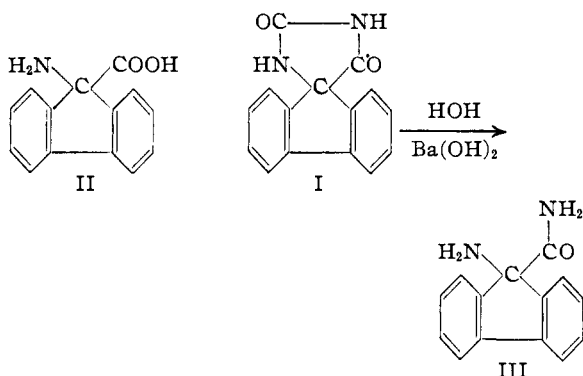


[CONTRIBUTION FROM THE DEPARTMENT OF CHEMISTRY, UNIVERSITY OF TEXAS]

Alkaline Hydrolysis of Fluorenone-spirohydantoin<sup>1</sup>BY WM. HENSLEY McCOWN<sup>2</sup> WITH HENRY R. HENZE

Fluorenone was converted into the corresponding spirohydantoin (I)<sup>3</sup> in order to attempt conversion of the latter into the  $\alpha$ -amino acid (II). When hydrolysis was carried out by means of barium hydroxide, the spirohydantoin was but slowly altered and instead of the anticipated amino acid, or the primary amine which might have resulted from decarboxylation, the chief product of reaction was identified as 9-biphenyleneaminoacetamide (III), although some fluorenone was noted also. Upon refluxing (III) in an



ethanol solution of hydrogen chloride, 9-chloro-fluorene<sup>4</sup> was obtained, while heating with aniline yielded 9-biphenyleneaminoacetanilide. Attempts to prepare (III) from 9-biphenylenechloroacetyl chloride and 9-biphenylenechloroacetamide were unsuccessful.

## Experimental

**Fluorenone-spirohydantoin (I).**—To 100 cc. of 80% alcohol in a glass-lined steel bomb were added 24 g. (0.134 mole) of fluorenone, 12 g. (0.185 mole) of potassium cyanide and 50 g. (0.44 mole) of ammonium carbonate and the resulting mixture was heated for twenty-six hours at 110°. After cooling, dilution with water and acidification, the product was placed in a Soxhlet apparatus and extracted with 1,4-dioxane. A yield of 26 g. (78% yield) of spirohydantoin was obtained; m. p. 324–325° (cor.) with

(1) This hydantoin was initially prepared in this Laboratory by David D. Humphreys, in 1939, using 80% ethyl alcohol as solvent; and by Loren M. Long, in 1940, using fused acetamide as the reaction medium.

(2) From the M.A. thesis of W. H. McCown, August, 1940.

(3) Novelli [*Atas de asoc. quim. argentina*, **29**, 83 (1941)] has recently reported the synthesis of this compound, naming it "5,5-*o*-bifenilenehidantoina"; in an abstract [*C. A.*, **35**, 6576 (1941)] this name is translated as "5,5-*o*-biphenylenehydantoin." More accurate nomenclature leads to usage of "fluorenone-spirohydantoin" or "spiro-[fluorene-9,4'-imidazolidine]-2',5'-dione.

(4) Werner and Grob, *Ber.*, **37**, 2896 (1904).

decomposition.<sup>5</sup> *Anal.* Calcd. for  $C_{16}H_{10}N_2O_2$ : N, 11.20. Found: N, 11.12.

**Action of Barium Hydroxide Solution on (I).**—A mixture of 11.3 g. (0.045 mole) of fluorenone-spirohydantoin (I), 76 g. (0.25 mole) of barium hydroxide octahydrate and 75 g. of water was heated at 110–120°; evolution of ammonia was noted after ninety minutes, and continued even after seventy-five hours. During the heating period the reaction mixture assumed a yellow tint and a yellow solid sublimed into the reflux condenser. This material was recrystallized from alcohol; its melting point, as well as that of its mixture with fluorenone, was 83–84° (cor.).<sup>6</sup> Additional fluorenone was obtained from the reaction mixture; in all 1.5 g. (18.4% yield) was recovered.

