Anal. of product identical with III. Calcd. same as above. Found: C, 73.06; H, 6.95; N, 3.52.

Both of these compounds, as well as their picrates gave no depression in melting point when compared with the corresponding compounds from the model reaction. The infrared spectra of the corresponding products were identical.

d-Camphor sulfonate of I. *d*-Camphor sulfonic acid (23.2 g., 0.1 mole) was dissolved in ethyl acetate containing I (24.3 g., 0.1 mole). From the solution, 20 g., (42% yield) of white crystalline material formed, m.p. 154.5–155.5°.

Anal. Calcd. for $C_{25}H_{33}NO_6S$: C, 63.16; H, 6.99; N, 2.95; S, 6.74. Found: C, 63.15; H, 7.13: N, 3.03; S, 6.73.

The diastereoisomer was not isolated since only one active form of I was needed.

(+) I. The *d*-camphor sulfonate salt (8 g., 0.017 mole) was dissolved in 200 ml. of benzene and refluxed with stirring with 100 ml. of 5% sodium hydroxide for 2 hr. The benzene was washed with water and concentrated to dryness. The residue was taken up in naphtha and refrigerated. Several crops of amorphous material formed totalling 2.6 g., (63.5% yield). After several recrystallizations from methanol-water a white crystalline material formed, m.p. 62–63.5°, $[\alpha]_D^{25}$ + 17.16° (*c*, 2.25 methanol).

Anal. Calcd. for $C_{15}H_{17}NO_2$: C, 74.04; H, 7.04; N, 5.76. Found: C, 74.10; H, 6.89; N, 5.81.

Reaction of (+) I with 3-phenoxy-1,2-epoxypropane. The active I (2.6 g., 0.0107 mole) was treated with 3-phenoxy-1,2-epoxypropane as before. Two products were isolated. The first, m.p. 96–97°, gave no mixed melting point depression with III and was optically inactive. The second compound, m.p. 84.5–85.5°, $[\alpha]_D^{25}$ +23.5° (*c*, 3.45 methanol) gave a marked mixed melting point depression with II.

Anal. of compound m.p. 84.5–85.5°. Calcd. for $C_{24}H_{27}NO_4$: C, 73.26; H, 6.92; N, 3.56. Found: C, 73.08; H, 6.90; N, 3.76.

Acknowledgment. We are grateful to L. L. Bolstad and P. A. Joyner for their assistance with this work.

MINNEAPOLIS, MINN.

[CONTRIBUTION FROM THE RESEARCH LABORATORIES OF THE UPJOHN CO.]

Some Reactions of Mannich Bases Derived from α-Phenoxyacetophenone and α-Phenoxypropiophenone

JOHN B. WRIGHT

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Mannich bases (I) derived from α-phenoxyacetophenone on treatment with polyphosphoric acid were converted in good yields to 2-dialkylaminomethyl-3-phenylbenzofurans (II). The carbinols (III), obtained by catalytic hydrogenation or by treatment of the Mannich bases with Grignard reagents, on treatment with polyphosphoric acid in a similar manner gave the corresponding dihydrobenzofurans (IV). The carbinols were also acylated (V) and several converted to urethanes (VI) by conventional procedures. Attempted acylation of one of the carbinols, namely 1,1-diphenyl-2-phenoxy-2-methyl-3-dimethylaminopropanol (III. R_2 = C_6H_5, R_1 = CH_3, R = CH_3) gave in good yield a nitrogen-free product which was identified as 1,1-diphenyl-2-phenoxypropene (VIII). Heating under reflux with dimethylaniline was found to be a convenient method for converting the Mannich bases (I) to α-phenoxyacrylophenones (VII).

Mannich bases (I) derived from α-phenoxyacetophenone and α-phenoxypropiophenone are prepared readily in good yield.[1,2] They are readily hydrogenated under catalytic conditions to the corresponding carbinols (III. R_2 = H).[1,3] We wish to report now on some further reactions of these compounds.

Reaction of the Mannich bases (I) with polyphosphoric acid, according to the method used by Davies and Middleton[4,5] to prepare phenylbenzofuran from α-phenoxyacetophenone, gave in good yield the corresponding 2-dialkylaminomethyl-3-phenylbenzofurans (II). These compounds, isolated as the *hydrochlorides*, are listed in Table I.

