by previously published procedures.[1,3] Physical constants and analytical data of new compounds are reported in Table I. The infrared spectra were determined in Nujol mulls using a Perkin–Elmer, model 21, spectrophotometer with sodium chloride optics.

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The Preparation of 3-Amino-2-acetylaminofluorene and 2-Amino-7-benzoylaminofluorene[1]

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For studies of the metabolism of the carcinogen 2-aminofluorene and related derivatives in progress in this Laboratory 3-amino-2-acetylaminofluorene and 2-amino-7-benzoylaminofluorene were desired. While there is no record for the synthesis of 2-amino-7-benzoylaminofluorene in the literature, the synthesis of 3-amino-2-acetylaminofluorene has been reported by Hayashi and Nakayama[2] by reduction of 3-nitro-2-acetylaminofluorene with stannous chloride to yield a product which melted at 194.5–195.5°. No data on the composition of their product were given. Attempts to prepare 3-amino-2-acetylaminofluorene by chemical reduction, either by the method of Hayashi and Nakayama[2] or with iron powder and glacial acetic acid, resulted in products which melted indefinitely starting at 130–140° and which could not be purified satisfactorily. Pure 3-amino-2-acetylaminofluorene, m.p. 225–227°,[3] was obtained by catalytic hydrogenation of 3-nitro-2-acetylaminofluorene.[2] The identity of the compound was established by elemental analysis and infrared spectrum. Treatment of the amine in cold, dilute sulfuric acid with sodium nitrite gave 1-N-acetyl-9H-fluoreno[3,2]-triazole. Formation of a triazole under similar conditions has been reported in the benzene series with *o*-aminoacetanilide.[4]

2-Amino-7-benzoylaminofluorene was obtained by reduction, with zinc dust and ethanol, of 2-nitro-7-benzoylaminofluorene. The latter compound was prepared by treating 2-amino-7-nitrofluorene[5,6] with benzoyl chloride. Diazotization of the amine followed by hydrolysis in dilute sulfuric acid gave only small amounts of 2-hydroxy-7-benzoylaminofluorene. This derivative was prepared in good yield and purity by benzoylation of the hydrochloride of 2-hydroxy-7-aminofluorene.[7]

Experimental

3-Amino-2-acetylaminofluorene.—2.70 g. of 3-nitro-2-acetylaminofluorene (0.01 mole), m.p. 201–202°,[2] N 10.4% (theory 10.4%), and 400 mg. of platinum oxide were suspended in 70 ml. of glacial acetic acid and hydrogenated[8] at 27° and 2.7 atmospheres. Hydrogen uptake was complete after 10 minutes, the observed pressure drop (2.6 lb./in.²) being close to the expected pressure drop (2.8 lb./in.²). The reaction mixture was filtered and the catalyst washed with glacial acetic acid. The filtrate was cooled in an ice-bath and rendered alkaline. The gray precipitate was collected, washed free of alkali with distilled water and dried in air. There was obtained 1.2 g. of material, m.p. 204–205°. Recrystallization of the product from 95% ethanol (75 ml./g.) gave 0.73 g. of 3-amino-2-acetylaminofluorene, m.p. 225–227° dec. Recrystallization of the product from benzene yielded long, colorless needles, m.p. 225–227° dec. The compound was soluble in dilute sulfuric and hydrochloric acid and in glacial acetic acid, but only very slightly soluble in diethyl ether. Hayashi and Nakayama[2] state that their product was readily soluble in diethyl ether.

Anal. Calcd. for $C_{15}H_{14}N_2O$: C, 75.6; H, 5.92; N, 11.8. Found: C, 75.6; H, 6.17; N, 11.8.

The infrared spectrum was determined using a Perkin-Elmer model 21 spectrometer fitted with a sodium chloride prism. The sample was prepared as a potassium bromide pellet. The following prominent absorption maxima were observed in the region 4000–1300 cm.$^{-1}$: 3400, 3320, 3260, 3020, 2920, 2840, 1650, 1620, 1585, 1530, 1490, 1470, 1455, 1435, 1405, 1370, 1310 cm.$^{-1}$.

