Synthesis of Furo[2,3-*c*]isoquinoline Derivatives (1)

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2-Methylfuro[2,3-c]isoquinolin-5(4*H*)one (X) and 1-phenylfuro[2,3-c]isoquinolin-5(4*H*)one (XI) were prepared from thermal cyclization *via* the Curtius rearrangement of 5-methyl-3-phenyl-2-furoyl azide (VI) and 3,4-diphenyl-2-furoyl azide (VII), respectively. Stability against acid, alkylation and conversion of the NHCO group to a C=N double bond of X and XI, which were synthesized, are described. Also, 5-substituted furo[2,3-c]isoquinolines (XVIIIa-c) and (XIXa-c) were prepared.

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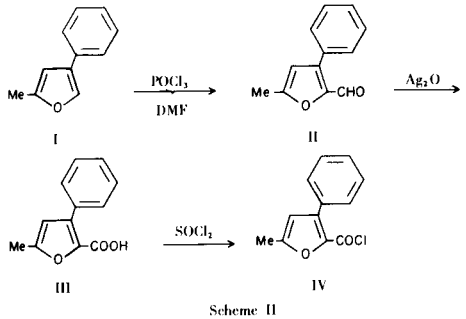
The simpler compounds having furo[2,3-*b*]pyridine ring have been described by Sliwa (2) and Snyder, *et al.*, (3) in relation to the some biological activities of the furo[2,3-*b*]quinoline alkaloids (4). These reports prompted us to investigate the synthesis of the furo[2,3-c]-isoquinoline derivatives in which the benzene ring is fused with the 3,4-position of pyridine ring.

Furo[2,3-*c*]isoquinolines have been synthesized by means of cyclization of 4-phenacylhomophthalimides which were prepared from homophthalimides by Bailey, *et al.*, (5). However, according to this report, only 2-phenylfuro[2,3-c]isoquinolin-5(4*H*)one and its *N*-methyl compound with a phenyl group at the α-position of the furan ring were synthesized. On the other hand, furo-[3,2-*c*]pyridones were synthesized *via* the thermal cyclization of β-furyl acryloyl azides by Eloy, *et al.*, (6). Therefore, we considered the formation of furo[2,3-*c*]-isoquinolinones (X) and (XI) to be possible by thermolysis of the compounds VI and VII with a phenyl group at the β-position and an acid azide group at the α-position of the furan ring.

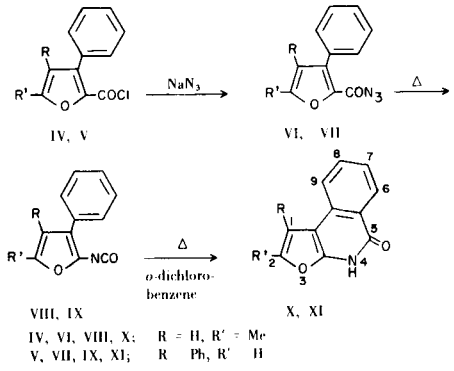
5-Methyl-3-phenyl-2-furoyl chloride (IV) was synthesized *via* 3 steps from 2-methyl-4-phenylfuran (I) prepared by Miller (7) (Scheme I). The Vilsmeier formylation of I gave 5-methyl-3-phenyl-2-furfural (II). It became apparent that the formyl group was introduced at the α-position because of the orientation of the furan ring and the presence of the signal due to the β-proton of the furan ring at δ 6.31 as a singlet (8) in the nmr spectrum of this compound. Oxidation of II with silver oxide afforded 5-methyl-3-phenyl-2-furoic acid (III), and the subsequent chlorination of III with thionyl chloride yielded 5-methyl-3-phenyl-2-furoyl chloride (IV). 3,4-Diphenyl-2-furoyl chloride (V) was obtained by chlorination of 3,4-diphenyl-2-furoic acid prepared from benzil and dimethyl diglycolate (9). Subsequently the furoisoquinolinones were synthesized as shown in Scheme II. The reaction of IV and V with sodium azide readily proceeded in dioxane at room temperature to afford the corresponding acid azides (VI) and (VII) in good yield. Thermolysis of VII in boiling *o*-dichlorobenzene gave 1-phenylfuro[2,3-c]isoquinolin-5(4*H*)one (XI) (in 72% yield), which was formed independently by cyclization of the isocyanate (IX) produced *via* the Curtius rearrangement. The ir spectrum of XI showed a characteristic absorption owing to secondary amide group at 2810 and 1625 cm^{-1}, and its nmr spectrum indicated a deshielded signal of C_6-H at δ 8.59 as a multiplet, the downfield shift of C_6-H being due to the paramagnetic anisotropic effect of C_5-carbonyl group. The intermediate, isocyanate (IX) was found to be produced by decomposition of VII in boiling benzene, which showed an absorption of -NCO group at 2260 cm^{-1} in its ir spectrum. Furthermore, heating of IX in boiling *o*-dichlorobenzene led to XI. In a similar manner, VI gave 2-methylfuro[2,3-c]isoquinolin-5(4*H*)one (X) in 69% yield.

