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XXIII.—Analyses of Air.

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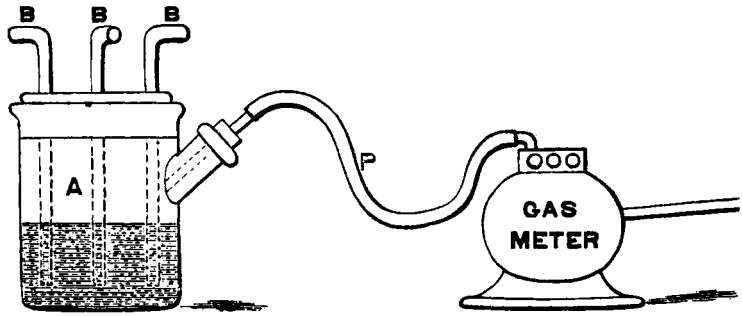
During the epidemic of the past year, 1879, my attention was continuously attracted by the theories concerning the cause of yellow fever.

The germ theory seeming to possess the best grounds for belief, I resolved, if possible, to try and furnish some facts, either to throw doubts upon, or confirm the theory. The following "*a priori* reasoning" led me to investigate the condition of the atmosphere with reference to the amount of free and albuminoid ammonia, viz., if the atmosphere contains germs, they will consist principally of albumen, because all the lower forms, with which we are acquainted, do; therefore, by determining the amount of albuminoid ammonia in the atmosphere, during the epidemic, we have a measure of the organized matter; and, if the atmosphere, during an epidemic, contained more albuminoid ammonia than during a normal condition of health, it would have a tendency to confirm our belief in the germ theory of disease.

Through the kindness of Dr. Samuel Choppin, Prest. Board of Health, of this State (La.), the remains of the laboratory at the Charity Hospital School of Medicine, were placed at my disposal. After many failures in my experiments, for lack of apparatus, I managed to prepare such apparatus as enabled me to make satisfactory analyses.

The manner in which analyses were conducted, is as follows:



The bottle A was placed on the ground, or otherwise, in the place where we wished to determine the amount of ammonia in the

air; the bottle was then filled three-fourths full (which took ½ liter) with pure water (free from ammonia); it was connected by rubber tubing with a meter; the meter, in turn, with an aspirator; the aspirator was regulated to draw about 200 cub. feet of air per day through the water contained in the bottle; in order to insure that the air would come in contact with the water, through the stopper of the bottle A, numerous small glass tubes B B . . . , were inserted, aggregating in area much more than exit tube leading to meter through P.

The water in the bottle was carefully measured after each filtration of the air, and a correction made accordingly. The correction * was made in the following manner: If the bottle contained only 480 cc after a filtration, I added on one twenty-fourth of results found, for the free and albuminoid ammonias.

The amount of free and albuminoid ammonia was determined by means of Wanklyn, Smith & Chapman's ammonia process. The results I tabulated, so that they might be compared with those of R. Angus Smith, *vide* "Air and Rain."

Date.	Grains per Million Cubic Feet.	
	Free Ammonia.	Albuminoid Ammonia.
Sept. 9	125.62	350.56
" 10	100.05	371.21
" 11	82.00	382.19
" 18	79.56	376.82
" 19	95.66	400.75
" 20	98.06	360.80
" 21	102.25	345.76
" 22	82.72	325.78
" 23	92.05	328.72
" 24	112.26	300.42
" 25	78.20	285.62
" 26	115.06	312.92
" 27	103.07	314.62
" 28	96.78	325.08
" 29	103.05	300.20
" 30	100.25	250.96

* The method of correction was adopted from results obtained in twenty duplicate analyses, as, for instance: through two bottles at the same time we filtered the air; through one bottle we drew 225 cubic feet, and the other 200; we found on measuring the water in the two bottles that it varied, and by making the correction mentioned in the article, the amount of ammonia was found to be the same in both instances when reduced to grains per million cubic feet, to within a fraction of a grain.

