glauca*, *mimosa julibrescens*, *jaxus procumbens*, *coryllus avellana*, *Herculea foetida*, *malva crispa*, *pinus strobus*, *colutea arborescens*, and *epilobium*, were separately exposed four hours to the light of the sun, in forty ounce measures of atmospheric air, and its purity was found to be neither increased nor diminished. After they had remained sixteen hours in the air, no effect was produced on it. The leaves were fresh gathered, and no decay could be observed upon any part of them.

though wounded or decaying leaves do

When leaves are plucked promiscuously, and are placed in atmospheric air either in the day or night, they diminish its purity. Wherever a leaf is perforated, and this is very generally done by insects, let the perforation be ever so small, the part decays, and the coal of this decayed part uniting to the oxygen of the atmospheric air, generates carbonic acid, which lessens its purity.

The following table shews the effect of the leaves of plants gathered promiscuously, exposed five hours to the light of the sun, in forty ounce measures of atmospherical air, at a temperature of 75° of Fahrenheit. Experiments in solar light;

A small handful of the	Fixed Air.	Atmospheric Air of the St. and Ard. of 100.
Leaves of <i>Datura stramonium</i> - -	3	96
<i>Rhododendron maximum</i> - -	5	87
<i>Apium petroselinum</i> - -	4	86
<i>Anthemis nobilis</i> - -	0	100
<i>Sophora australis</i> - -	2	95
<i>Sedum telephium</i> - -	0	100
<i>Amaranthus hybridus</i> - -	10	70

The following table will shew the effects produced in one night, on forty ounce measures of atmospheric air of the purity of 100, by a small handful of leaves gathered promiscuously from a variety of plants. in the dark.

	Fixed Air.	Atmosf. Air.
Leaves of <i>Ilex aquifolium</i> - -	5	88
<i>Juniperus officinalis</i> - -	4	93
<i>Berberis vulgaris</i> - -	2	86
<i>Franklinia alatamaha</i> - -	3	85
<i>Rhododendron maximum</i> - -	1	95
<i>Annona triloba</i> - -	2	88
<i>Buxus vulgaris</i> - -	2	90
<i>Pinus strobus</i> - -	2	88
<i>Mitchella repens</i> - -	0	100
<i>Arclepias Syriaca</i> - -	5	86
<i>Hamamelis Virginia</i> - -	0	100
<i>Bignonia radicans</i> - -	3	77
<i>Xanthoriza tinctoria</i> - -	1	94
<i>Magnolia tripetala</i> - -	5	67
<i>Kalmia latifolia</i> - -	2	85
<i>Pinus picea</i> - -	3	80
<i>Siriodendron tulipifera</i> - -	10	65

According to some philosophers, carbonic acid gas is secreted by certain vegetables in the night; but as the quantity of this air obtained is always in proportion to the decayed parts of plants,

plants, and to the temperature to which they are subjected, it appears more rational to ascribe the generation of it to the coal of the decayed parts uniting with the oxygen of the air in which they are placed.

leaves exposed to sunshine in a mixture of atmospheric air and azote, produced no effect.

To determine whether plants would absorb or devour azotic gas, eight ounce measures of this air were mixed with thirty-two ounce measures of atmospheric air, so that its purity was reduced from 100 to 91. A handful of the leaves of *euphorbia picta* and *coryllus avellana* were separately confined in forty ounce measures of this air, and exposed to the influence of a bright solar light five hours. No carbonic acid gas was generated, and the purity of the air was exactly the same as when first tried. No decayed portion could be observed upon these leaves.

leaves do not purify the atmosphere by decomposing its carbonic gas; because the quantity of this is very minute,

As it is acknowledged that the leaves, stems, and roots of plants, separate the oxygen from carbonic acid, it may be said, that the oxygenous portion of atmospheric air is supplied by the decomposition of this gas, as it is always found in the atmosphere, and often in water in which vegetables grow.

The quantity of carbonic acid gas in atmospheric air, is reckoned to be about one part in an hundred. It must, however, vary in different places. We would expect to find the most of it in cities, where it is formed by combustion, respiration, fermentation, and putrefaction. If one measure of the air of any large city is thrown up over lime-water in an eudiometer, no milky appearance will be produced, so that the quantity of carbonic acid in this air must be extremely small. As this gas is also seized upon by alkalis, earths, and metals, and absorbed by water, the quantity floating in the atmosphere may be less than one part in ten thousand.

and plants decompose the air much more.

