Reactivity of 4-Hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline Towards Base-catalyzed Cyclization, Mannich and Turpin Reactions

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Mannich reaction upon 4-hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**1**) as well as its nitration were studied. Condensation of the chloroquinoline **6b** with sodium azide, benzylamine and ethanolamine gave the quinoline derivatives **6c**, **6f** and **6g**, respectively. Phenylhydrazine and sodium borohydride effected reduction of the azidoquinoline **6c** to the corresponding amino- and hydroxyamino derivatives **6d** and **6e**, respectively. Also, Turpin's reaction gave the benzoquinobenzoxazines **7a-d** when applied to **6b**. Treatment of **6f**, **6g** with alkali and the condensation of **6b** with glycine in alcoholic sodium carbonate solution afforded the imidazo[4,5-*c*]quinoline derivatives **9a-c**, respectively.

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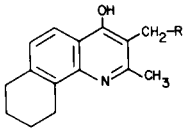
Since most of the benzoquinoline derivatives possess chemotherapeutic activities and find wide applications in the chemotherapeutic field, many of these derivatives are insoluble in water, so this difficulty could be overcome by introducing a basic side chain in the molecule, which through salt formation would enable water solubility and hence its absorption in the body.

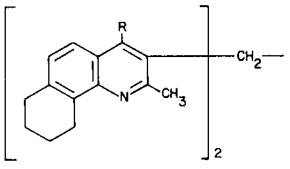
In the present work, 4-hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**1**) was allowed to undergo a Mannich reaction with ethylamine and/or diethylamine to give 3-ethylaminomethyl-4-hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**2a**) and the 3-diethylaminomethyl derivative **2b**, respectively.



2a, R = -NHC$_2$H$_5$
b, R = -N(C$_2$H$_5$)$_2$

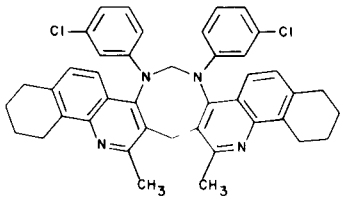
Isolation of these compounds in good yield affords promise for the synthesis of a number of compounds of chemical interest and possible therapeutic importance. The Mannich grouping was found to be situated at the 3-position of the pyridine ring.

Upon treatment of **2a** with phosphorus oxychloride, 3,3'-methylenebis[4-chloro-7,8,9,10-tetrahydro-2-methylbenzo[*h*]quinoline] (**3a**) was obtained. Consistent with these results is the reported self-condensation of phenolic Mannich bases to form bis(hydroxaryl)methanes (1,2). When compound **3a** was allowed to condense with *m*-chloroaniline in acidic medium, 3,3'-methylenebis[4-(*m*-chloroanilino)-7,8,9,10-tetrahydro-2-methylbenzo[*h*]-quinoline] (**3b**) was obtained. Introduction of the m-chloroaniline moiety was based upon the well known influence of chloroaryl moiety in the 2-(chlorophenyl)-quinolines. Heating **3b** with paraformaldehyde in alcohol afforded, 16,18-bis(*m*-chlorophenyl)-1,2,3,4,7,10,11,12,-



3a, R = Cl
b, R = -NH-C$_6$H$_4$-Cl-*m*

13,16,17,18-dodecahydro-6,8-dimethyl-1*H*-dibenzo[*h*,*h*]-[1,3]diazocino[5,4-*c*:7,8-*c*']diquinoline (**4**).



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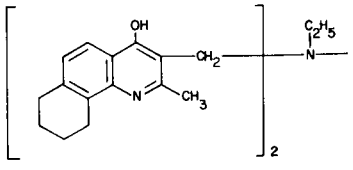
When compound **2a** was refluxed in alcohol, *N*-ethyl-bis[4-hydroxy-2-methyl-3-(7,8,9,10-tetrahydrobenzo[*h*]-quinolylmethyl]amine derivative **5** was precipitated in good yield.



