gether at 50° for two hours. The acetone was then removed by distillation and the residue refluxed with water for two hours. The aqueous portion on evaporation yielded 15 g. of chloro acid. After two recrystallizations from hot water, the chloro acid melted at 163–165°. The acid had a neutral equivalent of 123.3 as compared with a calculated value of 124.3 for $C_{10}H_{13}O_5Cl$ (V).

Oxidation of Methoxy-5-chloro-3-pentadiene-1,3 (IV).—To a vigorously stirred mixture of 20 g. of IV, 80 g. of potassium carbonate and 200 g. of water, maintained at 10–25°, 165 g. of potassium permanganate was added during the course of six hours. The mixture was then decolorized with sulfur dioxide, acidified with sulfuric acid and extracted with ether. The ether extract yielded 0.8 g. of oxalic acid and 2 g. of crude methoxyacetic acid, b. p. 70–110° (25 mm.); $n^{20}D$ 1.4140. The oxalic acid was identified by its melting point (97–101°) and its transformation into oxal-*p*-toluidide (m. p. 266°). The methoxyacetic acid was characterized by conversion into its amide, which melted, after one crystallization from alcohol, at 92–94°, as compared with a recorded value of 92°.[6]

Oxidation of Methoxy-5-chloro-1-pentadiene-2,3 (III).—One hundred and sixty grams of potassium permanganate was added during the course of five hours to a well-stirred mixture of 20 g. of III and 200 g. of water. The mixture was then decolorized with sulfur dioxide, filtered, acidified with sulfuric acid (carbon dioxide evolved) and extracted with ether in the usual way. The ether extract yielded 0.3 g. of oxalic acid (identified by its m. p. of 99–101°, and its *p*-toluidide, m. p. 267–269°) and 6 g. of liquid boiling at 95–110° (25 mm.). On cooling, the liquid fraction deposited chloroacetic acid, m. p. 48–53°. The chloroacetic acid was further identified by conversion into its amide, which melted at 118–120° as compared with a recorded value of 119.5°.[7]

(6) Gauthier, *Ann. chim. phys.*, [8] **16**, 307 (1909).

The author wishes to express his thanks to Dr. Wallace H. Carothers for his interest in this work and for his helpful suggestions.

Summary

The reaction between alpha chloro ethers and vinylacetylene is shown to be closely analogous to the addition of hydrogen chloride to vinylacetylene to form isochloroprene and chloroprene. The initial step appears to be 1,4 addition of the chloroethers $\underset{(ROCHCl)}{\overset{R'}{|}}$ to vinylacetylene with the formation of products of the formula $ROCHCH{=}C{=}CHCH_2Cl$ (R′ on the CH). In the presence of cuprous chloride and hydrochloric acid these products readily isomerize to compounds of probable structure $ROCHCH{=}CClCH{=}CH_2$ (R′ on the CH). The latter compounds polymerize to form resins which are somewhat rubber-like.

(7) Menschutkin and Jermolajew, *Z. Chem.*, [2] **7**, 5 (1871).

WILMINGTON, DEL. RECEIVED JULY 16, 1936

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE COLLEGE OF LIBERAL ARTS AND SCIENCES OF TEMPLE UNIVERSITY]

The Synthesis of 4-Methyl-6-oxypyrimidine-5-acetic Acid and 4-Methyluracil-5-methylamine

BY WILLIAM T. CALDWELL AND WILLIAM M. ZIEGLER

The first structure[1] for vitamin B_1 proposed by Williams contained an ethyl group in the pyrimidine nucleus. Later, Windaus, Tschesche and Grewe[2] expressed the opinion that the existence of two methyl groups rather than that of a single ethyl group in the primidine nucleus was in better harmony with their experimental results. Cleavage of the vitamin by sulfite[3] formed an amino sulfonic acid from which a corresponding hydroxy acid was obtained in which the sulfonic acid group presumably would be attached to the pyrimidine nucleus in position 5, in accord with the hypothesis of the existence of two free methyl groups in the nucleus.

A search of the literature, however, failed to disclose to us a case in which a pyrimidine with sulfonic acid group in position 5 had been isolated, and although this was no proof that a substance of the latter type was not formed by the sulfite cleavage, it nevertheless led us to consider the synthesis of compounds containing an amino methyl group in position 5.

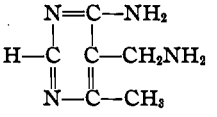
The formula proposed by Makino and Imai[4] expresses the same conclusion as to the likelihood of an amino methyl group in this position. We set about, accordingly, to synthesize a compound of the structure

(1) Williams, THIS JOURNAL, **57**, 229 (1935).

(2) Windaus, Tschesche and Grewe, *Z. physiol. Chem.*, **237**, 98 (1935).

(3) Williams, Buchman and Ruehle, THIS JOURNAL, **57**, 1093 (1935).

(4) Makino and Imai, *Z. physiol. Chem.*, **239, I**, 7 (1936).