When we consider likewise, that the oxygen is never separated from the carbonic acid by leaves, but when they are exposed, in contact with it, to the light of the sun; and that every perforation made in the living leaf, however minute, by an insect, causes the part to decay, and absorb oxygen by day and by night; and that, in the autumn in some countries, all leaves fall on the ground, ferment or putrify, and thus diminish the purity of common air; and that the petals and fruit of vegetables have the same effect, we must pronounce, that the oxygenous portion of atmospheric air cannot be supplied by vegetation.

THE air of the atmosphere, according to the most celebrated chemists, is composed of twenty-two parts of oxygenous gas or air, and seventy-eight parts of azotic gas. There is a constant consumption of the oxygenous portion of this air, by the burning of combustible bodies ; by the respiration of animals ; by the fermentation and putrefaction of vegetable and animal substances ; and by the calcination of metals. The oxygenous gas, decomposed by respiration and combustion only, in the city of London, is supposed to amount to the enormous quantity, of five millions cubic feet an hour. (NICHOLSON'S *Philosophical Journal*.)

The atmospheric air of Great Britain, France, of parts of Africa, and of America, has been examined by philosophers, and has been found to be exactly of the same degree of purity.

The oxygenous gas contained in it, is in the same proportion, at all times and in all places, in rainy or in dry weather, in the depth of winter, and in the middle of summer, on the land and on the ocean, in the crowded city and remote village.

In consequence of a most valuable discovery, made by the illustrious Dr. PRIESTLEY, that growing vegetables under certain circumstances, exposed to the light of the sun, yield oxygenous gas ; an opinion has been adopted, that they are the sources of the oxygenous part of common air.

This sentiment has been adopted by the chemists of all nations, but has lately been controverted by Dr. JAMES WOODHOUSE, professor of chemistry in the University of Pennsylvania. (NICHOLSON'S *Philosophical Journal*.)

The Doctor reasons in the following manner :

1st. He says, whenever oxygenous gas has been obtained from vegetables, carbonic acid, or fixed air, has been present. Upon reviewing the experiments of Dr. PRIESTLEY, he finds that this circumstance has actually taken place. The Dr. exposed plants to the influence of light, in atmospheric air, in which spirit of wine, and wax, and tallow candles, had burned out ; to air which had been vitiated by the death or putrefaction of mice and fishes ; and to air which had been frequently taken into his lungs, and found that the purity of the air, was in every instance restored. (PRIESTLEY on air. Vol. iii. p. 247 to 349.)

In all these cases, carbonic acid, (which is composed of carbon and oxygen) was formed ; the vegetable devoured its coal for food, by which means its oxygen escaped, in the form of pure air.

2dly. The seeds of *Zea mayz* or Indian corn, of *apium petroselinum* or parsley, of *lactuca sativa* or lettuce, of *cucurbita citrullus* or the water melon, of *phaseolus sativus* or beans, and of *raphanus sativus* or radishes, were planted in earth, and made to vegetate in atmospheric air, confined over water in vessels of white glass, and exposed to the action of solar light. This air, when examined at various times, was found to be reduced in purity, and when its oxygenous portion was completely absorbed, the plants died. Its oxygen united to the coal of the cotyledons of the seeds, or to that of some animal or vegetable matter contained in the earth, in which they were planted, or to that of some decayed portion of the leaves, and formed carbonic acid, quicker than the living plant could decompose it. To these experiments, we may add, that the celebrated and accurate SCHEELLE observed, that beans growing in atmospheric air, always rendered it impure.

3dly. Young plants of *datura stramonium* or Jameston weed, of *phytolacca decandra* or the poke, of *Zea mayz* or Indian corn, &c. growing in earth, were exposed to solar light in from forty to eighty ounce measures of atmospheric air, which was examined at various times, from one hour to thirty days after the plants had been placed in it. Carbonic acid gas was generally formed, and whenever this circumstance happened, the purity of the air was diminished.

When a plant in perfect health, growing in a soil, which contains little vegetable or animal matter, is confined in atmospheric air, it will live a long time without producing any change in it. Many of the vegetables, which were the subjects of these experiments, did not affect the air in five days ; some diminished its purity in three hours, and others altered it in a most slow and gradual manner, causing little change in it in 20 days.

4thly. Many of the same kind of vegetables were also confined in forty ounce measures of oxygenous gas, which had been well washed in lime water, and the purity of this air was very generally lessened, carbonic acid being formed.