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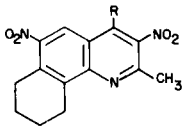
The formation of **5** may be rationalized through the formation of methylene quinone intermediate by elimination of one mole of ethylamine from **2a**, followed by condensation with another mole of **2a** to give **5**. These dimers **3a**, **3b**, **4** and **5** are analogues to cyanine dyes which have therapeutical values as good antiseptic for *Bacillus Coli*, antifilarial, anthelmentic and antimalarial agents (3).

Biochemistry and pharmacology of compounds possessing nitro groups include some of the most interesting

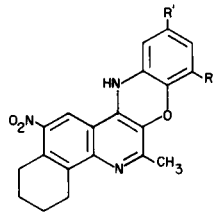
areas of current research (4). The nitro group participate to varying extents in the chemical reactions involving highly important biochemical and physiological responses. For this compound **1** was nitrated with nitric-sulphuric acid mixture to give 3,6-dinitro-4-hydroxy-2-methyl-7,8,-9,10-tetrahydrobenzo[*h*]quinoline (**6a**). Also, the dinitro compound **6a** was obtained through nitration of **5** with nitric-sulphuric acid mixture. Treatment of **6a** with phosphorus oxychloride gave, 3,6-dinitro-4-chloro-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**6b**). The chlorine atom was extremely active due to the adjacent nitro group. The reactivity of this atom facilitated



6a, R = OH
b, R = Cl
c, R = N_3
d, R = $-NH_2$
e, R = -NHOH
f, R = $-NH-CH_2-C_6H_5$
g, R = $-NH-CH_2-CH_2-OH$

condensation with amines, under alkaline or anhydrous neutral conditions. The presence of small amounts of hydrochloric acid rapidly catalyses the hydrolysis to the corresponding hydroxy compound. Besides, **6b** reacts with sodium azide in dimethylformamide to furnish the 4-azido derivative **6c**. The ir spectrum showed a peak at 2130 cm^{-1} which is characteristic of the azido group. Condensation of **6c** with phenylhydrazine gave the 4-amino derivative **6d**, which is not the expected product since an azido group adjacent to a nitro group in the benzene ring usually gives the triazole derivative (5,6). The ir spectrum of **6d** showed two bands due to the $-NH_2$ stretching frequency shifted from 3500-3400 at 3310 and 3405 cm^{-1}. This shift is attributed to the possibility that a six-membered chelate of high stability was formed, through strong N-H . . . O hydrogen bonding (7,8). Reduction of **6c** using sodium borohydride gave, the hydroxylamino derivative **6e**. Condensation of **6b** with benzylamine and ethanolamine in dry benzene gave, 4-benzylamino-3,6-dinitro-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**6f**) and 3,6-dinitro-4-(2′-hydroxyethylamino)-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**6g**), respectively.

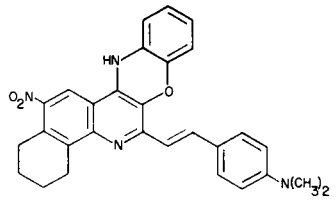
Further, in order to obtain the desired benzoquinobenzoxazines **7a-d**, Turpin's reaction was applied to **6b** (9). Moreover, a new procedure for Turpin's reaction was developed where the sodium salt of the intermediate diphenylamine was isolated and heated in dimethylsulphoxide or in dimethylformamide, resulting in cyclization to phenoxazine in good yield (10). Thus the reaction of **6b** with *o*-aminophenol, 2-amino-4-chlorophenol, 2-amino-4-hydroxymethylphenol and/or 2-amino-4-chloro-6-diethylaminomethylphenol in presence of sodium carbonate led to the formation of **7a-d**, respectively. Their structures were established from the analytical data, ir and nmr spectra.