The amount of water evaporated in the bottles seemed to be in direct relation to the amount of air drawn through the water, and also to amount of moisture in the air.

The greater the amount of air filtered, the greater the amount of water evaporated; the drier the air, the greater the amount of water evaporated. The amount of water evaporated rarely exceeded 10 cc.

DATE.		GRAINS PER MILLION CUBIC FEET.	
		FREE AMMONIA.	ALBUMINOID AMMONIA.
Oct.	1	76.02	275.23
"	2	70.25	206.05
"	3	68.70	198.33
"	4	74.09	150.42
"	5	63.92	125.05
"	6	78.82	150.02
"	7	92.74	125.67
"	8	100.86	105.82
"	9	125.92	150.32
"	10	103.33	175.06
"	11	92.88	162.73
"	12	92.07	165.22
"	13	90.02	154.21
"	14	98.62	160.02
"	15	92.08	168.06
"	16	105.30	200.32
"	17	102.06	250.32
"	18	107.45	292.08
"	19	102.01	300.67
"	20	125.66	290.62
"	21	120.02	230.04
"	22	118.56	226.05
"	23	112.06	203.05
"	24	111.56	201.03
"	25	90.06	225.76
"	26	85.67	203.03
"	27	83.04	180.16
"	28	85.09	170.22
"	29	89.70	162.00
"	30	76.22	150.02
"	31	70.06	147.22
Nov.	1	82.42	142.07
"	2	79.23	120.78
"	3	76.79	110.22
"	4	60.05	92.07
"	5	56.62	85.66
"	6	50.64	84.75
"	7	40.40	75.00
"	8	32.07	62.06
"	9	32.09	61.80
"	10	31.00	61.02
"	11	31.67	60.72
"	12	32.66	55.66
"	13	33.00	53.04
"	14	34.06	52.63
"	15	35.66	48.60
"	16	34.03	44.55
"	17	31.68	46.87

Date.	Grains per Million Cubic Feet.	
	Free Ammonia.	Albuminoid Ammonia.
" 18	27.32	43.66
" 19	23.02	56.52
" 20	26.24	55.03
" 21	27.45	52.90
" 22	24.00	49.60
" 23	23.22	48.07
" 24	23.31	47.25

In the above analyses the air was filtered at 42 S. Derbigney St., the yellow fever prevailing during the months of Sept. and Oct.; the bottle was placed upon the ground.

The following are a few analyses made by filtering the air in the yard of the Charity Hospital School of Medicine; the bottle was placed on the ground:

Date.	Grains per Million Cubic Feet.	
	Free Ammonia.	Albuminoid Ammonia.
Sept. 18	130.06	325.62
" 19	95.00	326.22
" 20	98.62	315.34
" 30	100.15	290.02
Oct. 15	83.04	256.05
" 22	100.30	268.09
" 23	105.67	240.83
" 25	88.32	235.06
Nov. 1	60.02	180.72
" 3	58.86	156.70
" 16	40.72	55.02
" 18	35.93	48.67

The following are determinations made from air filtrations, made on the roof of the Charity Hospital School of Medicine:

Sept. 19	38.62	86.42
" 25	38.42	76.02
" 30	39.42	88.46
Oct. 5	30.24	72.08
" 10	24.02	56.04
" 15	28.82	64.57
" 25	35.22	64.25
" 31	24.46	52.65
Nov. 3	23.39	48.65
" 10	28.02	43.02

The inferences that I draw from the above analyses regarding the condition of the atmosphere, are as follows:—1st. That the air was abnormally charged with albuminoid ammonia during the epidemic. 2d. That the abnormality disappeared with the fever. 3d. That the atmosphere not in immediate connection with the ground, was comparatively free from any abnormal variations from an average standard.

Ozone.

The ozone test papers were prepared in the following manner: A solution was made containing

Iodide of potassium	1 gramme.
Starch	5 "
Water	400 cc.