The reaction mixture was diluted with an equal volume of water, filtered while hot, and the residue was extracted with hot alcohol. The extract was allowed to crystallize and fluorenone was removed from the solid by extraction with ether. The residue was combined with material obtained from extraction with alcohol of the solid produced by saturation of the alkaline filtrate with carbon dioxide. After recrystallization from alcohol there was obtained 5.5 g. (54.6% yield) of white crystals (III) melting at 254–256° (cor.) with decomposition in a sealed tube. The material is slightly soluble in alcohol and 1,4-dioxane, insoluble in benzene, cold, dilute or concentrated hydrochloric acid and cold, dilute or concentrated sodium hydroxide solution.

*Anal.* Calcd. for  $C_{14}H_{12}N_2O$ : C, 74.97; H, 5.40; N, 12.50. Found: C, 74.76; H, 5.46; N, 12.56.

Better yields of (III) were obtained by heating the reaction mixture only until the first signs of the appearance of yellow color, diluting and filtering while hot, removing any unchanged hydantoin from the solid residue by leaching with sodium hydroxide, washing with dilute acid and crystallizing from hot alcohol. In this manner, 80% yields of (III) could be obtained.

An alcoholic solution of potassium hydroxide and chloroform did not yield a positive carbylamine reaction with (III). The latter was dissolved in hot alcohol, a few drops of a saturated aqueous solution of sodium nitrite was added and then dilute sulfuric acid, drop by drop. At first an evolution of a colorless gas was noted; but as soon as the mixture became slightly acidic, (III) was reprecipitated. Heating (III) with a 20% alcoholic solution of potassium hydroxide caused a slow evolution of ammonia throughout a period of seventy-five hours. After neutralization with hydrogen chloride, filtration and evaporation, the residue gave positive indication of the presence of an amino group.

**Action of Alcoholic Hydrogen Chloride with (III).**—One gram of (III) was added to 100 cc. of ethanol, which had been saturated at 0° with hydrogen chloride. The mixture was sealed in a glass tube and heated at 120° for six hours.

(5) Novelli, ref. 3, reported at 308–310° contraction and decomposition without melting.

(6) Staudinger and Kon [*Ann.*, **384**, 133 footnote (1911)] report m. p. 84°.

Upon cooling, two layers were noted; the lower was shown to contain water and ammonium chloride, the upper contained ethyl chloride and yielded white, crystalline needles which, after recrystallization from alcohol, yielded 0.5 g. of material (IV) melting at 91–92° (cor.).

*Anal.* Calcd. for  $C_{13}H_9Cl$ : C, 77.80; H, 4.52; Cl, 17.56. Found: C, 78.82; H, 5.06; Cl, 17.72.

Two grams of granulated zinc was treated with 2% copper sulfate solution, covered with 10% alcoholic potassium hydroxide solution, heated to boiling and to this mixture was added slowly an alcoholic solution of (IV). After heating for three hours, the metal was removed by filtration, the filtrate neutralized with sulfuric acid, and, after removal of salt, the filtrate yielded fluorene.

According to the method of Werner and Grob,<sup>4</sup> fluorenone was reduced in alcoholic solution by action of zinc dust and concentrated ammonium hydroxide solution. The 9-hydroxyfluorene crystallized from benzene in characteristic plates melting at 149° (cor.). The carbinol was dissolved in benzene and treated with phosphorus pentachloride to obtain a yellow crystalline mass. After recrystallization from alcohol there resulted white, needle-shaped crystals melting at 88–90°. The melting point of a mixture of this sample of 9-chlorofluorene with (IV) was found to be 90–92°.

**Reaction of Aniline with (II).**—One-half gram of (III) and 10 cc. of aniline were mixed and heated for one hour; ammonia was liberated. Upon cooling, a white solid separated and was recrystallized from hot alcohol, m. p. (sealed tube) of the anilide, 292–297° (cor.), with decomposition.

*Anal.* Calcd. for  $C_{20}H_{14}N_2O$ : C, 80.46; H, 5.38; N, 9.33. Found: C, 79.97; H, 5.29; N, 9.57.