7a, R = H; R′ = H
b, R = H; R′ = Cl
c, R = H; R′ = $-CH_2OH$
d, R = $-CH_2N(C_2H_5)_2$; R′ = Cl

Compounds **7a-d** gave the hydrochloride salts when boiled with 15% hydrochloric acid. These salts were easily hydrolyzed to the corresponding base when gently warmed in water.

It has been reported that in the field of antimalarials the 2-methyl group in quinoline compounds has a dystherapeutic effect (11) and that conversion of biologically inactive 4-amino-2-methylquinolines re-established antimalarial properties (12). For this, compound **7a** was treated with *p-N,N*-dimethylaminobenzaldehyde in presence of fused zinc chloride to give the corresponding 2-styryl compound, 6-[*p*-(dimethylamino)styryl]2,3,4,12-tetrahydro-14-nitro-1*H*-benzo[7,8]quino[3,4-*b*][1,4]-benzoxazine (**8**).



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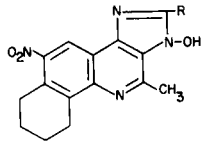
Ring closure of **6f** and **6g** was affected by the action of ethanolic sodium hydroxide solution to give, 6,7,8,9-tetrahydro-1-hydroxyl-11-methyl-5-nitro-2-phenyl-1*H*-benzo[*h*]imidazo[4,5-*c*]quinoline (**9a**) and 6,7,8,9-tetrahydro-1-hydroxy-11-methyl-5-amino-1*H*-benz[*h*]imidazo-[4,5-*c*]quinoline-2-methanol (**9b**), respectively. Also, condensation of **6b** with glycine in alcoholic sodium carbonate solution gave, 6,7,8,9-tetrahydro-1-hydroxyl-11-methyl-5-nitro-1*H*-benz[*h*]imidazo[4,5-*c*]quinoline-2-carboxylic acid (**9c**), its ir spectrum showed band at 3250 cm^{-1} (-OH stretching) which may be due to association with the neighbouring carboxylic group.



9a, R = $-C_6H_5$
b, R = CH_2OH
c, R = COOH

EXPERIMENTAL (13)

All melting points were uncorrected and were taken in a Gallenkamp electric melting point apparatus and Boëtius melting point microscope. The ir spectra were performed on a Carl-Zeiss Jena Infrared Spectrophotometer model "UR 10" using potassium bromide. Nmr spectra were obtained in deuteriochloroform or deuteriotrifluoroacetic acid solutions with a Varian Associates model "A-60" Spectrometer. Elemental analysis were performed by the microanalytical Laboratory, National Research Centre, Cairo, Egypt.

3-Ethylaminomethyl-4-hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**2a**).

A mixture of 5 g. (0.023 mole) of **1**, 0.75 g. (0.02 mole) of paraformaldehyde and 5 ml. of ethylamine in 40 ml. of absolute alcohol was stirred at room temperature for 15 minutes. The mixture was gently heated for one hour and then refluxed with stirring. The reaction mixture became a clear solution after 3 hours. This was allowed to cool and then filtered. The filtrate was poured into water and kept cooled overnight. The white product **2a** when dried, weighed 5 g. (80% yield). Recrystallization from dilute alcohol afforded white needles m.p. >350°; ir ν max: 3250 (NH stretching), 1620 (-NH bending) and 1570 cm^{-1} (C=N).

Anal. Calcd. for $C_{17}H_{22}N_2O$: C, 75.5; H, 8.2; N, 10.4. Found: C, 75.8; H, 8.0; N, 10.0.

3-Diethylaminomethyl-4-hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**2b**).