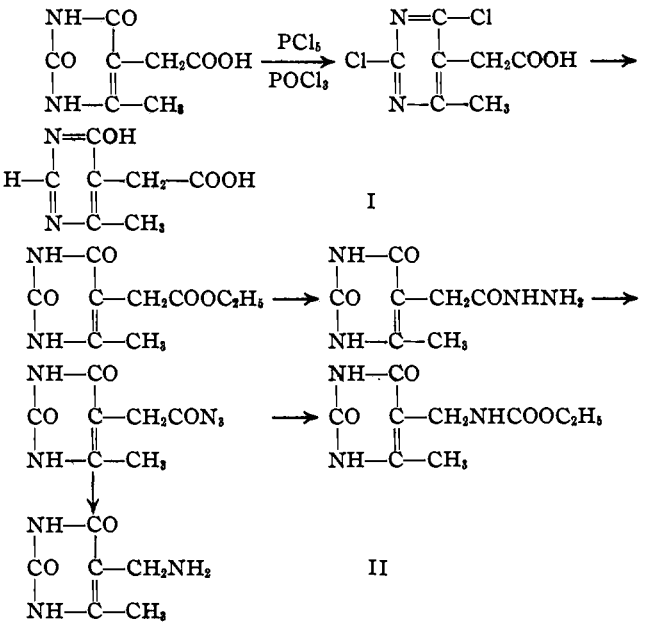
I

in the hope that it might prove to be identical with the compound $C_6H_{10}N_4$ isolated by Windaus as picrate. There has appeared quite recently, however, a report of further work by Williams[5] on the basis of which he proposes a new formula for vitamin B_1 from which it is quite clear that, although one amino group should be found in the side chain in position 5, the nuclear methyl group is in position 2 and not 4 as in the compound we hoped to prepare.

As a result of this new evidence, we have abandoned our original intention of preparing a compound represented by structure I, and are therefore reporting the synthesis of several new pyrimidine derivatives obtained as intermediates for the preparation of the diamine which we had thought might be identical with Windaus' $C_6H_{10}N_4$ but which Williams has shown now could be only an isomer thereof.

One plan of procedure involved the preparation of 4-methyl-6-oxypyrimidine-5-acetic acid from which, by means of the Curtius reaction which Johnson and Litzinger[6] had used successfully for an analogous reaction, we hoped to obtain a desired intermediate in good yield. Unfortunately, preliminary experiments gave little promise of satisfactory yields in our hands, so that we abandoned this path temporarily in the hope of securing more promising results by preparing first 4-methyluracil-5-methylamine. Although we have succeeded in preparing this compound, both as free base and as acetate, the yield is far from good. In fact, we have been unable to hydrolyze the urethan to the amine as yet; heating in a sealed tube at 130° for several hours produced a white, extremely insoluble compound but no amine. After a number of attempts to hydrolyze the urethan had yielded us only white solids that did not melt below 320° and which were insoluble in water or alcohol, we decided to attempt the direct conversion of the azide into the amine by the method described by Lindemann.[7] In this way we were able to obtain a small amount of the desired free base by liberating it from the acetate. This method appears to be more likely to give improved yields than the hydrolysis of the urethan.

The reactions that we shall describe are summarized by the following formulas



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Experimental Part

2,6 - Dichloro - 4 - methylpyrimidine - 5 - acetic Acid.—This compound was prepared from the corresponding 4-methyluracil-5-acetic acid which was obtained readily by the method described by Johnson and Heyl.[8] Phosphorus oxychloride (460 g.) was poured upon 4-methyluracil-5-acetic acid (63 g.). Hydrogen chloride was evolved but the solid apparently did not go into solution. Phosphorus pentachloride (350 g.) was then added to the ice-cooled mixture, and then this was heated for six hours on a boiling water-bath. By the end of this time, practically all of the material appeared to have dissolved, forming a very dark brown solution. Phosphorus oxychloride (443 g.) was removed under diminished pressure on the steam-bath, leaving a dark, resinous residue. This was cooled in ice, treated with ether and ice in portions until all had either gone into solution or broken up into small particles so that the material could be poured from the flask. This aqueous suspension and ether extract (both very dark brown or black) upon filtration with suction left a small residue of tarry material upon the filter paper. After separating the ether layer from the aqueous one, and re-extracting the latter with ether, the ether extract (about 2000 cc. in all) was set aside and allowed to evaporate slowly in such a way that the temperature did not rise above 25°. After several days, dark colored crystals (21.4 g.) separated. They were insoluble in benzene and in petroleum ether, but soluble in absolute ether, from which they were recrystallized, separating as pale yellow crystals, melting at 156–157°.

(5) Williams, THIS JOURNAL, **58**, 1063 (1936).
(6) Johnson and Litzinger, *ibid.*, **57**, 1139 (1935).
(7) Lindemann, *Helv. Chim. Acta*, **11**, 1028 (1928).
(8) Johnson and Heyl, *Am. Chem. J.*, **38**, 659 (1907).

Anal. Calcd. for $C_7H_6O_2N_2Cl_2$: Cl, 32.09. Found: Cl, 30.93.