5thly. A small handful of the healthy leaves of a variety of plants,

containing no decayed parts, were exposed during four, six, and eight hours to the influence of the light of the sun, in atmospheric air confined by water, and its purity was found to be neither increased nor diminished.

6thly. The leaves of various vegetables gathered promiscuously, exposed in the same manner, generally diminished the purity of atmospheric air, several degrees.

7thly. A handful of the leaves of several hundred different plants, among which may be mentioned, those of the apple, pear, peach, poplar, fringe, and persimmon trees, were separately exposed during several hours in glass vessels to solar light, in forty ounce measures of pump water, and from five to nineteen drachm measures of oxygen air, were produced in each vessel. Upon analysing the water, it was found to contain carbonic acid, with which it had been impregnated from a necessary, which stood within a yard of the pump.

8thly. The leaves of thirteen different plants, were separately exposed in the usual manner, in forty ounce measures of the water of the river Schuylkill, and about ten dram measures of air were procured, the principal part of which was azotic gas, which was disengaged from the water. No carbonic acid could be detected in the water of this river.

There are three wooden bridges erected over the Schuylkill, which rest upon large wooden logs, upon which great quantities of a species of conferva grow, and which is covered by the water. Upon viewing this vegetable when the sun shone upon it, for several hours, at different times, for several years, no air could be seen to form upon it, or to rise through the water.

9thly. The leaves of the same vegetables were exposed to light, in the same manner, in the same river water, impregnated with four quarts of the water, saturated with carbonic acid, from the carbonate of lime and the sulphuric acid; and seventy-seven drachm measures of oxygenous air of a very high degree of purity, were obtained.

10thly. No oxygenous air could be procured by exposing vegetable leaves in boiled, distilled, rain, or lime water; a proof that they do not decompose water.

11thly. Atmospheric air was impregnated with carbonic acid gas,

and an handful of the leaves of nine different vegetables, were separately exposed in it, to light, seven hours. The fixed air disappeared, and the atmospheric air was greatly increased in purity.

12thly. The limbs of trees covered with healthy leaves, and some vigorous evergreens growing in their natural soil, were confined from one day to a month, in atmospheric air over water, and exposed to light, and its purity was never found to be increased, but was generally considerably diminished.

These experiments incontestibly prove, that whenever oxygen gas has been obtained from vegetables, by exposing them to the influence of solar light, carbonic acid has been present, and that it is from the decomposition of this gas, that the pure air is obtained.

As it is acknowledged that the leaves of plants separate the oxygen from carbonic acid, it may be said, that the oxygenous portion of atmospheric air is supplied by the decomposition of this gas, as it is always found in the atmosphere. The quantity of carbonic acid, accidentally diffused, in atmospheric air, (for it is not one of its component parts) is reckoned to be about one part in an hundred. It must however vary in different places. We would expect to find the most of it in cities, where it is formed by combustion, respiration, fermentation, and putrefaction. If one measure of the air of any great city, be passed up over lime water, in an eudiometer, no carbonate of lime will be formed, so that the quantity of carbonic acid in this air, must be extremely small. As this gas is also seized upon by alkalis, earths and metals, and absorbed by water, the proportion of it in the atmosphere may be less than one part in ten thousand.

When we consider likewise, that the oxygen is never separated from the carbonic acid by leaves, but when they are exposed in contact with it to the light of the sun, and that every perforation made in a living leaf, however minute by an insect, causes the part to decay, and absorb oxygen by day and by night; and that in the autumn, in some countries, all leaves fall on the ground, ferment and putrify, and thus diminish the purity of common air, and that the petals and fruit of vegetables, have the same effect, we must pronounce, that the oxygenous portion of atmospheric air cannot be supplied by vegetation.

Dr. Darwin supposes, that the air in the air bladders of vegetables serve to oxygenate the seed. The air of the air bladders of *cardiospermum halicacabum*, *staphylia trifoliata*, *colutea arborefcens*, and *sophora australis* being examined, was found to be a little worse than the air of the atmosphere.

Air bladders of various plants contain air worse than that of the atmosphere.

NLM copy: bound between p. 12 and p. 13 is a bifolium taken from a contemporary publication; the bifolium is paginated 264-267 and has a running title ("VEG"); printed on the bottom of p. 267: "Domestic Encyclopedia, American Edition"; includes passage citing this Woodhouse publication.