Scheme I



I II III IV

Scheme II

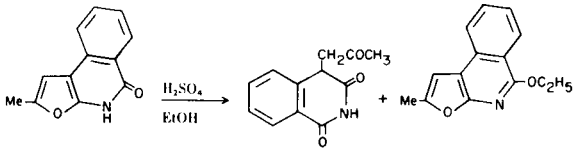


IV, V VI, VII VIII, IX X, XI

IV, VI, VIII, X: R = H, R' = Me
V, VII, IX, XI: R = Ph, R' = H

Treatment of X and XI with concentrated sulfuric acid afforded furoisoquinolinones containing a sulfuric acid group as reported by Bailey, *et al.*, (5). However, on taking into account the chemical properties of the furan ring, it may be expected that cleavage of the furan ring will occur with diluted sulfuric acid. Thus, treatment of X in ethanol containing sulfuric acid gave the 4-acetonylhomophthalimide (XII) along with 2-methyl-5-ethoxyfuro[2,3-c]isoquinoline (XIII) (Scheme III). Treatment of XI in ethanol containing sulfuric acid did not give homophthalimide but only a small amount of 1-phenyl-5-ethoxyfuro[2,3-c]isoquinoline (XIVb) was obtained.

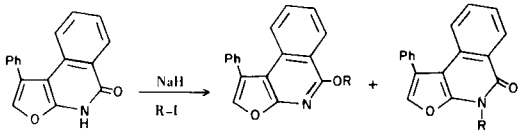
Scheme III



X XII XIII

Reaction of XI with alkyl iodides in the presence of sodium hydride in dimethylformamide furnished *O*-alkyl- (XIVa,b) (in low yield, 5 and 12%) and *N*-alkylfuroisoquinolines (XVa,b) (66 and 28% yield) as shown in Scheme IV. *O*-Ethylation of X and XI with triethyloxonium fluoroborate was carried out. However, the reaction proceeded unsuccessfully, affording only a small amount of XIII and XIVb.