**Attempt to Synthesize 9-Biphenylene-aminoacetamide.**—Fifty grams of phenanthraquinone was heated with 500 cc. of 20% sodium hydroxide solution on a steam-bath for three hours. After separation from a small amount of fluorenone, acidification produced a creamy solid. The latter was dissolved in a mixture of ethyl alcohol and benzene and was precipitated by pouring into a large amount

of water. Thus obtained and purified, 9-hydroxyfluorene-9-carboxylic acid (42% yield) melted at 167–168° (cor.).<sup>7</sup>

The acid thus obtained was mixed with 46 g. of phosphorus pentachloride and the mixture was cooled in an ice-bath. The phosphorus oxychloride formed was removed by distillation under diminished pressure. The residue was covered with ether, then filtered. The yield was 8 g. (30% yield) of 9-biphenylenechloroacetyl chloride melting at 111°.<sup>8</sup>

In turn, the acid chloride was dissolved in absolute ether and the solution saturated with anhydrous ammonia. After evaporation of the solvent, the residue was washed with cold water to remove ammonium chloride, then dried before being recrystallized from 1,4-dioxane and water. Thus obtained in 73% yield, 9-biphenylenechloroacetamide melts at 194° (cor.).<sup>9</sup>

The chloroacetamide was added slowly to a solution of sodium amide in anhydrous liquid ammonia; the solution changed color and hydrogen was liberated. After removal of the solvent the solid residue was washed with water and, after drying, the brown amorphous mass melted at 60–70° with decomposition. By crystallization from dilute alcohol, a small amount of yellow crystalline material was obtained and was shown to be fluorenone. The majority of the product from this experiment was a non-crystallizable gummy mass containing nitrogen and chlorine and definitely was not the desired 9-biphenyleneaminoacetamide (III).

### Summary

Hydrolysis by means of barium hydroxide of fluorene-spirohydantoin forms 9-biphenyleneaminoacetamide rather than the anticipated amino acid or amine.

(7) Klinger [*Ann.*, **389**, 239 (1912)] reported m. p. 166–167°.

(8) Klinger, *ibid.*, p. 234, reported m. p. of 111° for crude material, 111.5–112.5° after second recrystallization from ligroin and ether.

(9) Klinger, *ibid.*, p. 245, reports m. p. 194°.

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## The Preparation and Rearrangement of Phenylglycosides

BY EDNA M. MONTGOMERY, NELSON K. RICHTMYER AND C. S. HUDSON

Arthur Michael first obtained  $\beta$ -phenylglucoside by the interaction of acetochloroglucose and potassium phenolate in absolute alcohol<sup>1</sup>; subsequently a number of other methods and variations have been described for the preparation of phenylglycosides. By carrying out the reaction in ether,<sup>2</sup> or in a mixture of ether and water,<sup>3</sup> Emil Fischer was able to isolate the acetylated  $\beta$ -phenyl and vanillin glucosides in 60% yields.

(1) Michael, *Am. Chem. J.*, **1**, 306 (1879); see also Koenigs and Knorr, *Ber.*, **34**, 964 (1901).

(2) Fischer and Armstrong, *ibid.*, **34**, 2897 (1901).

(3) Fischer and Raske, *ibid.*, **43**, 1465 (1909).

Mannich<sup>4</sup> introduced the use of aqueous acetone to furnish a homogeneous solution of acetobromoglucose, sodium hydroxide and the desired phenol; the procedure is relatively simple and the method is now widely used.<sup>5</sup>

Fischer and Mechel<sup>6</sup> were the first to obtain an  $\alpha$ -phenylglycoside derivative, a mixture of the

(4) Mannich, *Ann.*, **394**, 225 (1912); see also Mauthner, *J. prakt. Chem.*, [2] **88**, 764 (1913).

(5) Cf. Glaser and Wulwek, *Biochem. Z.*, **145**, 514 (1924); Helferich and Burt, *Ann.*, **520**, 156 (1936); Helferich and Griebel, *ibid.*, **544**, 201 (1940); Fisher, Hawkins and Hibbert, *THIS JOURNAL*, **62**, 1413 (1940).

(6) Fischer and Mechel, *Ber.*, **49**, 2814 (1916).