

Mannich Reactions. Synthesis of 4,5-Dihydropyrrolo[1,2-*a*]quinoxalines, 2,3,4,5-Tetrahydro-1*H*-pyrrolo[1,2-*a*][1,4]diazepines and 5,6-Dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepines.

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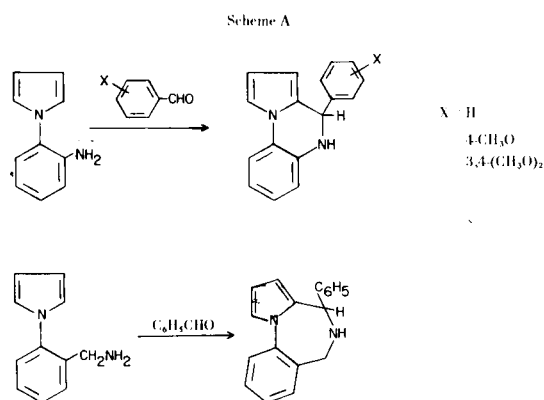
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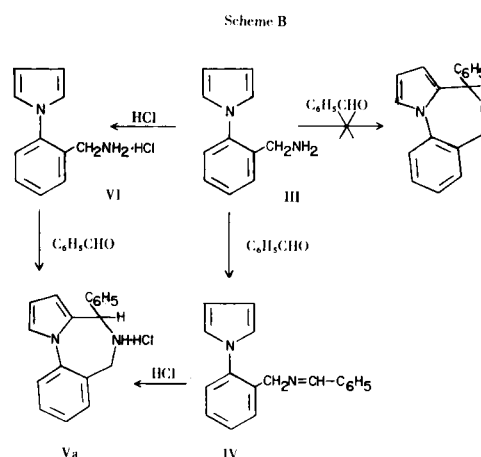
1-(2-Aminophenyl)pyrrole (I) and 1-[2-(aminomethyl)]phenylpyrrole hydrochloride (III) undergo cyclization reactions with aldehydes and ketones to form 4,5-dihydropyrrolo[1,2-*a*]quinoxalines and 5,6-dihydropyrrolo[1,2-*a*][1,4]benzodiazepines, respectively. It was also found that the use of the free base of compounds corresponding to III do not cyclize directly but lead instead to the intermediate Schiff bases which are subsequently cyclized to the desired benzodiazepines by treatment with hydrochloric acid.

J. Heterocyclic Chem., 13, 711 (1976).

Cheeseman and Rafiq (1) have reported a method for preparing 4-substituted-4,5-dihydropyrrolo[1,2-*a*]quinoxalines and 4-phenyl-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine utilizing the Mannich reaction (Scheme A).



We have investigated the Mannich reaction shown in Scheme A. As previously reported (1), 1-(2-aminophenyl)pyrrole (I) when heated with benzaldehyde in ethanol gave 4-phenyl-4,5-dihydropyrrolo[1,2-*a*]quinoxaline (IIa) (Scheme C). However, heating 1-[2-(aminomethyl)phenyl]pyrrole (III) with benzaldehyde in ethanol only gave the Schiff base, *N*-[*o*-(pyrrol-1-yl)-benzyl]benzylideneimine (IV) (Scheme B). Treatment of IV with hydrochloric acid gave the cyclization product, 4-phenyl-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine hydrochloride (Va). The use of 1-[2-(aminomethyl)phenyl]pyrrole hydrochloride (VI) in the place of compound III in the Mannich reaction gave Va directly. Similarly, III yielded *N*-[*o*-

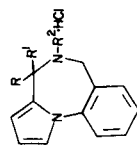


(pyrrol-1-yl)benzyl]-3,4,5-trimethoxybenzylideneimine (VII), when reacted with 3,4,5-trimethoxybenzaldehyde, which in turn was cyclized to 4-(3,4,5-trimethoxyphenyl)-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine hydrochloride (Vm) by treatment with hydrochloric acid. It appears that Cheeseman and Rafiq (1), after forming the Schiff base IV, caused cyclization to Va during conversion to the hydrochloride.

In the case of the 4,5-dihydropyrrolo[1,2-*a*]quinoxalines, while compound I and benzaldehyde (VIII) in refluxing ethanol gave 4-phenyl-4,5-dihydropyrrolo[1,2-*a*]quinoxaline (IIa), no reaction occurred between VIII and 1-(2-aminophenyl)pyrrole hydrochloride (IX) (Scheme C).