Reaction of the Mannich bases (I) with Grignard reagents gave the corresponding tertiary carbinols (III). These compounds are listed in Table II. In those cases where reaction with the Grignard reagent produced a new asymmetric carbon atom a mixture of diastereoisomers was produced and some difficulty was experienced in separating the two isomers. Treatment of several of the carbinols (III) with polyphosphoric acid in the manner described above gave the corresponding 3-phenyl-2-dialkylaminodihydrobenzofurans (IV, Table III). In the preparation of these compounds a simple dehydration of the carbinols (III. where R_1 = H) to give an isomeric substituted styrene is also possible; however, the dihydrobenzofuran structure is assigned on the basis of the ultraviolet absorption data obtained for these compounds.

The carbinols (III) when treated with acetic anhydride or propionic anhydride in the presence of pyridine gave the corresponding acylated compounds (V). Treatment of the carbinols with phenyl chlorocarbonate followed by cleavage of the resulting product with liquid ammonia gave the

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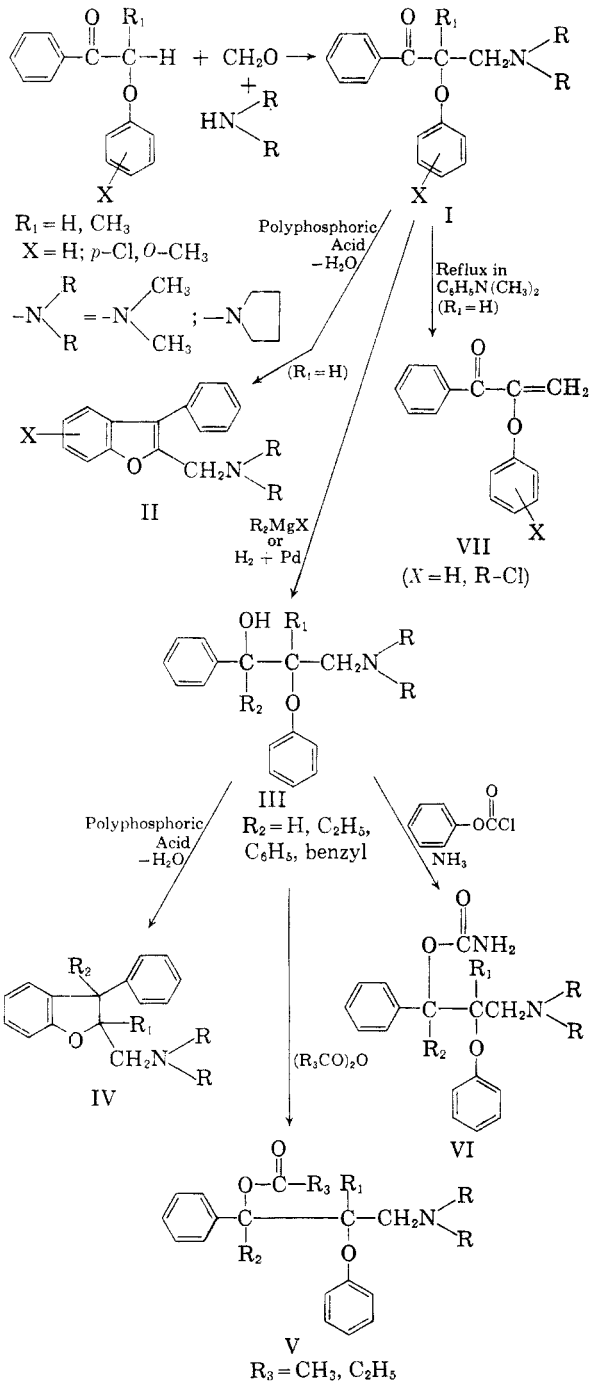
(1) J. B. Wright and E. H. Lincoln, *J. Am. Chem. Soc.*, 74, 6301 (1952).

(2) U. S. Patent 2,655,542.

(3) U. S. Patent 2,695,919.

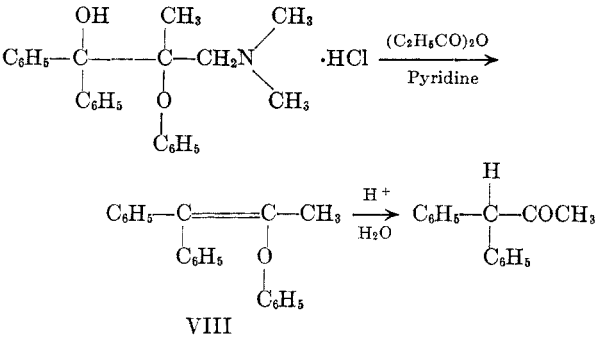
(4) W. Davies and S. Middleton, *Current Trends in Heterocyclic Chemistry*, Academic Press, Inc., New York, N.Y., 1958, p. 58.