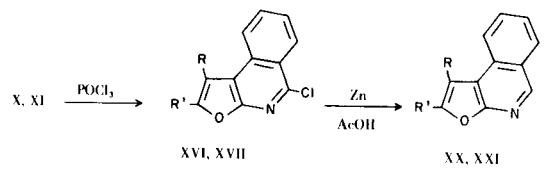
Scheme IV



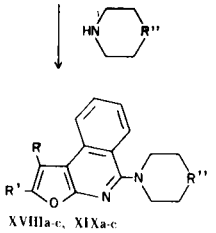
XI XIVa,b XVa,b

XIVa, XVa; R = Me
XIVb, XVb; R = Et

Scheme V



XVI, XVII XX, XXI

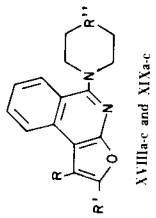


XVIIIa-c, XIXa-c

XVI, XVIIIa-c, XX; R = H, R′ = Me
XVII, XIXa-c, XXI; R = Ph, R′ = H

Table I

5-Amino Derivatives of 1-Methyl or 2-Phenylfuro[2,3-c]isoquinolines



XVIIIa-c and XIXa-c

Compound	R	R′	R″	Appearance	M.p. °C	Yield %	Recrystallization Solvent	Empirical Formula	Calcd., % C	H	N	Found, % C	H	N
XVIIIa	H	Me	CH_2	Colorless needles	72-73	76	Ether	$C_{17}H_{18}N_2O$	76.66	6.81	10.52	76.46	6.60	10.41
XVIIIb	H	Me	O	Colorless needles	91-92	81	Ether	$C_{16}H_{16}N_2O_2$	71.62	6.01	10.44	71.72	5.97	10.33
XVIIIc	H	Me	NMe	Colorless needles	92-93	74	Ether	$C_{17}H_{19}N_3O$	72.57	6.81	14.94	72.33	6.73	14.69
XIXa	Ph	H	CH_2	Yellow prisims	130-131	94	Ethanol	$C_{22}H_{20}N_2O$	80.46	6.14	8.53	80.49	6.06	8.54
XIXb	Ph	H	O	Yellow needles	159-160	88	Ethanol	$C_{21}H_{18}N_2O_2$	76.34	5.49	8.43	76.19	5.38	8.46
XIXc	Ph	H	NMe	yellow prisims	151-152	80	Ether	$C_{22}H_{21}N_3O$	76.94	6.16	12.24	76.86	6.05	12.18

Thus, we here elected to reinvestigate the synthesis of furo[2,3-c]isoquinoline derivatives. Furo[2,3-c]isoquinolinones (X) and (XI) were converted with phosphorus oxychloride to 5-chlorofuro[2,3-c]isoquinolines (XVI) and (XVII), followed by condensation of these compounds with several amines to give 5-substituted furo[2,3-c]-isoquinolines (XVIIIa-c) and (XIXa-c). The physical properties of XVIIIa-c and XIXa-c are shown in Table I. Further reduction of the 5-chloro compounds (XVI) and (XVII) with zinc powder in acetic acid caused dechlorination to afford 1-phenyl- (XX) and 2-methylfuro[2,3-c]-isoquinolines (XXI). The pharmacological evaluation of these synthesized compounds is now in progress.

EXPERIMENTAL

Melting points are uncorrected. The ir spectra were measured with a Jasco IRA-1 spectrometer and the nmr spectra were recorded on a JEOL-PS-100 spectrometer using TMS as an internal standard. Mass spectra were taken with a Hitachi RMU-6 spectrophotometer.

5-Methyl-3-phenyl-2-furfural (II).

To a mixture of 15 g (0.2 mole) of dimethylformamide and 31 g. (0.2 mole) of phosphorus oxychloride which was kept 0-5° for 20 minutes was added 31.5 g. (0.2 mole) of 5-methyl-3-phenylfuran (I) in 50 ml. of dimethylformamide under stirring at such a rate that the temperature of reaction mixture did not rise above 20°. After the addition of I, the mixture was kept at 0-5° for 1 hour and then at room temperature for 1 hour. The reaction mixture was poured into 1500 ml. of cracked ice and water, neutralized with 53 g. (0.5 mole) of sodium carbonate and allowed to stand overnight. The resulting product was filtered off and purified by recrystallization from ether to give 31 g. (84%) of II as colorless prisms, m.p. 70-71°; ir ν max (potassium bromide): 2810, 1655 cm^{-1} (CHO); nmr δ (deuteriochloroform): 9.47 (1H, s, CHO), 7.40 (5H, m, phenyl-H), 6.31 (1H, s, C_4-H), 2.43 (3H, s, CH_3).

Anal. Calcd. for $C_{12}H_{10}O_2$: C, 77.40; H, 5.41. Found: C, 77.40; H, 5.26.

5-Methyl-3-phenyl-2-furoic acid (III).

A vigorously stirred suspension of 46 g. (0.2 mole) of freshly prepared silver oxide in 400 ml. of water was treated with 8 g. (0.2 mole) of sodium hydroxide, and then 18.6 g. (0.1 mole) of II was added without a break. The mixture was heated at 90-95° for 1 hour. The precipitates were filtered off and washed with water. The combined filtrates were acidified with concentrated hydrochloric acid and allowed to stand overnight. The resulting product was filtered off and purified by recrystallization from ether to afford 15.5 g. (77%) of III as pale yellow prisms, m.p. 165-166°; ir ν max (potassium bromide): 2850, 1680 cm^{-1} (COOH); nmr δ (deuteriochloroform): 12.27 (1H, br, OH), 7.44 (5H, m, phenyl-H), 6.25 (1H, s, C_4-H), 2.42 (3H, s, CH_3).