A mixture of 0.35 g. (0.012 mole) of paraformaldehyde, 4 ml. (0.05 mole) of diethylamine and 25 ml. of ethyl alcohol was refluxed until the paraformaldehyde dissolved. To this solution was added 3.3 g. (0.015 mole) of **1** and the mixture was allowed to reflux for 8 hours. The reaction mixture was concentrated and cooled to give 3.8 g. (88% yield) of **2b**, m.p. >350° dec., (from ethanol); nmr (deuteriochloroform): τ 1.98 (aromatic protons, 2H); τ 6.13 (N-CH_2 protons); τ 8.92 (ethoxy CH_3 protons, 6H, triplet); τ 6.80-7.68 (ethoxy CH_2 together with CH_3 and CH_2 at C_7 and C_{10}, 11H, complex pattern) and τ 8.14 (CH_2 at C_8 and C_9, quintet).

Anal. Calcd. for $C_{19}H_{26}N_2O$: C, 76.5; H, 8.7; N, 9.4. Found: C, 76.9; H, 9.0; N, 9.7.

3,3'-Methylene-bis[4-chloro-7,8,9,10-tetrahydro-2-methylbenzo-[*h*]quinoline] (**3a**).

A mixture of 5 g. (0.018 mole) of **2a** and excess of freshly distilled phosphorus oxychloride was heated on a water bath for 3 hours. The excess phosphorus oxychloride was distilled from the reaction mixture, which became intensively red coloured. It was kept cool while being diluted with water and basified with sodium hydroxide solution. Upon good cooling, a viscous precipitate formed. The precipitate was filtered off and dried to give 4 g. (88% yield) of **3a**. After recrystallization from aqueous alcohol it gave an analytical sample, m.p. 37-38°; nmr (deuteriochloroform): τ 2.7-3.0 (aromatic protons, 4H); τ 2.18 (CH_2 group, doublet); τ 7.38 (2 CH_3, 6H, singlet); τ 8.17 (CH_2 at C_8 and C_9, 8H, quintet) and τ 6.74 and τ 7.16 (CH_2 at C_7 and C_{10}, 8H, triplet).

Anal. Calcd. for $C_{29}H_{28}Cl_2N_2$: C. 73.2; H, 5.9; N, 5.9; Cl, 15.0. Found: C, 73.7; H, 5.3; N, 5.6; Cl, 14.5.

3,3'-Methylene-bis[4-(*m*-chloroanilino)-7,8,9,10-tetrahydro-2-methylbenzo[*h*]quinoline] (**3b**).

A mixture of 1.4 g. (0.003 mole) of **3a** and 0.37 g. (0.003 mole) of 3-chloroaniline was dissolved in 15 ml. of absolute ethyl alcohol. The mixture was acidified with concentrated hydrochloric acid and then was refluxed for 10 hours. The reaction mixture after concentration was treated with aqueous sodium hydroxide solution and cooled. The precipitated free base was collected and dried to give 1.5 g. (78% yield) of **3b**. Recrystallization from alcohol showed m.p. 265-267°; ir ν max: 3340 (-NH stretching), 1590 (NH bending) and 685 cm^{-1} (Ar-Cl).

Anal. Calcd. for $C_{41}H_{38}Cl_2N_4$: C, 74.9; H, 5.8; N, 8.5; Cl, 10.8. Found: C, 75.0; H, 6.1; N, 8.3; Cl, 10.7.

16-18-Bis(*m*-chlorophenyl)-1,2,3,4,7,10,11,12,13,16,17,18-ondecahydro-6,8-dimethyldibenzo[*h,h'*][1,3]diazocino[5,4-*c*:7,8-*c'*]diquinoline (**4**).

A mixture of 0.5 g. (0.0007 mole) of **3b** and 0.026 g. (0.0007 mole) of paraformaldehyde in 10 ml. of absolute alcohol was refluxed for 4 hours. The reaction mixture was concentrated and cooled to give 0.4 g. (80% yield) of **4**. Recrystallization from alcohol gave white crystals, m.p. 156-157°.

Anal. Calcd. for $C_{42}H_{38}Cl_2N_4$: C, 75.3; H, 5.8; H, 8.4; Cl, 10.6. Found: C, 75.7; H, 6.1; N, 8.0; Cl, 10.2.