(5) W. Davies and S. Middleton, *J. Chem. Soc.*, 822 (1958).

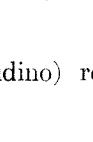


corresponding urethanes (VI). The compounds of the type V and VI that were prepared are listed in Table IV.

In the attempted acylation of 1,1-diphenyl-2-phenoxy-2-methyl-3-dimethylaminopropanol-1 hydrochloride (III. R_2 = C_6H_5, R_1 = CH_3, R = CH_3) with propionic anhydride and pyridine, according to the method that was used to prepare compounds of type V, none of the desired product was obtained but rather a *nitrogen-free* product, in very good yield. The empirical formula of this product, according to microanalysis, was $C_{21}H_{18}O$. The structure of this compound appears to be 1,1-diphenyl-2-phenoxypropene (VIII) on the basis of its infrared and ultraviolet spectra and the fact that on acid hydrolysis it gave diphenylacetone.



The nature of this reaction is not clear at the present time. However, it appears to be limited to carbinols of the type III that contain a methyl group (R_1 = CH_3) that may sterically block reaction at the hydroxyl grouping.

It was previously shown[1,6] that attempted distillation of β-piperidino-α-phenoxypropiophenone (I.  = piperidino) resulted in the elimination of piperidine with the formation of α-phenoxyacrylophenone (VII. X = H). It has been found that this reaction may be carried out more conveniently and in a better yield by refluxing the Mannich base (I) in dimethylaniline for a short period of time. By means of this method α-phenoxyacrylophenone and *p*-chloro-α-phenoxyacrylophenone (VII. X = *p*-Cl) were prepared from the corresponding Mannich bases in yield of 85% and 65%, respectively.

EXPERIMENTAL[7,8]

α-Phenoxy-p-chloropropiophenone. To a stirred solution of 122.4 g. of *p*-chloropropiophenone in 500 ml. of anhydrous ether cooled in an ice bath was added dropwise 116 g. of bromine. The solution was washed with water, dried over anhydrous magnesium sulfate, and the ether removed. To the flask containing the crude bromoketone (177.5 g.; m.p. 77–80°) was added 68.5 g. of phenol, 134.3 g. of potassium carbonate, and 1450 ml. of acetone and the mixture heated under reflux for 7 hr. To the cooled reaction mixture was added 1400 ml. of water and the mixture extracted with ether. The ethereal extracts were washed with 10% sodium hydroxide, dried over anhydrous magnesium sulfate, and the ether removed. The residual solid was recrystallized from

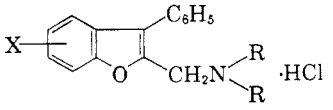
(6) J. B. Wright and E. H. Lincoln, *J. Am. Chem. Soc.*, 80, 6697 (1958).

(7) All melting points reported are uncorrected and were taken in a capillary tube.

(8) We are indebted to Mr. William Struck and his coworkers of these laboratories for the microanalytical data and to Mr. Marvin Grostic and Mr. James Stafford of these laboratories for infrared and ultraviolet spectral determinations. Our thanks are due especially to Mr. Albert Lallinger for technical assistance and to Dr. Richard Heinzelman for suggestions and discussions.

TABLE I

2-DIALKYLAMINOMETHYL-3-PHENYLBENZOFURAN HYDROCHLORIDES

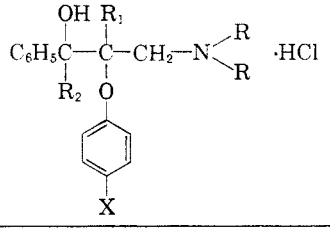


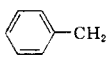
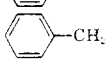
X	—N(R)R	M.P.	Yield, %	Formula	Calcd. C	Calcd. H	Calcd. Cl	Calcd. N	Found C	Found H	Found Cl	Found N
H[a]	—N(CH₃)₂[a]	187.5–188.5[a]	97	$C_{17}H_{17}NO \cdot HCl$	70.95	6.30	12.32	4.87	70.86	6.64	12.23	4.74
H	—N(C₂H₅)₂	158.5–159.5	87	$C_{19}H_{21}NO \cdot HCl$	72.25	7.02	11.23	4.44	72.06	7.02	11.14	4.80
H	—N(CH₂—CH₂)(CH₂—CH₂)	181.5–182.5	87	$C_{19}H_{19}NO \cdot HCl$	72.71	6.42	11.30	4.46	72.78	6.21	11.20	4.74
5-Cl	—N(CH₃)₂	206.5–207.0	94.5	$C_{17}H_{16}ClNO \cdot HCl$	63.36	5.32	22.02		62.68	5.23	21.81	
7-CH₃O	—N(C₂H₅)₂	212.5–214	85	$C_{20}H_{23}NO_2 \cdot HCl$	69.45	6.99	10.25	4.05	69.45	7.16	10.26	4.33