4 - Methyl - 6 - oxypyrimidine - 5 - acetic Acid.—The above dichloro compound (11.8 g.) was reduced by the method of Gabriel and Colman.[9] The free acid, after liberation from its potassium salt with acetic acid, extraction with benzene and recrystallization from the latter, was obtained as snow-white crystals, melting at 147–149° and giving no Beilstein test; yield 3.5 g.

Anal. Calcd. for $C_7H_8O_3N_2$: N, 16.66. Found: N, 16.38.

4 - Methyluracil - 5 - carbethoxymethylamine.—The ethyl ester of 4-methyluracil-5-acetic acid (22 g.), m. p. 221–222°, was converted into the hydrazide in the usual way. From these white crystals that darkened slightly above 320° but did not melt by 375°, the azide was obtained easily and was converted into the urethan by heating with an excess of absolute alcohol. After the vigorous evolution of gas had ceased, the hot liquid was filtered from considerable insoluble white solid and concentrated. The urethan, which was soluble in water and in alcohol, was obtained as fine white crystals of m. p. 214–215° from absolute alcohol; yield, 12 g. of urethan from 20 g. of hydrazide.

Anal. Calcd. for $C_9H_{13}O_4N_3$: N, 18.50. Found: N, 18.48.

Our attempts to hydrolyze this urethan by heating with concentrated hydrochloric acid either at atmospheric pressure or in a sealed tube for a day at 130–140° failed to yield any of the desired 5-aminomethyl compound. The product was a white solid that did not melt or decompose by 320°, and which was insoluble in all organic solvents that we tried.

4-Methyluracil-5-methylamine.—In view of the unexpected difficulty encountered in the hydrolysis of the above urethan, we made use of Lindemann's method[7] for the conversion of an azide into an amine. By heating the azide with 50% acetic acid, the substance dissolved with evolution of gas. After a few minutes, white solid began to appear and was removed from time to time as the liquid was concentrated. This material was insoluble in water and did not melt below 310°. The filtrate was evaporated to dryness, the residue dissolved in water, filtered, and again concentrated. The white crystals obtained in this way, when dissolved in water, turned red litmus slowly, but distinctly, blue. With a drop of concentrated sulfuric acid the odor of acetic acid became easily perceptible, and the analysis also indicated that the product was the acetate of the amine. The yield from 12 g. of the azide was 2.8 g.

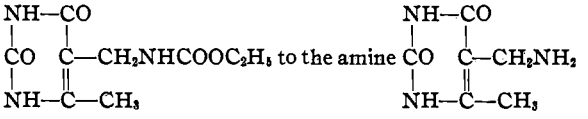
Anal. Calcd. for $C_6H_9O_2N_3 \cdot C_2H_4O_2$: N, 19.53. Found: N, 19.55.

The white salt turned to a very pale yellow material at 227–229°, but on further heating to 360° merely became progressively darker. On adding a solution of potassium hydroxide to a solution of the acetate there soon separated, upon scratching with glass, a finely crystalline white solid—fine needles under the microscope. After washing well with absolute alcohol, they were recrystallized from water in which they were easily soluble. The free base is a strong one, turning red litmus blue. On heating, it became brown by 335° but did not melt; yield 0.5 g.

Anal. Calcd. for $C_6H_9O_2N_3$: C, 46.45; H, 5.85; N, 27.09. Found: C, 46.50; H, 6.50; N, 27.27.

Summary

Several new pyrimidines, whose preparation was stimulated by the work of Williams and others on vitamin B, are reported. Attention is called to the difficulty met in the attempt to hydrolyze the urethan



(9) Gabriel and Colman, *Ber.*, **32**, 1533–1534 (1899).

PHILADELPHIA, PENNA. RECEIVED JULY 13, 1936

[CONTRIBUTION FROM THE CHEMICAL LABORATORY OF THE UNIVERSITY OF NEW HAMPSHIRE]

A New Method for the Separation of Yttrium from the Yttrium Earths

BY H. C. FOGG AND LEWIS HESS

The use of urea as a precipitant for aluminum in the presence of calcium, barium, magnesium, manganese, zinc, cobalt, nickel, iron, cadmium and copper was the subject of an investigation by Willard and Tang,[1] and its use as a precipitant for gallium in the quantitative determination of that element was studied by Willard and Fogg.[2] Since the decomposition of urea[3] results in the formation of ammonia at a slow and uniform rate throughout the homogeneous solution, it may advantageously be applied to the fractionation of the yttrium earths.

(1) H. H. Willard and N. K. Tang, unpublished work.
(2) H. H. Willard and H. C. Fogg, unpublished work.
(3) E. A. Werner, *J. Chem. Soc.*, **113**, 84 (1918).

Method of Separation

The mixed earths, in the form of their oxides, are dissolved in nitric acid, and the solution is nearly neutralized with ammonia and diluted. Ammonium sulfate is added in amount just insufficient to cause precipitation, followed by one- to two-tenths of an equivalent of urea. The solution is heated with stirring to 90–95°, and