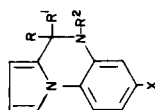
The 2,3,4,5-tetrahydro-1*H*-pyrrolo[1,2-*a*][1,4]diazepine ring system was prepared by a two step procedure from 1-(3-aminopropyl)pyrrole (X) (Scheme D) in a manner

Table I

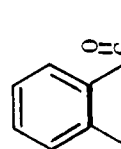


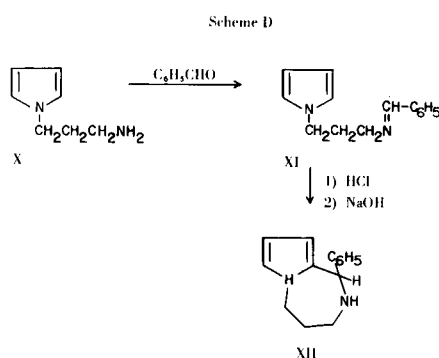
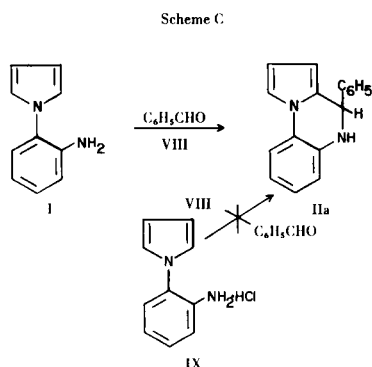
No.	R	R ¹	R ²	Recrystallization Solvent	M.p.	% Yield	% Calcd.				% Found				Molecular Formula
							C	H	N	Cl	C	H	N	Cl	
Va	C ₆ H ₅	H	H	methanol-ether	242-244 dec.	75	72.84	5.77	9.44	11.94	72.91	5.73	9.38	11.56	C ₁₈ H ₁₆ N ₂ ·HCl
Vb	H	H	H	ethanol	268-270 dec.	71	65.31	5.94	12.69	16.06	65.48	5.79	12.58	16.12	C ₁₂ H ₁₂ N ₂ ·HCl
Vc	CH ₃	H	H	methanol-ether	255.5-257.5 dec.	34	66.52	6.44	11.93	15.10	66.52	6.40	11.70	14.95	C ₁₃ H ₁₄ N ₂ ·HCl
Vd	4-CH ₃ C ₆ H ₄	H	H	ethanol- <i>n</i> -hexane	235-239 dec.	60	73.42	6.16	9.01	11.41	73.26	5.95	9.20	11.87	C ₁₉ H ₁₉ N ₂ ·HCl
Ve	4-HOC ₆ H ₄	H	H		253-255 dec.	56	69.12	5.48	8.95	11.33	68.94	5.30	8.73	11.60	C ₁₈ H ₁₆ N ₂ O·HCl
Vf	4-CH ₃ OC ₆ H ₄	H	H	methanol-ether	241-243 dec.	50	69.83	5.86	8.57	10.85	70.05	5.66	8.38	11.20	C ₁₉ H ₁₈ N ₂ O·HCl
Vg		H	H	methanol	225-228 dec.	40	63.46	4.99	9.25	11.71	63.20	4.94	9.26	12.20	C ₁₆ H ₁₄ N ₂ S·HCl
Vh		H	H	ethanol- <i>n</i> -hexane	340-343 dec.	50	68.57	5.42	14.11	11.90	68.85	5.59	14.00	12.25	C ₁₇ H ₁₅ N ₃ ·HCl
Vi	CH ₃	CO ₂ C ₂ H ₅	H	2-propanol	208-210 dec.	73	62.64	6.24	9.13	11.56	62.51	6.25	9.00	11.38	C ₁₆ H ₁₈ N ₂ O ₂ ·HCl
Vj	H	H	CH ₃	<i>s</i> -dichloroethane	212-214	24	66.52	6.44	11.93	15.10	66.83	6.29	12.12	15.56	C ₁₃ H ₁₄ N ₂ ·HCl
Vk	CH ₃	H	CH ₃	ethanol-ether	199-202	56	67.60	6.89	11.26	14.25	67.38	6.78	11.08	14.26	C ₁₄ H ₁₆ N ₂ ·HCl
Vi	C ₆ H ₅	H	CH ₃	ethanol	221-224 dec.	73	73.42	6.16	9.01	11.41	73.76	6.39	8.99	11.77	C ₁₉ H ₁₈ N ₂ ·HCl