[a] The free base is a solid melting at 64.5–65.5° after recrystallization from ethanol-water (2:1). *Anal.* Calcd. for $C_{17}H_{17}NO$: C, 81.24; H, 6.82; N, 5.57. Found: C, 81.36; H, 7.04; N, 5.49.

TABLE II

3-AMINO-2-PHENOXY-1-PHENYLPROPANOL HYDROCHLORIDES



R_2	R_1	X—NR_2	Procedure	Yield, %	M.P. °C.	Formula	Calcd. C	Calcd. H	Calcd. Cl	Calcd. N	Found C	Found H	Found Cl	Found N
C_2H_5	H	H—N(CH₃)₂	..	45	176–176.5	$C_{19}H_{25}NO_2 \cdot HCl$	67.94	7.80	10.56	4.17	68.27	7.57	10.41	4.41
C_6H_5	H	H—N(CH₃)₂	A	69	100° (dec.)[a]	$C_{23}H_{25}NO_2 \cdot HCl$	71.96	6.83	9.23	..	72.13	6.81	8.98	..
C_6H_5	H	Cl—N(CH₃)₂	A	27	92–94°[b]	$C_{23}H_{24}ClNO_2$[c]	72.34	6.33	9.28	3.67	72.17	6.23	9.66	3.48
C_6H_5	CH_3	H—N(CH₃)₂	A	47	126.5–127.5[b]	$C_{24}H_{27}NO_2$[c]	79.74	7.53	...	3.87	79.64	7.53	...	3.83
	H	H—N(CH₃)₂	A	27	233–235°	$C_{24}H_{27}NO_2 \cdot HCl$[e]	72.43	7.09	8.91	3.52	72.30	7.62	9.03	3.65
	CH_3	H Pyrrolidino	A	37	231–231.5	$C_{27}H_{31}NO_2 \cdot HCl$[d]	74.04	7.37	8.09	3.20	73.88	6.89	8.03	3.47

[a] The free base melted at 89.5–90.5° after recrystallization from ethanol. *Anal.* Calcd. for $C_{23}H_{25}NO_2$: C, 79.51; H, 7.25; N, 4.03. Found: C, 79.40; H, 7.17; N, 4.01. [b] Recrystallized from ethanol. These are the melting points of the free base. [c] Only the free base was prepared. [d] Recrystallized from methyl ethyl ketone–anhydrous ethanol (5:2). [e] Recrystallized from a methanol–ethyl acetate mixture (1:4).

ethanol. There was obtained 163.7 g. (87%) of colorless needles melting at 83–84°. Additional recrystallization from ethanol raised the melting point to 85–86°.

Anal. Calcd. for $C_{15}H_{13}ClO_2$: C, 69.10; H, 5.02; Cl, 13.60. Found: C, 69.20; H, 5.13; Cl, 13.31.

α-p-Chlorophenoxy-p-chloropropiophenone was prepared according to the procedure given above for α-phenoxy-*p*-chloropropiophenone, using an equivalent amount of *p*-chlorophenol; yield, 76%; m.p. 94.5–95.0° after recrystallization from ethanol.

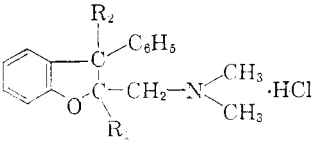
Anal. Calcd. for $C_{15}H_{12}Cl_2O_2$: C, 61.04; H, 4.10; Cl, 24.02. Found: C, 61.10; H, 4.41; Cl, 24.02.

Preparation of Mannich bases. The preparation of several of the Mannich bases used as starting materials has been described elsewhere.[1] Those that were not prepared previously are listed in Table V. The general methods described previously[1] were used for the preparation of these compounds.