N-Ethyl-bis[4-hydroxy-2-methyl-3-(7,8,9,10-tetrahydrobenzo[*h*])-quinolylmethyl]amine (**5**).

A solution of 1 g. (0.0037 mole) of **2a** in 10 ml. of absolute alcohol was heated under reflux for 5 hours, to give 0.6 g. (67% yield) of **5** as a white precipitate. It was insoluble in most organic solvents, but easily soluble in acidified alcohol. The analytical sample was obtained by recrystallization from dimethylformamide, m.p. >350°; ir ν max: 3320 (-CH), 3210 (-NH stretching) and 110 cm^{-1} (tertiary amine).

Anal. Calcd. for $C_{32}H_{37}N_2O_3$: C, 77.5; H, 7.6; N, 8.5. Found: C, 77.0; H, 7.2; N, 8.0.

3,6-Dinitro-4-hydroxy-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]-quinoline (**6a**).

Method A.

To 10 ml. of concentrated sulphuric acid was added 5 g. (0.02 mole) of **1**. The mixture was cooled to 0° and nitrated, dropwise, with a nitrating mixtures of nitric acid (5 ml., d 1.5) and concentrated sulphuric acid (12 ml.). The mixture was allowed to stand overnight at room temperature, it was then poured over ice-water and the crude dinitro product precipitated. This product was filtered and washed thoroughly with cold water. After drying, it gave 5 g. (67% yield) of **6a**. Upon recrystallization from acetone it gave yellow crystals m.p. 233-235°; ir ν max: 3300 (-OH stretching) and 1350 cm^{-1} (C-NO_2).

Anal. Calcd. for $C_{14}H_{13}N_3O_5$: C, 55.5; H, 4.3; N, 13.9. Found: C, 55.9; H, 4.5; N, 14.2.

Method B.

A mixture of 2 g. (0.004 mole) of the dimer **5** in 2 ml. of concentrated sulphuric acid was cooled then nitrated with a mixture of 1 ml. of nitric acid and 2 ml. of concentrated sulphuric acid. The reaction mixture was kept at room temperature for 24 hours, and when poured into crushed ice a yellow precipitate was formed. The precipitate was washed several times with water and then with alcohol. Recrystallization from acetone gave 0.7 g. (60% yield) of faint yellow needles of **6a**, m.p. 234-236°. Both products from A and B gave no depression in the mixed melting point.

3,6-Dinitro-4-chloro-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]-quinoline (**6b**).

A mixture of 1 g. (0.003 mole) of **6a** and 5 g. of phosphorus oxychloride was refluxed until solution was complete (*ca.* 6 hours). The excess phosphorus oxychloride was distilled off and the

reaction mixture was kept cool while being diluted with water. Neutralization with ammonium hydroxide solution gave a yellow precipitate, which was filtered and washed several times with water. Recrystallization from acetone gave 0.8 g. (80% yield) ob **6b** as yellow needles m.p. 160-162°; ir ν max: 650 (C-Cl), 1360 (C-NO_2) and 1580 (C=N).

Anal. Calcd. for $C_{14}H_{12}ClN_3O_4$: C, 52.3; H, 3.8; N, 13.1; Cl, 11.0. Found: C, 52.4; H, 3.7; N, 13.1; Cl, 11.2.

4-Azido-3,6-dinitro-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]-quinoline (**6a**).

A mixture of 1 g. (0.003 mole) of **6b**, 0.2 g. (0.003 mole) of sodium azide and 7 ml. of dimethylsulphoxide was shaken for 1 hour. The reaction mixture was poured onto cold water, filtered, washed several times with water and dried. Recrystallization from alcohol gave 0.8 g. (80% yield) of **6c** as white needles m.p. 115-116°.

Anal. Calcd for $C_{14}H_{12}N_6O_4$: C, 51.2; H, 3.7; N, 25.6. Found: C, 50.8; H, 4.0; N, 26.0.