Anal. Calcd. for $C_{12}H_{10}O_3$: C, 71.28; H, 4.99. Found: C, 71.27; H, 4.87.

5-Methyl-3-phenyl-2-furoyl Chloride (IV).

A solution of 20 g. (0.1 mole) of III and 20 g. (0.15 mole) of thionyl chloride in 200 ml. of benzene was refluxed under stirring for 2 hours. Evaporation of excess of thionyl chloride and benzene gave brownish crystals, which were purified by recrystallization from petroleum benzin to afford 17 g. (78%) of IV as pale yellow prisms, m.p. 121-122°; ir ν max (potassium bromide): 1735 cm^{-1} (C=O).

Anal. Calcd. for $C_{12}H_9ClO_2$: C, 65.32; H, 4.11. Found: C, 65.36; H, 3.99.

5-Methyl-3-phenyl-2-furoyl azide (VI).

To a solution of 8.8 g. (0.04 mole) of IV in 60 ml. of dioxane was added dropwise 3.9 g. (0.06 mole) of sodium azide in 40 ml. of water. The mixture was stirred for 1 hour at room temperature and poured into 700 ml. of cracked ice and water. The organic layer was separated and the aqueous layer was extracted twice with 200 ml. of ether. The combined organic layer was dried over magnesium sulfate and the ether was removed at 40-45° to give 8 g. (88%) of VI as a reddish brown oil; ir ν max (film): 2130 (N_3), 1675 cm^{-1} (CO).

3,4-Diphenyl-2-furoyl azide (VII).

To a solution of 11.2 g. (0.04 mole) of 3,4-diphenyl-2-furoyl chloride (V) in 80 ml. of dioxane was added dropwise 3.9 g. (0.06 mole) of sodium azide in 40 ml. of water. The mixture was stirred for 1 hour at room temperature and poured into 700 ml. of cracked ice and water. The resulting product was filtered off and purified by recrystallization from ether to give 9.2 g. (80%) of VII as colorless needles, m.p. 104-105°; ir ν max (potassium bromide): 2140 (N_3), 1695 cm^{-1} (CO); nmr δ (deuteriochloroform): 7.70 (1H, s, C_5-H), 7.17 (10H, m, phenyl-H x 2).

Anal. Calcd. for $C_{17}H_{11}N_3O_2$: C, 70.58; H, 3.83; N, 14.53. Found: C, 70.68; H, 3.58; N, 14.51.

5-Methyl-3-phenyl-2-furyl isocyanate (VIII).

A solution of 2.3 g. (0.01 mole) of VI in 20 ml. of benzene was heated for 1 hour under reflux, and the resulting product was characterized to be VIII by ir spectrum.

3,4-Diphenyl-2-furyl isocyanate (IX).

The procedure described for VIII was employed to convert VII to IX, which showed the absorption of an isocyanate group in its ir spectrum.

2-Methylfuro[2,3-*c*]isoquinolin-5(4*H*)one (X).

To a solution of 15 ml. of boiling *o*-dichlorobenzene was added dropwise 2.3 g. (0.01 mole) of VI in 7 ml. of *o*-dichlorobenzene under stirring. The mixture was stirred under reflux for 5 hours. After cooling, the resulting product was filtered off and purified by recrystallization from methanol to give 1.37 g. (69%) of X as colorless needles, m.p. 216-217°; ir ν max (potassium bromide): 2810, 1630 cm^{-1} (NHCO); nmr δ (deuteriochloroform): 13.44 (1H, br, NH), 8.50 (1H, m, C_6-H), 7.49 (3H, m, $C_{7\text{-}9}$-H), 6.48 (1H, s, C_1-H), 2.44 (3H, s, CH_3).

Anal. Calcd. for $C_{12}H_9NO_2$: C, 72.35; H, 4.55; N, 7.03. Found: C, 72.17; H, 4.33; N, 6.93.