1-N-Acetyl-9H-fluoreno[3,2]triazole.—0.78 g. of 3-amino-2-acetylaminofluorene (0.0033 mole) was dissolved in 80 ml. of 1.6 *M* sulfuric acid with slight warming on the steam-bath. The solution was filtered and the filter rinsed with 40 ml. of 1.6 *M* sulfuric acid. The solution was cooled to 10–15° in an ice-bath and 0.24 g. of sodium nitrite (0.0034 mole) in 10 ml. of distilled water was added dropwise to the rapidly stirred solution over a period of 0.5 hour. After addition of a few drops of the sodium nitrite solution the reaction mixture turned a purplish-red color and a white material precipitated. After addition of the sodium nitrite solution had been completed the suspension was stirred an additional 15 minutes. Excess nitrous acid was destroyed by addition of solid urea and the suspension stirred at room temperature 30 minutes longer. The precipitate was collected and washed free of acid with distilled water. After drying at reduced pressure over calcium chloride it weighed 0.47 g., m.p. 210–214°. The compound was recrystallized from ethanol to give long needles, m.p. 217–218°. Recrystallization from benzyl alcohol gave a product melting at 219–220°. Further recrystallization from glacial acetic acid did not change the melting point. The compound was readily soluble in ether or benzene.

Anal. Calcd. for $C_{15}H_{11}N_3O$: C, 72.3; H, 4.45; N, 16.9. Found: C, 72.0; H, 4.95; N, 16.7 (Dumas).

Nitrogen determinations by the micro Kjeldahl procedure[9] using digestion times of 2 or 8 hours gave a value of 5.76% (4 determinations).

2-Nitro-7-benzoylaminofluorene.—4.3 g. of 2-amino-7-nitrofluorene[5] (0.013 mole), m.p. 229–232°, was dissolved in 40 ml. of hot pyridine, diluted with 250 ml. of hot benzene and treated dropwise with 2.2 ml. (0.019 mole) of benzoyl chloride in 20 ml. of benzene. The solution, heated and stirred vigorously during the addition, turned deep-orange and a yellow precipitate began to form. After the addition, heating and stirring were continued for 4 hours. The mixture was allowed to stand overnight at 4°, and the precipitate was collected, washed with 10 ml. of cold benzene, then twice with cold 95% ethanol. There was obtained 5.7 g. of a yellow, fluffy material, m.p. 283–285° dec., 90% yield. Recrystallization of 0.2 g. of the compound from glacial acetic acid gave a product melting from 282–286° dec.

Anal. Calcd. for $C_{20}H_{14}N_2O_3$: C, 72.7; H, 4.27; N, 8.49. Found: C, 72.7; H, 4.29; N, 8.50.

2-Amino-7-benzoylaminofluorene.—4.0 g. (0.012 mole) of 2-nitro-7-benzoylaminofluorene, m.p. 282–286°, was ground in a mortar with 15 g. of zinc dust, and then heated under reflux with stirring with 220 ml. of 95% ethanol, 1.0 g. of calcium chloride in 10 ml. of distilled water and a trace of $CuSO_4 \cdot 5H_2O$. After 2 hours 5.0 g. of zinc dust and 50 ml. of 95% ethanol were added and heating and stirring

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[1] Supported by a grant from the American Cancer Society on recommendation of the Committee on Growth, National Research Council.

[2] M. Hayashi and A. Nakayama, *J. Soc. Chem. Ind. Japan* [*Suppl.*], **36**, 127B (1933).

[3] All melting points are uncorrected.

[4] F. Bell and J. Kenyon, *J. Chem. Soc.*, 954 (1926).

[5] O. Diels, *Ber.*, **35**, 3285 (1902).