Table II



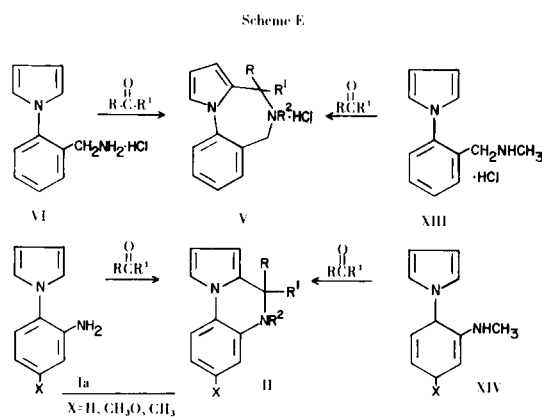
No.	R	R ¹	R ²	X	Recrystallization Solvent	M.p.	% Yield	% Calcd.			% Found			Molecular Formula
								C	H	N	C	H	N	
IIa	C ₆ H ₅	H	H	H	ethanol	95-97	90	82.90	5.73	11.37	82.86	5.74	11.19	C ₁₇ H ₁₄ N ₂
IIb	H	H	H	H	n-hexane	115-117	45	77.62	5.92	16.46	77.49	6.14	16.73	C ₁₁ H ₁₀ N ₂
IIc	CH ₃	H	H	H		106-107/ 0.1mm	95	78.23	6.57	15.21	78.11	6.23	15.39	C ₁₂ H ₁₂ N ₂
II d	C ₂ H ₅	H	H	H		127/0.1mm	79	79.21	7.60	13.20	79.04	7.38	12.80	C ₁₄ H ₁₆ N ₂
IIe	C(CH ₃) ₂ (CH ₂) ₂ CN	H	H	H	ethanol	126-128	31	76.94	7.22	15.84	76.72	7.56	15.61	C ₁₇ H ₁₉ N ₃
II f	2-HOC ₆ H ₄	H	H	H	methanol- water	169-171	51	77.84	5.38	10.68	77.82	5.45	10.37	C ₁₇ H ₁₄ N ₂ O
II g	3-CH ₃ OC ₆ H ₄	H	H	H	ethanol	132-134	66	78.23	5.84	10.14	78.29	5.69	10.04	C ₁₈ H ₁₆ N ₂ O
II h	3,4,5-(CH ₃ O) ₃ C ₆ H ₄	H	H	H	methanol	133-134	58	71.41	5.99	8.33	71.50	6.07	8.18	C ₂₀ H ₂₀ N ₂ O ₃
II i	CH ₃ CO ₂ C ₂ H ₅		H	H		142-145/ 0.1mm	53	70.29	6.29	10.93	70.00	6.09	11.03	C ₁₅ H ₁₆ N ₂ O ₂
II j	— (CH ₂) ₅ —		H	H	ethanol- ether	99-101	65	80.63	7.61	11.76	80.59	7.56	11.58	C ₁₆ H ₁₈ N ₂
II k	— (CH ₂) ₆ —		H	H	ethanol	114-115	32	80.91	7.99	11.10	80.52	7.60	11.40	C ₁₇ H ₂₀ N ₂
III	H			H	DMF	200/dec	98	79.39	4.44	10.29	79.32	4.58	10.03	C ₁₈ H ₁₂ N ₂ O
II m	H	H	CH ₃	H	methanol	65-66	22	78.23	6.57	15.21	78.16	6.71	15.50	C ₁₂ H ₁₂ N ₂
II n	C ₆ H ₅	H	H	CH ₃	ethanol	123-125	75	83.04	6.20	10.76	83.09	6.18	10.87	C ₁₈ H ₁₆ N ₂
II o	C ₆ H ₅	H	H	CH ₃ O	methanol- benzene	138-141	72	78.23	5.84	10.14	78.08	5.81	10.27	C ₁₈ H ₁₆ N ₂ O



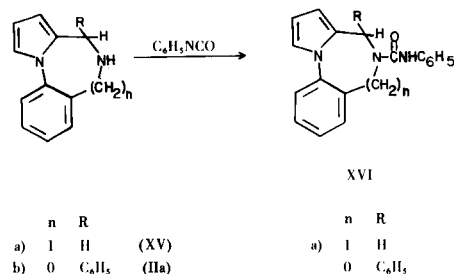


similar to the preparation of 4-phenyl-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine hydrochloride (Va).