N,N-Dimethyl(2-phenoxy-3-hydroxy-3-phenyl)amylamine hydrochloride. To a solution of ethylmagnesium bromide in ether, prepared from 3.65 g. (0.15 mole) of magnesium, 16.35 g. (0.15 mole) of ethyl bromide and 50 ml. of ether was added 10 ml. of dry benzene. Then, keeping the inner temperature below 0°, there was added a solution of 13.45 g. (0.05 mole) of β-dimethylamino-α-phenoxypropiophenone[1] in 40 ml. of dry benzene. Heat was applied and the ether removed until the inner temperature reached 65°. The mixture was hydrolyzed by pouring into a cold solution of 15%

TABLE III

2-DIMETHYLAMINOMETHYL-3-PHENYL-2,3-DIHYDROBENZOFURAN HYDROCHLORIDES

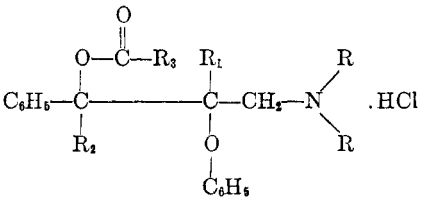


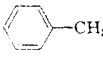
R_1	R_2	M.P.	Yield, %	Formula	Calcd. C	H	Cl	N	Found C	H	Cl	N
H	H	216.5–217	38	$C_{17}H_{19}NO\cdot HCl$	70.46	6.96	12.23	4.83	70.25	7.27	12.24	4.84
CH_3	H	201 (dec.)	59	$C_{18}H_{21}NO\cdot HCl$[a]	71.16	7.30	11.67	..	70.48	7.35	11.41	..
H	C_6H_5	267 (dec.)[b]	69[b]	$C_{23}H_{23}NO\cdot HCl$[c]	75.50	6.61	9.69	3.83	75.52	6.47	9.68	3.84
CH_3	C_6H_5	269 (dec.)	94	$C_{24}H_{25}NO\cdot HCl$[d]	75.87	6.90	9.33	3.69	75.97	7.03	9.42	3.76

[a] Recrystallized from an ethanol–methyl ethyl ketone (1:15) mixture. [b] The free base melted at 109–109.5° after recrystallization from ethanol. *Anal.* Calcd. for $C_{23}H_{23}NO$: C, 83.86; H, 7.04; N, 4.25. Found: C, 83.90; H, 7.63; N, 4.16. [c] Recrystallized from isopropanol. [d] Recrystallized from an anhydrous ethanol–ethyl acetate (1:1) mixture.

TABLE IV

3-ACYLOXY-3-PHENYL-2-PHENOXYPROPYL AMINE HYDROCHLORIDES



R_3	R_2	R_1	$-N(R)(R)$	Procedure	Yield, %	M.P.	Formula	Calcd. C	H	Cl	N	Found C	H	Cl	N
CH_3	C_6H_5	H	$-N(CH_3)_2$	B	19	179–80[a]	$C_{25}H_{27}NO_3\cdot HCl$	—	—	8.32	3.29	—	—	8.25	3.26
NH_2	C_6H_5	H	$-N(CH_3)_2$	C	42	178 (dec.)[b]	$C_{24}H_{26}N_2O_3\cdot HCl$	67.51	6.38	8.30	6.56	67.62	6.56	8.20	6.42
NH_2	H	H	$-N(CH_3)_2$	C[e]	45	169–170[c]	$C_{18}H_{22}N_2O_3$[d]	68.76	7.06	—	8.91	69.04	7.23	—	8.64
C_2H_5		H	$-N(CH_3)_2$	B	84	204–206.5[f]	$C_{27}H_{31}NO_3\cdot HCl$	71.42	7.10	7.81	3.09	71.63	7.03	7.77	2.96

[a] Recrystallized from methyl ethyl ketone. [b] Recrystallized from anhydrous ethanol–ether (1:3). The free base melted at 133–135° after recrystallization from petroleum ether (b.p. 60–71°)–anhydrous ethanol (20:1). *Anal.* Calcd. for $C_{24}H_{26}N_2O_3$: C, 73.82; H, 6.71; N, 7.18. Found: C, 74.10; H, 6.45; N, 7.08. [c] Recrystallized from ethanol. This is the melting point of the free base. [d] The hydrochloride was not prepared. [e] Benzene was used in place of the ether for extraction of the compound. [f] Recrystallized from acetone.

ammonium chloride. The benzene layer was separated and the aqueous layer extracted with benzene. The benzene was removed by distillation. The residue after standing in the refrigerator for some time partially solidified. The mixture was triturated with petroleum ether (b.p. 29–38°), the solid recovered by filtration and recrystallized from methanol. There was obtained 6.78 g. (45%) of colorless prisms melting at 99.5–100.5°.

Anal. Calcd. for $C_{19}H_{25}NO_2$: N, 4.68. Found: N, 4.73.

