2.5 cc. of hydrogen and 535 cc. of ethane, all volumes being corrected.

In a second experiment, using 75 cc. of benzene, reaction started slowly and four hours elapsed before an appreciable quantity of mercury separated. The yields were: 45% of benzoic acid and 17% of terephthalic acid.

From a third experiment, which differed from the second only in limiting the time of reaction to twenty hours, the yield of benzoic acid was 33% and the yield of terephthalic acid was 11%. Positive fluorescein tests were also obtained in the second and third experiments.

**Metalation with Ethylsodium.**—The procedure was identical with the first experiment with ethylpotassium, 1.84 g. (0.08 g. atom) of sodium being used. Reaction set in immediately. The products identified were: 41% of benzoic acid; a small quantity of terephthalic acid (mixed melting point with dimethyl ester); and phthalic acid (as indicated by a positive fluorescein test). The gas evolved contained 12 cc. of ethylene, 10 cc. of hydrogen and 420 cc. of ethane. Incidentally, the limited evolution of ethylene and hydrogen belies any considerable metalation by alkali hydride which arises from the thermal decomposition of ethylalkali compound.[12]

(12) Carothers and Coffman, THIS JOURNAL, **51**, 588 (1929).

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## Comparison of the Total Nitrogen in Wheat Seeds by the Gunning (Modified Kjeldahl) and the Dumas Combustion Methods

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Smyth and Wilson[1] analyzed peas for total nitrogen before and after germination in distilled water, in salt solution media and in alkaloids. The peas showed an increase of 0.2 to 0.3% nitrogen in the dry residue after germination.

In the opinion of these authors, the increase in nitrogen was not the result of atmospheric nitrogen assimilation, but was due to the inadequacy of the Kjeldahl method to measure the total nitrogen in the ungerminated peas. By the official Kjeldahl procedure only 90% of the total nitrogen as compared with the Dumas combustion method could be obtained, and this varied with different modifications of the official procedure. On the basis of these results, Smyth and Wilson concluded that in the process of germination the nitrogen of the seeds was converted into compounds which were more easily determinable by the Kjeldahl method than those in the dry seeds.

(1) E. M. Smyth and P. W. Wilson, *Biochem. Z.*, **282**, 1 (1935).

Since Smyth and Wilson's results cast doubt on the validity of the conclusions drawn by Lipman and Taylor[2] and others who obtained similar results relative to the power of green plants to fix atmospheric nitrogen, it seemed desirable to make a study of the modified Gunning method and the Dumas combustion method as a means of determining the nitrogen in seeds and seedlings. To this end, wheat seeds of the "little club" variety were subjected to analysis for total nitrogen by both the modified Gunning and Dumas combustion methods.

TABLE I

N ANALYSIS OF 12 SAMPLES OF WHEAT SEEDS BY THE MODIFIED GUNNING METHOD

| Sample no. | Sample wt. | % N | |
|---|---|---|---|
| 1 | 1.0000 | 2.27 | |
| 2 | 1.0000 | 2.20 | |
| 3 | 1.0920 | 2.18 | |
| 4 | 1.4060 | 2.25 | |
| 5 | 1.4060 | 2.25 | |
| 6 | 1.4040 | 2.27 | Average |
| 7 | 1.4000 | 2.25 | 2.25% |
| 8 | 1.4000 | 2.25 | |
| 9 | 1.4026 | 2.25 | |
| 10 | 1.4000 | 2.20 | |
| 11 | 1.4010 | 2.30 | |
| 12 | 1.4020 | 2.31 | |

N ANALYSIS OF 6 SAMPLES OF WHEAT SEEDS BY THE DUMAS METHOD (COMBUSTION)

| | | | |
|---|---|---|---|
| 1 | 1.0205 | 2.25 | |
| 2 | 1.1100 | 2.27 | |
| 3 | 1.0000 | 2.28 | Average |
| 4 | 1.0344 | 2.31 | 2.28% |
| 5 | 1.0000 | 2.30 | |
| 6 | 1.0000 | 2.29 | |

A study of the table makes it clear that the modified Gunning method as used in this experiment yields as much nitrogen as the Dumas method for the wheat seeds analyzed. It appears, therefore, that such results as were obtained by Lipman and Taylor and by others who claimed to have shown nitrogen fixation by wheat plants cannot be invalidated on the basis of the results and conclusions of Smyth and Wilson, cited above.

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(2) C. B. Lipman and J. K. Taylor, *J. Franklin Inst.*, 475–506 (1924).