1-Phenylfuro[2,3-*c*]isoquinolin-5(4*H*)one (XI).

To a solution of 15 ml. of boiling *o*-dichlorobenzene was added dropwise 2.9 g. (0.01 mole) of VII in 7 ml. of *o*-dichlorobenzene under stirring. The mixture was stirred under reflux for 10 hours, then was cooled. Evaporation of the solvent *in vacuo* gave brownish crystals, which were purified by recrystallization from methanol to give 1.88 g. (72%) of XI as colorless prisms, m.p. 230-232°; ir ν max (potassium bromide): 2810, 1625 cm^{-1} (NHCO); nmr δ (deuteriochloroform): 12.92 (1H, br, NH), 8.59 (1H, m, C_6-H), 7.54 (8H, m, phenyl-H and $C_{7\text{-}9}$-H), 7.34 (1H, s, C_2-H).

Anal. Calcd. for $C_{17}H_{11}NO_2$: C, 78.15; H, 4.24; N, 5.36. Found: C, 78.00; H, 4.10; N, 5.14.

Reaction of X with Sulfuric Acid in Ethanol.

To a solution of 1 g. of concentrated sulfuric acid in 10 ml. of ethanol was added 1 g. (0.005 mole) of X, and the mixture was stirred for 12 hours under reflux. The mixture was poured into 100 ml. of cracked ice and water, and neutralized with sodium carbonate. The resulting product was filtered off and separated in addition of boiling petroleum benzin. The insoluble portion was purified by recrystallization from ethanol to give 0.5 g. (46%) of 4-acetonylhomophthalimide (XII) as colorless plates, m.p. 168-169°; ir ν max (potassium bromide): 3170, 3055, 1720-1670 cm^{-1} (CONHCO and CO); nmr δ (deuteriochloroform): 9.01 (1H, br, NH), 8.23 (1H, m, C_8-H), 7.44 (3H, m, C_{5-7}-H), 4.15 (1H, t, J = 4.6 Hz, C_4-H), 3.47 (2H, d, J = 4.6 Hz, CH_2), 2.16 (3H, s, CH_3); mass (m/e) 217 (M^+).

Anal. Calcd. for $C_{12}H_{11}NO_3$: C, 66.35; H, 5.10; N, 6.45. Found: C, 66.20; H, 5.08; N, 6.33.

After evaporation of petroleum benzin, the residue was purified by column chromatography on silica gel with chloroform to give 0.2 g. (18%) of 2-methyl-5-ethoxyfuro[2,3-*c*]isoquinoline (XIII) as colorless needles, m.p. 65-66°; nmr δ (deuteriochloroform): 8.26 (1H, m, C_6-H), 7.80-7.48 (3H, m, C_{7-9}-H), 6.55 (1H, s, C_1-H), 4.57 and 1.50 (5H, C_2H_5), 2.45 (3H, s, CH_3).

Anal. Calcd. for $C_{14}H_{13}NO_2$: C, 73.99; H, 5.77; N, 6.16. Found: C, 73.73; H, 5.61; N, 6.06.

Reaction of XI with Sulfuric Acid in Ethanol.

To a solution of 1 g. of concentrated sulfuric acid in 10 ml. of ethanol was added 1 g. (3.8 mmoles) of XI, and the mixture was stirred under reflux for 12 hours. The reaction mixture was filtered off and 0.9 g. of XI was unreacted. The filtrate was treated according to the above procedure, and the product gave 20 mg. (2%) of 1-phenyl-5-ethoxyfuro[2,3-*c*]isoquinoline (XIVb) as colorless needles, which was identified by mixed melting point test and ir spectral comparison of XIVb prepared *via* ethylation of XI.

Alkylation of XI.