The *hydrochloride* was prepared by adding an ethereal hydrogen chloride solution to a solution of the free base in ether. After recrystallization from methyl ethyl ketone there was obtained colorless needles melting at 176–176.5°.

Anal. Calcd. for $C_{19}H_{25}NO_2HCl$: C, 67.94; H, 7.80; Cl, 10.56; N, 4.17. Found: C, 68.27; H, 7.57; Cl, 10.41; N, 4.41.

The methanolic mother liquors from the recrystallization of the free base on long standing in the refrigerator deposited 1.47 g. of material melting at 54–55.5°. This was converted to its *hydrochloride* salt and the latter recrystallized repeatedly from ethyl acetate–methyl ethyl ketone (1:1). There was obtained 250 mg. of fine colorless needles melting at 190–191°.

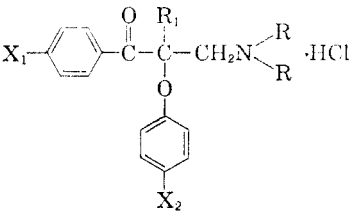
Anal. Calcd. for $C_{19}H_{25}NO_2\cdot HCl$: Cl, 10.56; N, 4.17. Found: Cl, 10.84; N, 4.38.

Procedure A. α-(2-Dimethylamino-1-methyl-1-phenoxyethyl)benzhydrol hydrochloride. To a stirred solution of phenylmagnesium bromide (0.2 mole) in 150 ml. of ether was added dropwise a solution of 31.9 g. (0.1 mole) of α-phenoxy-β-dimethylaminopropiophenone in 100 ml. of ether. The mixture was stirred and heated under reflux for an hour and was then decomposed with 150 ml. of a 20% ammonium chloride solution. The ether layer was separated and the aqueous layer extracted with ether. The combined ethereal extracts were dried over anhydrous magnesium sulfate, the drying agent removed by filtration, and the hydrochloride precipitated by the addition of an ethereal hydrochloric acid solution.

Procedure B. 1,2-Diphenyl-3-phenoxy-4-dimethylamino-2-butylpropionate hydrochloride. A mixture of 3.98 g. (0.01 mole) of 1,2-diphenyl-3-phenoxy-4-dimethylamino-2-buta-

TABLE V

MANNICH BASE HYDROCHLORIDES



X_1	X_2	R_1	—NR_2	Yield, %	M.P.	Formula	Calcd. C	Calcd. H	Calcd. N	Calcd. Cl	Found C	Found H	Found N	Found Cl
H	H	H	pyrrolidino	—	157.5–158.0[a]	$C_{19}H_{21}NO_2 \cdot HCl$	68.77	6.68	4.22	10.68	68.88	6.60	4.32	10.65
H	H	CH_3	pyrrolidino	—	181[b]	$C_{20}H_{23}NO_2 \cdot HCl$	69.45	6.99	4.05	10.25	69.21	7.20	3.93	10.12
H	Cl	H	—$N(CH_3)_2$	77[d]	164–165[c]	$C_{17}H_{18}ClNO_2 \cdot HCl$	60.01	5.63	4.11	20.84	59.78	5.65	4.21	20.95
Cl	H	CH_3	—$N(CH_3)_2$	72[d,f]	138–139[a]	$C_{18}H_{20}ClNO_2 \cdot HCl$	61.02	5.98	3.95	20.02	60.85	6.01	4.11	19.95
Cl	Cl	CH_3	—$N(CH_3)_2$	97[d,f]	182[e]	$C_{18}H_{19}Cl_2NO_2 \cdot HCl$	55.61	5.19	3.60	27.36	55.75	5.16	3.38	27.43

[a] Recrystallized from acetone. [b] Recrystallized from methyl ethyl ketone–ethanol (3:1). [c] Recrystallized from methyl ethyl ketone–ethanol (1:1). [d] The yield is based upon the amount of propiophenone actually used in the reaction. [e] Recrystallized from ethanol. [f] Procedure B of reference 1 was employed.

nol hydrochloride, 4 ml. of propionic anhydride, and 4 ml. of pyridine was heated under reflux for 4 hr. The mixture was allowed to cool, anhydrous ether was added, and the solid removed by filtration and purified by recrystallization.