[6] F. E. Cislak and C. S. Hamilton, THIS JOURNAL, **53**, 746–749 (1931).

[7] Prepared according to a personal communication from Dr. John H. Weisburger, National Cancer Institute, National Institutes of Health.

[8] R. Adams and V. Voorhees, "Organic Syntheses," Coll. Vol. I, John Wiley and Sons, Inc., New York, N. Y., 1943, p. 61.

[9] L. Miller and J. A. Houghton, *J. Biol. Chem.*, **169**, 373 (1945).

continued for 7 hours. The boiling reaction mixture was filtered through a heated funnel into 1.5 liters of distilled water. The zinc sludge was extracted twice with 50 ml. of boiling 95% ethanol and the extract added to the filtrate. The white precipitate was collected, washed with water and dried in air. There was obtained 3.1 g. m.p. 232–233° dec., 86% yield. Recrystallization of 0.64 g. of the compound with 100 ml. ethanol (Norit A added) gave 0.37 g. of material melting at 232–234° dec.

Anal. Calcd. for $C_{20}H_{16}N_2O$: C, 80.0; H, 5.37; N, 9.33. Found: C, 80.1; H, 5.50; N, 9.10.

2-Hydroxy-7-benzoylaminofluorene from 2-Amino-7-benzoylaminofluorene.—1.04 g. of 2-amino-7-benzoylaminofluorene (0.0035 mole), m.p. 230–232°, was dissolved in 150 ml. of boiling glacial acetic acid. Ten ml. of concentrated sulfuric acid and 40 ml. of distilled water was added and the suspension cooled in an ice-bath at 10°. The material was diazotized over a period of 0.25 hour by the dropwise addition of 0.25 g. (0.0036 mole) of sodium nitrite in 10 ml. of distilled water to the rapidly stirred suspension. The resulting dark-brown solution, which did not contain any excess nitrous acid as judged by a negative starch–iodide test, was added dropwise over a period of 1 hour to 500 ml. of a vigorously boiling and stirred solution of 0.2 *M* sulfuric acid. The resulting suspension was cooled to 15–20° in an ice-bath. The precipitate was collected and dried at reduced pressure over calcium chloride. The light tan material weighed 0.92 g. and melted at 242–247° dec.; 0.41 g. of the product was suspended in 50 ml. of 5% potassium hydroxide solution, Norit A was added and the suspension warmed on a water-bath to 75° for 5 minutes. The mixture was filtered, the filtrate cooled in an ice-bath and acidified with concentrated hydrochloric acid. The precipitate was collected and washed with water, and after drying at reduced pressure over calcium chloride there was obtained 0.10 g. of a gray material melting at 253–256° dec. Recrystallization of the compound from glacial acetic acid gave 0.05 g. which melted at 254–256° dec. The compound gave a positive spot test with diazotized sulfanilic acid indicating the presence of a hydroxyl group. A negative spot test was obtained with *p*-dimethylaminobenzaldehyde indicating the absence of a diazotizable amino group.[10]

Anal. Calcd. for $C_{20}H_{15}NO$: C, 79.7; H, 5.02; N, 4.65. Found: C, 79.4; H, 4.95; N, 4.62.

2-Hydroxy-7-benzoylaminofluorene from 2-Hydroxy-7-aminofluorene.[7]—2.0 g. (0.0086 mole) of the hydrochloride of 2-hydroxy-7-aminofluorene was dissolved with stirring in 40.0 ml. of pyridine and 1.0 ml. of benzoyl chloride (0.0087 mole) was added to the solution. The reaction mixture was boiled for 5 minutes under reflux and then cooled in an ice-bath; 100 ml. of distilled water was added which caused formation of a white precipitate. The ice-cold suspension was acidified with concentrated hydrochloric acid and allowed to stand overnight at 4°. The precipitate then was collected and washed with 130 ml. of boiling distilled water followed by 150 ml. of cold distilled water. After drying at reduced pressure over calcium chloride there was obtained 2.21 g. of a white, crystalline product, m.p. 254–256° dec., 86% yield. A mixture melting point with the authentic sample of 2-hydroxy-7-benzoylaminofluorene gave a melting point of 254–256° dec.