The Mannich reaction generally involves a source of acidic protons, an aldehyde and an amine containing at least one NH proton (2). Often, the aldehyde is formaldehyde, although other activated aldehydes have been used with a limited degree of success (2). A number of compounds (Tables I and II) were prepared according to the reactions shown in Scheme E to determine the scope of the cyclization reaction. Unexpectedly, the carbonyl compounds that participated included ketones (Tables I and II), and this provided a method for preparing compounds wherein R and R' are groups other than hydrogen, compounds difficult to synthesize by other methods.



The reaction of 5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine (XV) and IIa with phenyl isocyanate gave the expected *N*-phenylcarbamoyl derivatives, XVIa and XVIb, respectively.



EXPERIMENTAL

1-(2-Cyanophenyl)pyrrole.

To a stirred suspension of 54.3% sodium hydride in mineral oil (88.6 g., 2.0 moles) in DMF (800 ml.), pyrrole (134.1 g., 2.0 moles) dissolved in DMF (200 ml.) was added dropwise under a nitrogen atmosphere. After all was added, the mixture was stirred for 30 minutes at 25° followed by the addition of 2-chlorobenzonitrile (275.1 g., 2.0 moles) dissolved in DMF (600 ml.). The mixture was heated under reflux for 7 hours, after which sodium chloride was filtered off and the solvent removed under reduced pressure. The resulting dark oil was distilled and the product was collected at 96-99° (0.1 mm) in a yield of 50% (169.0 g.). The product solidified on standing at room temperature and was recrystallized from *n*-hexane, m.p. 48-50° [lit. m.p. 47-48° (1)].

Anal. Calcd. for C₁₁H₈N₂: C, 78.55; H, 4.79; N, 16.66. Found: C, 78.22; H, 4.71; N, 16.81.

1-[2-(Aminomethyl)phenyl]pyrrole (III).

A solution of 1-(2-cyanophenyl)pyrrole (168.0 g., 1.0 mole) in anhydrous THF (300 ml.) was added dropwise to a stirred suspension of LAH (37.9 g., 1.0 mole) in THF (1000 ml.) and after the addition was complete, the mixture was heated under reflux for 7 hours with stirring under a nitrogen atmosphere. Upon cooling to room temperature, water (50 ml.) was cautiously added in a dropwise manner followed by the addition of a saturated sodium sulfate solution (50 ml.) and then anhydrous sodium sulfate (200 g.). The mixture was stirred for 30 minutes at room temperature, then heated under reflux for 2 hours, cooled and filtered. The filtrate was dried, concentrated *in vacuo* and distilled at 74-76° (0.1 mm), lit b.p. 125-130/0.2 mm (1) giving a 69% yield (117 g.) of compound III.

1-[2-(Aminomethyl)phenyl]pyrrole Hydrochloride (VI).

Ethereal hydrogen chloride was added to an ethereal solution of compound III and the resulting precipitate was recrystallized from ethanol, m.p. 212-214° dec. [lit. m.p. 226-227° (1)].

Anal. Calcd. for C₁₁H₁₂N₂·HCl: C, 63.31; H, 6.28; N, 13.42. Found: C, 63.29; H, 6.35; N, 13.36.

Methyl [2-(1-Pyrrolyl)benzyl]carbamate.

To a stirred mixture of benzene (20 ml.), compound III (5.1 g., 0.03 mole) and triethylamine (20 ml.), methyl chloroformate (2.8 g., 0.03 mole) in benzene (20 ml.) was added dropwise followed by heating under reflux for 1 hour. Next the reaction mixture

was cooled, washed with 10% aqueous hydrochloric acid, dried and evaporated. The residue which solidified on standing was recrystallized from *n*-hexane containing a few drops of THF (yield 3.0 g., 44%), m.p. 66-68.5°.

Anal. Calcd. for C₁₃H₁₄N₂O₂: C, 67.81; H, 6.13; N, 12.17. Found: C, 67.88; H, 6.08; N, 12.20.

1-[2-(Methylaminomethyl)phenyl]pyrrole Hydrochloride (XIII).