To a solution of 1 g. (3.8 mmoles) of XI in 10 ml. of dimethylformamide was added portionwise 0.2 g. (4 mmoles) of sodium hydride (50% suspension in mineral oil), washed with petroleum benzin, and the mixture was stirred for half an hour at room temperature. To the cooled solution was slowly added 0.6 g. (4.2 mmoles) of methyl iodide in 1 ml. of dimethylformamide, and then the mixture was stirred at room temperature for 1 hour. The reaction product was poured into 100 ml. of water and extracted with benzene. The organic layer was dried over magnesium sulfate and evaporated to afford amorphous substance, which was purified by column chromatography on silica gel. Elution with benzene gave 50 mg. (5%) of 1-phenyl-5-methoxyfuro[2,3-*c*]isoquinoline (XIVa) as colorless needles, m.p. 93-94°.

Anal. Calcd. for $C_{18}H_{13}NO_2$: C, 78.53; H, 4.76; N, 5.09. Found: C, 78.49; H, 5.00; N, 4.86.

Further the elution of chloroform gave brown crystals, which were purified by recrystallization from methanol to give 0.7 g. (66%) of 1-phenyl-4-methylfuro[2,3-*c*]isoquinolin-5-one (XVa) as colorless needles, m.p. 127-128°; ir ν max (potassium bromide): 1660 cm^{-1}: (CO); nmr δ (deuteriochloroform): 8.32 (1H, m, C_6-H), 7.37 (8H, m, phenyl-H and C_{7-9}-H), 7.16 (1H, s, C_2-H), 3.68 (3H, s, CH_3).

Anal. Calcd. for $C_{18}H_{13}NO_2$: C, 78.53; H, 4.76; N, 5.09. Found: C, 78.65; H, 4.51: N, 4.97.

Similarly, reaction of XI with ethyl iodide afforded 1-phenyl-5-ethoxyfuro[2,3-*c*]isoquinoline (XIVb) and 1-phenyl-4-ethylfuro-[2,3-*c*]isoquinolin-5-one (XVb). Compound XIVb (0.13 g., 12%) was obtained as colorless needles, m.p. 73-74°; nmr δ (deuteriochloroform): 8.31 (1H, m, C_6-H), 7.78 (1H, m, C_9-H), 7.38 (8H, m, other aromatic-H), 4.59, 1.51 (5H, C_2H_5).

Anal. Calcd. for $C_{19}H_{15}NO_2$: C, 78.87; H, 5.23; N, 4.84. Found: C, 78.67; H, 5.30; N, 4.91.

Compound XVb (0.31 g., 28%) was obtained as colorless needles, m.p. 105-106°; ir ν max (potassium bromide): 1665 cm^{-1}: (CO).

Anal. Calcd. for $C_{19}H_{15}NO_2$: C, 78.87; H, 5.23; N, 4.84. Found: C, 78.90; H, 5.21; N, 4.71.

2-Methyl-5-chlorofuro[2,3-*c*]isoquinoline (XVI).

A mixture of 2 g. (0.01 mole) of X and 50 ml. of phosphorus oxychloride in a sealed tube was heated at 180-190° for 10 hours. After cooling, phosphorus oxychloride was evaporated *in vacuo* and poured into 100 ml. of cracked ice and water, neutralized with sodium carbonate and extracted wtih benzene. The extract was washed with water, dried over magnesium sulfate and evaporated to afford an amorphous substance, which was purified by column chromatography on silica gel with benzene to give 1.7 g. (78%) of XVI as colorless needles, m.p. 113-114°; nmr δ (deuteriochloroform): 8.28 (1H, m, C_6-H), 7.90 (1H, m, C_9-H), 7.58 (2H, m, $C_{7,8}$-H), 6.68 (1H, s, C_1-H), 2.52 (3H, s, CH_3).

Anal. Calcd. for $C_{12}H_8ClNO$: C, 66.22; H, 3.71; N, 6.44. Found: C, 66.31; H, 3.80; N, 6.25.

1-Phenyl-5-chlorofuro[2,3-*c*]isoquinoline (XVII).

A mixture of 2 g. (7.7 mmoles) of XI and 50 ml. of phosphorus oxychloride in a sealed tube was heated at 180-190° for 12 hours. After cooling, phosphorus oxychloride was evaporated *in vacuo* and poured into 100 ml. of cracked ice and water, neutralized with sodium carbonate and extracted with benzene. The extract was washed with water, dried over magnesium sulfate and evaporated to give an amorphous substance, which was purified by column chromatography on silica gel with benzene to give 1.6 g. (75%) of XVII as colorless needles, m.p. 81-82°; nmr δ (deuteriochloroform): 8.30 (1H, m, C_6-H), 7.88 (1H, m, C_9-H), 7.57 (1H, s, C_2-H), 7.40 (7H, m, other aromatic-H).