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(10) J. H. Peters and H. R. Gutmann, This Journal, **76**, 2267 (1954).

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Dehydration of Amino Amides of the Amidone Series

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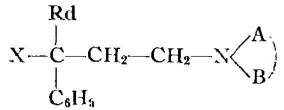
It has been reported that when a stream of hydrogen chloride or hydrogen bromide is passed into



$$X-\overset{\displaystyle Rd}{\underset{\displaystyle C_6H_5}{C}}-CH_2-CH_2-N{<}^{A}_{B}$$

X	$-N{<}^{A}_{B}$	Rd			Method and % yield		M.p., °C.[a]	Neut. equiv. Calcd.	Neut. equiv. Found[b]	Halogen or oxalic acid, % Calcd.	Halogen or oxalic acid, % Found	N, % Calcd.	N, % Found	U.V. spectr. in i-C_3H_7OH, $\lambda_{max.}$ mμ	U.V. spectr. ε	Parasympatholytic act. (atropine sulf. = 100) Rabbit ileum[c] molar P.R.	Rabbit ileum[c] $f_{P.R.}$[e]	Mydriasis mice[d] molar P.R.	Mydriasis mice[d] $f_{P.R.}$
H	$-N(C_2H_5)_2$	$CONH_2$	Base	$C_{14}H_{22}N_2O$	B	82	82	234.3	234.7	..	..	12.0	12.1	259.3	223	<0.5	..	<0.5	..
H	$-N(C_2H_5)_2$	CN	$C_2H_2O_4$	$C_{16}H_{22}N_2O_4$	A	85	171–173	306.4	307.1	29.4	29.7	9.1	9.0	257.5	221	.05	1.30	.4	1.10
H	$-N(C_2H_5)_2$	CN	$C_2H_2O_4$	$C_{16}H_{22}N_2O_4$	C	50	174	306.4	308.9	29.4	29.9	9.1	9.1	257.5	229	.05	1.40	< .5	..
H	$-NC_5H_{10}$	$CONH_2$	Base	$C_{15}H_{22}N_2O$	B	80	99	246.4	245.9	..	..	11.4	11.4	259.3	219	< .5	..	.25	1.38
H	$-NC_5H_{10}$	CN	HCl	$C_{15}H_{21}N_2Cl$	A	79	178	264.8	264.3	13.4	13.5	10.6	10.7	257.5	216	⩽ .1	..	⩽ .6	..
H	$-NC_5H_{10}$	CN	HCl	$C_{15}H_{21}N_2Cl$	C	55	178	264.8	265.2	13.4	13.4	10.6	10.6	257.5	233	.07	1.17	⩽ .5	..
C_6H_5	$-N(CH_3)_2$	$CONH_2$	Base	$C_{18}H_{22}N_2O$	B	78	140	282.4	282.2	..	..	..	..	260.0	430	4.7	1.56	13.0	1.10
C_6H_5	$-N(CH_3)_2$	CN	$C_2H_2O_4$	$C_{26}H_{22}N_2O_4$	A	81	163	354.4	256.1	25.4	25.6	7.9	8.1	258.5	420	1.5	1.25	<1.0	..
C_6H_5	$-N(CH_3)_2$	CN	$C_2H_2O_4$	$C_{20}H_{22}N_2O_4$	C	25	163	354.4	353.9	25.4	25.9	7.9	7.9	258.5	490	0.9	1.32	<1.0	..
C_6H_5	$-NC_4H_8$	$CONH_2$	Base	$C_{20}H_{24}N_2O$	B	83	146–147	308.4	311.5	..	..	..	..	260.0	423	59.7	1.27	27.0	1.19