To a stirred mixture of LAH (2.6 g., 0.07 mole) in THF (150 ml.), methyl[2-(1-pyrrolyl)benzyl]carbamate (8.0 g., 0.035 mole) in THF (50 ml.) was added in a dropwise manner over a fifteen minute period. After heating under reflux for 4 hours, the reaction mixture was cooled followed by the addition of water (5 ml.), saturated sodium sulfate solution (5 ml.) and sodium sulfate (25 g.). After filtering and evaporation, the residue was distilled (73-77°/0.5 mm), yield 5.9 g. (50%) of the base.

The base was dissolved in ether and to this ethereal hydrogen chloride was added, and the formed solid XIII filtered (m.p. 156-159°).

Anal. Calcd. for C₁₂H₁₄N₂·HCl: C, 64.72; H, 6.79; N, 12.58. Found: C, 64.44; H, 6.76; N, 12.61.

General Procedure A for the Preparation of 5,6-Dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine Hydrochlorides (V).

A mixture of compounds VI or XIII (0.02 mole), a carbonyl compound (0.02 mole) (3) and methanol (50 ml.) was heated under reflux with stirring for 3 hours. After cooling, the products were precipitated by the addition of ether and filtered (Table I).

Vb: *ir* λ max (nujol): 3.0(w), 3.72(s), 3.90(s), 4.12(m), 6.30(m), 6.71(s), 7.53(m), 8.52(m), 9.21(m), 11.29(m), 13.14(s), 13.55(s), and 13.95(s) μ.

5,6-Dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine (XV).

To compound Vb dissolved in water, 5% aqueous sodium hydroxide was added and the resulting suspension was extracted with benzene, dried, concentrated and distilled giving compound XV, b.p. 112-113°/0.15 mm.

Anal. Calcd. for C₁₂H₁₂N₂: C, 78.23; H, 6.56; N, 15.21. Found: C, 77.70; H, 6.61; N, 15.17.

XV: *nmr* τ (DMSO-*d*₆): 2.52-2.81 (4H), 2.96-3.03 (1H), 3.72-3.92 (2H), 6.30-6.35 (4H) and 7.21-7.29 (1H).

5-Phenylcarbamoyl-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine (XVIa).

To a solution of compound XV (4.6 g., 0.025 mole) in benzene (100 ml.), phenyl isocyanate (3.0 g., 0.025 mole) was added. After heating to reflux for 20 minutes, the mixture was cooled and filtered. The white powder obtained was recrystallized from methanol to give 6.0 g. (80%) of compound XVIa, m.p. 218-220°.

Anal. Calcd. for C₁₉H₁₇N₃O: C, 75.22; H, 5.65; N, 13.85. Found: C, 75.38; H, 5.70; N, 13.81.

N-[*o*-(pyrrol-1-yl)benzyl]benzylideneimine (IV).

A mixture of compound III (8.6 g., 0.05 mole), benzaldehyde (5.3 g., 0.05 mole) and ethanol (100 ml.) was heated under reflux with stirring for 4 hours. After cooling, the solvent was removed and the residue dissolved in benzene and passed through a silica gel column. The first eluate after removal of solvent gave pure IV (9.8 g., 75% yield) as a thick oil, *ir* (film): 6.10 ν (CH=N).

Anal. Calcd. for C₁₈H₁₆N₂: C, 83.04; H, 6.20; N, 10.76. Found: C, 83.10; H, 6.43; N, 10.89.

4-Phenyl-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine Hydrochloride (Va).

To an ethereal solution of compound IV (5.2 g., 0.02 mole), ethereal hydrogen chloride was added. The precipitate was recrystallized from methanol-ether, m.p. 241-244°; the yield was 3.0 g. (50%). The product was shown to be identical to Va prepared by general procedure A (*ir*, mixed m.p.).

N-[*o*-(Pyrrol-1-yl)benzyl]-3,4,5-trimethoxybenzylideneimine (VII).

A mixture of compound III (8.6 g., 0.05 mole), 3,4,5-trimethoxybenzaldehyde (9.8 g., 0.05 mole) and ethanol (100 ml.) was heated under reflux with stirring for 3 hours. After cooling, the solvent was removed, the residue was dissolved in benzene and passed through a silica gel column, yielding 8.8 g. (50%) of pure VII, *ir* (film): 6.01 μ (CH=N).

Anal. Calcd. for C₂₁H₂₂N₂O₃: C, 71.98; H, 6.33; N, 8.00. Found: C, 72.10; H, 6.39; N, 7.85.