Anal. Calcd. for $C_{17}H_{10}ClNO$: C, 72.99; H, 3.60; N, 5.01. Found: C, 73.10; H, 3.75; N, 4.95.

Preparation of XVIIIa-c and XIXa-c.

A mixture of 1 g. of XVI or XVII in 10 ml. of alicyclic amines was refluxed for 2-4 hours. The mixture was poured into 200 ml. of water and allowed to stand overnight. The resulting product was filtered off and purified by recrystallization, which is shown in Table I.

2-Methylfuro[2,3-*c*]isoquinoline (XX).

A mixture of 1 g. (4.6 mmoles) of XVI and 2 g. of zinc powder in 10 ml. of acetic acid was stirred under reflux for 2 hours. The resulting precipitate was filtered off and washed with acetic acid. The combined filtrate was poured into 100 ml. of water, neutralized with sodium carbonate and extracted with ether. The ethereal extract was washed with water, dried over magnesium sulfate to afford an amorphous compound which was purified by column chromatography on silica gel with benzene to afford 0.3 g. (36%) of XX as colorless needles, m.p. 63-64°; nmr δ (deuteriochloroform): 8.76 (1H, s, C_5-H), 7.94 (2H, m, $C_{6,9}$-H), 7.53 (2H, m, $C_{7,8}$-H), 6.71 (1H, s, C_1-H), 2.52 (3H, s, CH_3).

Anal. Calcd. for $C_{12}H_9NO$: C, 78.67; H, 4.95; N, 7.65. Found: C, 78.77; H, 4.96; N, 7.73.

1-Phenylfuro[2,3-*c*]isoquinoline (XXI).

A mixture of 1 g. (3.6 mmoles) of XVII and 2 g. of zinc powder in 10 ml. of acetic acid was stirred under reflux for 2 hours. The resulting precipitate was filtered off and washed with acetic acid. The combined filtrate was poured into 100 ml. of

water, neutralized with sodium carbonate and extracted with ether. The extract was washed with water, dried over magnesium sulfate and evaporated to afford an amorphous substance, which was purified by column chromatography on silica gel with benzene to give 0.3 g. (34%) of XXI as colorless needles, m.p. 42-43°; nmr δ (deuteriochloroform): 8.90 (1H, s, C_5-H), 7.98 (2H, m, $C_{6,9}$-H), 7.69 (1H, s, C_2-H), 7.52 (7H, m, other aromatic-H).

Anal. Calcd. for $C_{17}H_{11}NO$: C, 83.24; H, 4.52; N, 5.71. Found: C, 83.30; H, 4.49; N, 5.75.

REFERENCES AND NOTES

(1) This constitutes Part XXXIX of a series entitled "Studies on Heterocyclic Compounds, Part XXXVIII", A. Tanaka, K. Yakushijin and S. Yoshina, *J. Heterocyclic Chem.*, submitted.

(2) H. Sliwa, *Bull. Soc. Chim. France*, 646 (1970).

(3) H. R. Snyder, Jr. and F. F. Ebetino, *J. Heterocyclic Chem.*, **3**, 202 (1966).

(4) H. T. Openshaw, "The Alkaloids", P. H. F. Manske, Ed., Vol. 9, Academic Press, New York, N.Y., 1967, Chapter 6.

(5) A. S. Bailey and D. L. Swallow, *J. Chem. Soc.*, 2477 (1956).

(6) F. Eloy and A. Deryckere, *J. Heterocyclic Chem.*, **8**, 57 (1971).

(7) D. Miller, *J. Chem. Soc. (C)*, 12 (1969).

(8) On the nmr spectra of 2-methylfuran compounds, the methyl singlet and the furan C_3-H singlet are broadened by long range coupling to each other.

(9) S. Yoshina and K. Yamamoto, *J. Pharm. Soc. Japan*, **94**, 1312 (1974).