Procedure C. α-(2-Dimethylamino-1-phenoxyethyl)benzhydryl carbamate hydrochloride. To a stirred ice-cooled solution of 31.9 g. (0.09 mole) of α-(2-dimethylamino-1-phenoxyethyl)benzhydrol in 36 ml. of dry pyridine was added dropwise 14.04 g. (0.09 mole) of phenyl chlorocarbonate. This suspension was added with stirring to about 200 ml. of liquid ammonia over a period of about 0.5 hr. The mixture was stirred at reflux for 8 hr. using a Dry Ice condenser. The ammonia was allowed to evaporate overnight. Water and ether were added to the mixture. The ether layer was separated and the aqueous layer extracted with ether. The combined ethereal extracts were washed twice with a 5% sodium hydroxide solution, once with a saturated salt solution and dried over anhydrous magnesium sulfate. The ether was removed by distillation. The residual oil solidified upon standing and was purified by recrystallization. The free base was dissolved in ether and the hydrochloride precipitated by the addition of a saturated ethereal hydrogen chloride solution.

Procedure for 2-dialkylaminomethyl-3-phenylbenzofuran hydrochlorides. 2-Diethylaminomethyl-3-phenylbenzofuran hydrochloride. Into a three-necked flask was weighed 308 g. of polyphosphoric acid.[9] The flask was fitted with a stirrer and a drying tube and heated on the steam bath. To the stirred polyphosphoric acid was added 30.8 g. (one tenth of the weight of acid) of α-phenoxy-β-diethylaminopropiophenone hydrochloride.[1] Effervescence took place immediately and the mixture became red in color. The mixture was heated on the steam bath with stirring for 2.5 hr. To the reaction mixture when cool was added 150 g. of ice, with stirring, as soon as this became possible. The mixture was transferred to a large beaker, ice and water were added, and the acid neutralized by the addition of a sodium hydroxide solution. Additional water was added to make the mixture sufficiently fluid for extraction.

The mixture was extracted with ether, the ethereal extracts dried over anhydrous magnesium sulfate, the drying agent removed by filtration, and the hydrochloride precipitated by the addition of an ethereal hydrogen chloride solution. The product was purified by recrystallization from acetone.

The compounds listed in Table I were prepared by this general procedure.

Procedure for 2-dimethylaminomethyl-3-phenyl-2,3-dihydrobenzofuran hydrochlorides. 2-Dimethylaminomethyl-3-phenyl-2,3-dihydrobenzofuran hydrochloride. Ten grams of 3-dimethylamino-1-phenyl-2-phenoxypropanol-1 hydrochloride[1] was heated with ten times its weight of polyphosphoric acid according to the procedure described above for 2-diethylaminomethyl-3-phenylbenzofuran hydrochloride. Using the requisite carbinol all of the compounds listed in Table III were prepared in this general way.

Attempted preparation of 1,1-diphenyl-2-phenoxy-2-methyl-3-dimethylaminopropylpropionate hydrochloride. Preparation of 1,1-diphenyl-2-phenoxypropene. A mixture of 17.4 g. (0.046 mole) of 1,1-diphenyl-2-phenoxy-2-methyl-3-dimethylaminopropanol-1-hydrochloride (prepared by adding gaseous hydrogen chloride to an ethereal solution of the free base), 15 ml. of dry pyridine and 15 ml. of propionic anhydride was heated under reflux for 2 hr. The mixture when cool was diluted with an excess of anhydrous ether. The solution was decanted from the small amount of oil that precipitated, was washed with water, and the ether removed. The yellow solid residue was recrystallized from ethanol. There was obtained 7.27 g. (55%) of colorless prisms melting at 61–62.5°. Additional recrystallizations from ethanol raised the melting point to 64–65°.

Anal. Calcd. for $C_{21}H_{18}O$: C, 88.08; H, 6.34. Found: C, 88.33; H, 6.64.

One gram of the product was heated under reflux for 2 hr. with 1.1 ml. of concd. hydrochloric acid, 4 ml. of water, and 20 ml. of ethanol. The alcohol was removed *in vacuo*. The residue was diluted with water, made basic with a solution of sodium carbonate, and extracted with ether. The ethereal extracts were washed with a 5% sodium hydroxide solution and dried over anhydrous magnesium sulfate. The crude solid was recrystallized from petroleum ether (b.p. 60–71°). There were obtained colorless prisms melting at 58.5–59.5° which gave no depression when mixed with an authentic sample of diphenylacetone. The infrared spectrum of the compound was identical with that from diphenylacetone.

Anal. Calcd. for $C_{15}H_{14}O$: C, 85.68; H, 6.71. Found: C, 85.50; H, 6.70.

(9) Obtained from The Victor Chemical Company—115% Ortho equivalent.