4-(3,4,5-Trimethoxyphenyl)-5,6-dihydro-4*H*-pyrrolo[1,2-*a*][1,4]benzodiazepine Hydrochloride (Vm).

To an ethereal solution (300 ml.) of compound VII (10.5 g., 0.03 mole), ethereal hydrogen chloride was added and a gum separated. The supernatant liquid was decanted and the gum dissolved in hot methanol which was treated with charcoal and filtered. After the addition of ether, crystals slowly formed (9.3 g., 80%), m.p. 234-238° dec.

Anal. Calcd. for C₂₁H₂₂N₂O₃·HCl: C, 65.20; H, 5.99; N, 7.24; Cl, 9.16. Found: C, 65.09; H, 5.86; N, 7.47; Cl, 8.96.

N-(3-Aminopropyl)pyrrole (X).

To a cooled stirred suspension of LAH (3.8 g., 0.1 mole) in anhydrous ether (200 ml.), *N*-(2-cyanoethyl)pyrrole (12 g., 0.1 mole) dissolved in anhydrous ether (20 ml.) was added dropwise. After the addition was complete, water (4 ml.), 20% sodium hydroxide (3 ml.), and water (14 ml.) were added successively. The ethereal solution was decanted from the insoluble material. After drying the solvent was removed, the resulting yellow oil was distilled, and the product collected at 99-101° (0.45 mm) in a yield of 6.4 g. (52%).

N-[3-(Pyrrol-1-yl)propyl]benzylideneimine (XI).

A mixture of compound X (6.2 g., 0.05 mole), benzaldehyde (5.2 g., 0.05 mole) and ethanol (100 ml.) was heated under reflux for 3 hours with stirring. After removal of the solvent, the resulting brown oil was distilled and the product was collected at 98-101° (0.03 mm) in a yield of 6.3 g. (59%).

Anal. Calcd. for C₁₄H₁₆N₂: C, 79.21; H, 7.60; N, 13.20. Found: C, 79.06; H, 7.76; N, 13.38.

1-Phenyl-2,3,4,5-tetrahydro-1*H*-pyrrolo[1,2-*a*][1,4]diazepine (XII).

To a solution of compound XI (4.2 g., 0.02 mole) in anhydrous ether (50 ml.), ethereal hydrogen chloride was added slowly with constant agitation. A solid formed which was filtered, dissolved in water (50 ml.), made basic with 5% aqueous sodium hydroxide and extracted with benzene. The benzene layer was dried, concentrated and the resulting residue distilled. Compound XII was collected at 107-111° (0.01 mm) in a yield of 3.1 g. (81%) which solidified on standing, m.p. 57-59°.

1-(2-Nitro-4-methoxyphenyl)pyrrole and 1-(2-Nitro-4-methylphenyl)pyrrole.

A mixture of nitroaniline (1 mole), diethoxytetrahydrofuran (1 mole) and acetic acid (300 ml.) was refluxed with stirring for 1 hour (4). In the case of 1-(2-nitro-2-methoxyphenyl)pyrrole, steam distillation removed the acetic acid and the product that

remained behind solidified on cooling, was recrystallized from *n*-hexane and taken directly to the next step.

1-(2-Amino-4-methoxyphenyl)pyrrole and 1-(2-Amino-4-methylphenyl)pyrrole.

1-(2-Nitro-4-methoxyphenyl)pyrrole (1 mole) was dissolved in ethanol (150 ml.), while 1-(2-nitro-4-methylphenyl)pyrrole was only partially dissolved in acetic acid (150 ml.). Each was hydrogenated using 10% palladium/carbon as a catalyst and 40 PSI until uptake was complete. After filtration and evaporation, 1-(2-amino-4-methoxyphenyl)pyrrole solidified on standing and was recrystallized from *n*-hexane in a yield of 61% (m.p. 41-43°).

Anal. Calcd. for $C_{11}H_{12}N_2$: C, 70.18; H, 6.43; N, 14.88. Found: C, 69.91; H, 6.53; N, 14.95.

In the case of compound 1-(2-amino-4-methylphenyl)pyrrole, after filtration and evaporation, the solid residue was recrystallized from ethanol followed by recrystallization from *n*-hexane, giving a 10% yield (m.p. 87.5-90°).

Anal. Calcd. for $C_{11}H_{12}N_2$: C, 76.71; H, 7.01; N, 16.23. Found: C, 76.52; H, 6.98; N, 16.32.