Fine Swiss filter paper was then thoroughly soaked in the above solution, in the dark, then carefully dried and cut into strips 3 in. × 1 in., and these were placed in black bottles and carefully protected from light and air until needed.

Other ozone test papers were also made by soaking the paper in a solution of

Iodide of potassium	2 grammes.
Water	200 cc.

The next step was the preparation of the standards with which to compare the effects produced on the ozone papers when exposed to the air. Ozone was generated in a small gasometer filled with air, by means of an electrical machine. On making an analysis of the ozone contained in the air of the gasometer, I found that the air contained 1½ grains of ozone per 100 cubic feet at a temperature of 60° F. and barometer 30.09 inches; the ozone was determined by passing the ozonized air through a standardized solution of iodide of potassium, containing a little hydrochloric acid, then determining the iodine freed, as indicated by the following formula:

$$O_3 + 2KI + H_2O = 2KHO + O_2 + I_2.$$

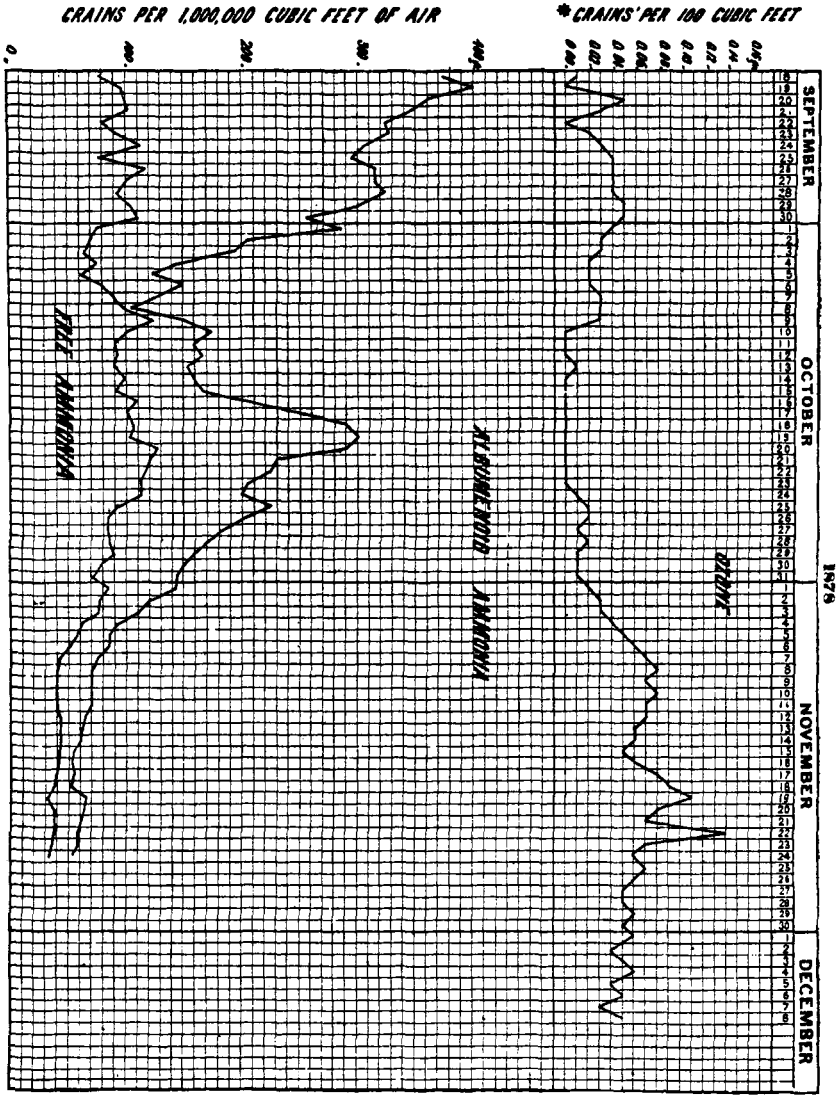
The ozonized air was passed into a glass measure, and from thence transferred to jars containing known quantities of air, and mixtures were made which contained, at 60° F. and 30.09 bar., the following quantities of ozone:

Sample No.	1	0.02	of a grain	per 100 cub. ft.
" "	2	0.04	"	"
" "	3	0.06	"	"
" "	4	0.08	"	"
" "	5	0.10	"	"
" "	6	0.12	"	"
" "	7	0.14	"	"
" "	8	0.16	"	"
" "	9	0.18	"	"
" "	10	0.20	"	"

Slips of ozone papers (both wet and dry) were exposed for half an hour to the above mixtures, and these were the standards with which I compared the action of the ozone on the test papers exposed to the air. The reasons why I adopted the above standards are, that on Jan. 15th and Feb. 18th, 1878, during electrical storms, I made

quantitative determinations of ozone in the atmosphere, and found 0.10 of a grain per 100 cubic feet, and 0.13 of a grain, respectively. I then, every day, commencing on Sept. 18th, 1878, exposed three ozone papers to the action of the atmosphere for twenty-four hours (viz., 1 iodide of potassium without starch and 2 with starch, one kept dry and the other moist); these were protected from direct sunlight. They were then compared with the standards, with the following results (which are the mean of the three papers):

DATE.	GENERAL CONDITION OF ATMOSPHERE.	OZONE.
Sept. 18	Fair	½
" 19	Cloudy	—
" 20	"	2½
" 21	"	1½
" 22	"	—
" 23	Fair	1
" 24	"	1½
" 25	"	2
" 26	"	2
" 27	"	2
" 28	"	2
" 29	"	2½
" 30	"	2½
Oct. 1	Rainy	2
" 2	Fair	1½
" 3	"	1½
" 4	"	1
" 5	Rain	1
" 6	Fair	1
" 7	"	1
" 8	"	1½
" 9	Rain	1½
" 10	Cloudy	—
" 11	Fair	—
" 12	"	—
" 13	"	½
" 14	"	—
" 15	Cloudy	—
" 16	"	—
" 17	Fair	—
" 18	"	—
" 19	"	—
" 20	"	—
" 21	"	—
" 22	"	—
" 23	"	—
" 24	"	½
" 25	"	1
" 26	"	1



* The ozone curve shows merely the relative effects produced on the ozone test papers when exposed to the atmosphere, as compared to the effects produced by known quantities of ozone.

DATE.	GENERAL CONDITION OF ATMOSPHERE.	OZONE.
Oct. 27	Fair	½
" 28	Cloudy	1
" 29	Fair	1½
" 30	"	½
" 31	"	½
Nov. 1	"	1
" 2	"	1½
" 3	"	1½
" 4	"	2
" 5	"	2½
" 6	"	3
" 7	"	3½
" 8	"	4
" 9	"	3½
" 10	Cloudy	4
" 11	Rainy	3½
" 12	Cloudy	3½
" 13	Very Rainy	3
" 14	Fair	3
" 15	"	2½
" 16	Cloudy	3
" 17	Rainy	4
" 18	Very Rainy	4½
" 19	Rainy	5½
" 20	Fair	4
" 21	"	3½
" 22	"	7
" 23	"	3½
" 24	"	3
" 25	Very Rainy	3½
" 26	Rainy	3
" 27	Fair	2½
" 28	"	2½
" 29	"	3
" 30	"	2½
Dec. 1	Rain	3
" 2	Fair	2
" 3	"	2½
" 4	"	3
" 5	"	2½
" 6	"	3
" 7	Rain	1½
" 8	"	2½

The ozone papers were exposed near the ground and on the roof, about 20 feet from the ground, but difference of position seemed to have no effect. The only inference that I draw from the above data is, that with increase of ozone, albuminoid ammonia fell off. This is best shown by the accompanying curves.

New Orleans, Feb. 20, 1879.