values: liquid sulfur at elevated temperatures[5] has a g-value of 2.024 and the blue oleum solutions of sulfur contain two radical species with g-factors of 2.016 and 2.026.[3] The similarity of the g-values of the radicals in these three systems suggests that the paramagnetism of ultramarine may arise from some type of sulfur radical. The concentration of sulfur in an ultramarine is estimated to be 20×10^{-4} g.-atoms/g., on the basis of an average empirical formula $Na_9Al_6Si_6O_{24}S_2$. A rough intensity measurement of the paramagnetic absorption in sample (a) gave an order of magnitude estimate of 4×10^{-4} g.-atoms/g. for the concentration of unpaired electrons; samples (b), (c) and (d) have about this same concentration of radical. It is possible, however, that the paramagnetism is caused by the presence of paramagnetic ions of the transition metals, and this notion was tested by qualitative arc spectrographic analysis of samples (c) and (d). No transition metals except titanium, iron and copper were detected, and these were present in only trace amounts. The observed intensity of paramagnetism is thus of the correct order of of magnitude to be accounted for by sulfur radicals and appears to be much greater than could be attributed to the quantity of heavy-metal impurities present.

Stronger evidence than this for the origin of the paramagnetism could probably be obtained by an investigation of ultramarines in which the sulfur had been replaced by selenium and tellurium, since, if the paramagnetism in ultramarine does arise from sulfur, the substitution of selenium and tellurium should give rise to paramagnetic spectra with characteristically different g-values.

We wish to thank J. M. Nelson for the gift of samples (a), (b) and (f) and T. P. Sciacca for the sample of lazurite. We wish to thank J. A. Dunbar for performing the spectrographic analysis.

(5) D. M. Gardner and G. K. Fraenkel, THIS JOURNAL, **76**, 5891 (1954), and unpublished results.

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FORMATION OF 6-FURFURYLAMINOPURINE FROM DNA BREAKDOWN PRODUCTS

Sir:

A compound, 6-furfurylaminopurine (kinetin), isolated from commercial DNA has been shown[1,2] to bring about cellular proliferation in fragments of tobacco pith when used in conjunction with 3-indoleacetic acid. This compound was found to be growth promoting for a strain of carrot tissue (clone II)[3] at a concentration of 0.1 γ/cc. in presence of three co-factors, coconut milk filtrate, 7 mg./cc., 3-indoleacetic acid, 1 γ/cc., and thiamine 0.1 γ/cc. Using this assay the original observation[1] was confirmed that 6-furfurylaminopurine is present in samples of commercial DNA several years old or solutions of fresh commercial DNA autoclaved at pH 4.3 at 15 lb. for 30 minutes.

(1) C. O. Miller, *et al.*, THIS JOURNAL, **77**, 1392 (1955).
(2) C. O. Miller, *et al.*, *ibid.*, **77**, 2662 (1955).
(3) Full biological details will be published elsewhere.

The purpose of the present work was to determine whether 6-furfurylaminopurine occurs in DNA as such or whether it is formed from natural constituents of DNA. A solution of 1 g. (7.4 mmoles) of adenine and 1 g. (7.4 mmoles) of 2-deoxy-D-ribose in 50 cc. of 0.148 M phosphate buffer (pH 4.0) was autoclaved at 15 lb. for 30 minutes. This solution at a concentration of 10 γ/cc. in the assay media showed the same biological activity as 0.1 γ/cc. of 6-furfurylaminopurine. After removal of phosphate ions by addition of 2.4 g. of barium acetate the reaction product was partitioned on a column containing 100 g. of cellulose powder with water–n-butyl alcohol–1% concentrated ammonia. The biologically active fraction was passed through a column of Dowex-1 $\times$ 4 (200–400 mesh, formate cycle). After removal of some adenine and other compounds with 0.01 M formate solution (pH 8.0), 5.4 mg. of crystalline 6-furfurylaminopurine was eluted by 0.01 M formic acid. This sample isolated in 0.54% yield melted at 266–267°. On admixture with an authentic sample of 6-furfurylaminopurine,[4] the melting point was not depressed. Further, the isolated sample had the same ultraviolet absorption curves in dilute acid, neutral solution and dilute alkali, and the same R_f values on paper in six separate solvent systems as authentic 6-furfurylaminopurine.

Solutions of deoxyadenosine, or of furfuryl alcohol and adenine, after autoclaving at pH 4.0 at 15 lb. for 30 minutes became strongly biologically active. The latter solution was found to contain 6-furfurylaminopurine in 2% yield by a procedure similar to that above.

That 6-furfurylaminopurine was not a natural constituent of salmon sperm DNA was shown by behavior of a highly polymerized sample prepared from salmon sperm by the method of Dounce.[5] This sample had no growth-promoting activity for clone II carrot tissue either before or after autoclaving at pH 4.6 at 15 lb. for 30 minutes.

It was therefore concluded that 6-furfurylaminopurine in autoclaved commercial DNA was artificially formed by interaction of adenine and 2-deoxy-D-ribose.

(4) This sample was synthesized by Dr. M. W. Bullock of this Laboratory.
(5) A. Dounce, *et al.*, THIS JOURNAL, **74**, 1724 (1952).

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A NEW MODIFICATION OF BORON MONOXIDE

Sir:

During the course of investigations not primarily concerned with boron–oxygen compounds, we have had occasion to prepare sub-boric acid, $B_2(OH)_4$, and to observe its conversion, by dehydration, into a hitherto unreported form of boron monoxide, BO. The latter substance can, in turn, be converted into the reported form[1,2] by either of two paths,

(1) R. C. Ray and P. C. Sinbe, *J. Chem. Soc.*, 742 (1941).
(2) E. Zintl, W. Morawietz and E. Gastinger, *Z. anorg. allgem. Chem.*, **245**, 8 (1940).