1-(2-Methylaminophenyl)pyrrole (XIV).

To a suspension of LAH (8.4 g., 0.22 mole) in anhydrous THF (300 ml.), ethyl [2-(1-pyrrolylphenyl)]carbamate (4) (25.3 g., 0.11 mole) in THF (200 ml.) was added, dropwise. The mixture was stirred for one half hour at room temperature and heated under reflux for 6 hours. After cooling, water (3.6 ml.) was added, followed by a saturated solution (25 ml.) of sodium sulfate and anhydrous sodium sulfate (15 g.) and additional THF (150 ml.). The mixture was filtered and the filtrate was evaporated to give an oil (12.2 g., 64%) which was distilled at 74-76° (0.3 mm).

Anal. Calcd. for $C_{11}H_{12}N_2$: C, 76.71; H, 7.02; N, 16.27. Found: C, 76.56; H, 6.79; N, 16.18.

To an ethereal solution of a sample of compound XIV, ethereal hydrogen chloride was added. The precipitate was removed and recrystallized from chloroform-ether (m.p. 158-161°).

Anal. Calcd. for $C_{11}H_{13}ClN_2$: C, 63.31; H, 6.28; N, 13.42. Found: C, 63.86; H, 5.95; N, 13.41.

General Procedure for the Preparation of 4,5-Dihydropyrrolo-[1,2-*a*]quinoxaline Compounds (II).

A mixture of compounds Ia or XIV (4) (0.02 mole), the

carbonyl compound (0.02 mole) (3) and ethanol (5) (50 ml.) was heated under reflux with stirring for 5 hours. On cooling, most solid products crystallized out of solution, the remaining solid products solidified after removal of the solvent. The liquid products were distilled after removal of the ethanol (Table II). In the case of compound III, the carbonyl compound employed was 2-carboxybenzaldehyde and only the lactamized product was isolated.

IIc: *ir* λ max (film): 3.05(m), 3.41(m), 3.62(m), 6.22(s), 6.67(s), 6.80(s), 6.95(m), 7.09(s), 7.31(s), 7.51(s), 7.79(s), 8.00(m), 8.59(s), 8.95(m), 9.20(m), 9.84(m), 10.25(m), 11.29(m), 12.81(m), 13.50(s), 13.95(s), and 14.40(s) μ .

IIb: *nmr* τ (deuteriochloroform): 2.50-2.94 (2H), 2.94-3.41 (3H), 3.60-3.81 (1H), 5.60 (2H), 6.35-6.88 (1H).

IIj: τ *nmr* (deuteriochloroform): 2.60-2.98 (2H), 2.98-3.42 (3H), 3.61-3.81 (1H), 3.92-4.09 (1H), 5.65-5.92 (1H), and 8.00-8.63 (10H).

5-Phenylcarbamoyl-4-phenyl-4,5-dihydro-pyrrolo[1,2-*a*]quinoxaline (XVIIb).

To a solution of the compound IIa (2.5 g., 0.01 mole) in benzene (50 ml.), phenyl isocyanate (1.8 g., 0.015 mole) in benzene (10 ml.) was added slowly and heated under reflux for 3 hours. After removal of the benzene, the residue was solidified by triturating with *n*-hexane, yield 3.0 g. (82%), m.p. 144-147°.

Anal. Calcd. for $C_{24}H_{19}N_3O$: C, 78.88; H, 5.24; N, 11.50. Found: C, 78.97; H, 5.50; N, 11.76.

REFERENCES AND NOTES

- (1) G. W. H. Cheeseman and M. Rafiq, *J. Chem. Soc. (C)*, 2732 (1971).
- (2) F. F. Blicke, *Org. Reactions*, 1, 303 (1942); B. Reichert, "Die Mannich-Reaction," Springer-Verlag, Berlin, 1959; H. Hellman and G. Opitz, "α-Aminoalkylierung," Verlag Chemie, Gmbh, Weinheim/Bergotr., 1960.
- (3) In the case of formaldehyde, a 37% aqueous formaldehyde solution was used, and where a low boiling carbonyl compound was employed, an excess of 10-20% of carbonyl compound was utilized.
- (4) G. W. H. Cheeseman and B. Tuck, *J. Chem. Soc. (C)*, 852 (1966).
- (5) In the case of IIk, methoxyethanol was used.