α-Phenoxyacrylophenone.[1,6] A mixture of 50 g. (0.186 mole) of β-dimethylamino-α-phenoxypropiophenone[1] and 50 ml. of *N,N*-dimethylaniline was heated under reflux for 1 hr. After cooling to room temperature the reaction mixture was dissolved in 300 ml. of ether and the ethereal solution extracted twice with 400 ml. of 1*N* hydrochloric acid. The ethereal solution was dried over anhydrous magnesium sulfate, the ether removed, and the residue recrystallized from ethanol. There was obtained 35.4 g. (85%) of colorless prisms melting at 100–102°.

α-p-Chlorophenoxyacrylophenone was prepared by heating β-dimethylamino-α-*p*-chlorophenoxypropiophenone under reflux with *N,N*-dimethylaniline, as described above for α-phenoxyacrylophenone. The product after recrystallization from anhydrous ethanol consisted of colorless prisms melting at 102.5–104.5°, yield, 65%.

Anal. Calcd. for $C_{15}H_{11}ClO_2$: C, 69.64; H, 4.29; Cl, 13.70. Found: C, 69.76; H, 4.17; Cl, 13.32.

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Studies on Naphthalides. III.[1] Action of Substituted Phenylacetic Acids, Quinaldine and Picolines on Naphthalic Anhydride

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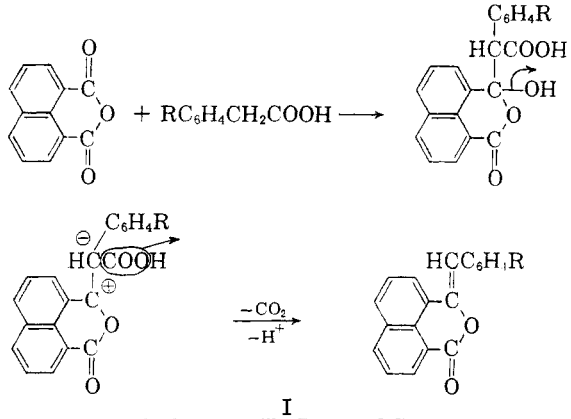
Substituted phenylacetic acids were condensed with naphthalic anhydride, to show the effect of different groups on the products, which are 3-benzalnaphthalides (I) or β-diketones (II). Other active methylene compounds, *e.g.* quinaldine, α-picoline, and γ-picoline were allowed to condense with naphthalic anhydride to produce the corresponding pyronaphthalones.

The authors[1] have already shown that naphthalic anhydride reacts with phenylacetic acid and sodium acetate to give a mixture of 8-phenyl-*peri*-naphthindan-7,9-dione (IIa) and 3-benzalnaphthalide (Ia). This work is now extended to investigate the effect of substitution in the aromatic ring of phenylacetic acid on the above Perkin condensation.

A semiquantitative study on the relative yields of the β-diketones (II) to the benzalnaphthalides (I) has been taken as a criterion for this investigation (*cf.* Table I). The following mechanism is proposed for this condensation:



I

Ia. R = H; Ib. R = *p*-OCH_3;
Ic. R = *p*-Cl; Id. R = *o*-Cl

II

IIa. R = H; IIb. R = OCH_3; IIc. R = *p*-Cl

TABLE I

RELATIVE YIELDS OF β-DIKETONES AND BENZALNAPHTHALIDES

	Benzalnaphthalide, %	β-Diketone, %	Total yield, %
Phenylacetic acid	16	50	66
p-Methoxyphenylacetic acid	22.3	40	62.3
p-Chlorophenylacetic acid	9	13	22
o-Chlorophenylacetic acid	13	—	13
p-Nitrophenylacetic acid	—	—	—

It is likely that II arises from I by the action of sodium acetate by a mechanism analogous to Scheme A (*inter alia*).

In the case of *p*-methoxyphenylacetic acid, the total yield is slightly less than that of phenylacetic acid but the ratio of the diketone is much higher. The total yields in the case of *o*- and *p*-chlorophenylacetic acids are much less when compared with the other two cases. It is also to be noticed that, in the case of the chloro derivatives, the benzal compounds (I) are predominant. No diketone was isolated in the case of *o*-chlorophenylacetic acid, perhaps because the electron attracting groups (*i.e.* Cl, —I>+T) facilitates the partial decarboxylation of such acids prior to condensation which may be responsible for the relatively poor yields in such cases. This is verified by the fact

(1) O. M. Aly, W. I. Awad, and A. M. Islam, *J. Org. Chem.*, **23**, 1624 (1958).