4-Amino-3,6-dinitro-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]-quinoline (**6d**).

A mixture of 1 g. (0.003 mole) of **6c** and 1.6 ml. (0.01 mole) phenylhydrazine in 25 ml. of absolute ethanol was refluxed for 10 hours. The reaction mixture was cooled and the precipitate formed filtered, m.p. 260-263°. Recrystallization from ethanol gave 0.5 g. (58% yield) of **6d** as deep yellow crystals m.p. 270-272°.

Anal. Calcd. for $C_{14}H_{14}N_4O_4$: C, 55.6; H, 4.6; N, 18.8. Found: C, 56.0; H, 4.5; N, 18.5.

4-Hydroxylamino-3,6-dinitro-2-methyl-7:8,9,10-tetrahydrobenzo-[*h*]quinoline (**6e**).

To a solution of 1 g. (0.003 mole) of **6c** in 10 ml. of ethanol was added 0.26 g. (0.005 mole) of sodium borohydride portion-wise with continuous stirring for 1 hour. The solid that separated upon concentrating the mixture was filtered, washed several times with water and dried. Recrystallization from ethanol gave 0.7 g. (78% yield) of **6e** as pale brown crystals m.p. 75-78°: ir ν max: (-OH stretching), 3210 (-NH stretching) and 1590 cm^{-1} (-NH bending).

Anal. Calcd. for $C_{14}H_{14}N_4O_5$: C, 52.8; H, 4.4; N, 17.6. Found: C, 53.0; H, 4.6; N, 17.2.

Substituted-2,3,4-12-tetrahydro-6-methyl-14-nitro-1*H*-benzo[7,8]-quino[3,4-*b*][1,4]benzoxazine (**7a-d**).

General Procedure.

Equal molecular porportions of the aminophenols or their hydrochlorides and **6b** were dissolved separately in boiling alcohol, when the solutions had cooled slightly, they were mixed and two (or three if the hydrochloride had been used) molecular proportions of sodium hydroxide in dilute alcohol were gradually but rapidly added while stirring constantly. The liquid became almost pasty from the separation of brown crystals. The precipitate was filtered immediately, washed with water, then with alcohol. The solid obtained was crystallized from chloroform (about 50% yield), (Table 1).

The nmr of compound **7d** (deuteriochloroform) showed signals at τ 6.23 (CH_2-N protons, doublet); τ 7.44 and τ 8.96 (two C_2H_5 groups, quartet-triplet pattern); τ 7.22 (CH_3, 3H, sharp singlet); τ 8.17 (CH_2 at C_2 and C_3, quintet); τ 6.7 and τ 7.0 (CH_2 at C_1 and C_4, two triplets) and τ 2.65-3.3 (aromatic protons, 3H, multiplet).

6-[*p*-(Dimethylamino)styryl]-2,3,4,12-tetrahydro-14-nitro-1*H*-benzo[7,8]quino[3,4-*b*][1,4]benzoxazone (**8**).

A mixture of 0.5 g. (0.001 mole) of **7a**, 0.44 g. (0.002 mole) of *p*-*N*,*N*-dimethylaminobenzaldehyde and 0.22 g. of fused zinc chloride in 0.6 ml. of acetic anhydride was refluxed for 6 hours. The reaction mixture was cooled and triturated with water, the precipitate which formed was filtered and washed with water, then with alcohol. Recrystallizaiton from a chloroform-ethanol mixture gave 0.4 g. (66% yield) of **8**, m.p. 248-250°.

Anal. Calcd. for $C_{29}H_{26}N_4O_3$: C, 72.8; H, 5.5; N, 11.7. Found: C, 73.2; H, 5.7; N, 11.2.

4-Benzylamino-3,6-dinitro-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]-quinoline (**6f**).

A mixture of 2 g. (0.006 mole) **6b** and 1.6 ml. (0.012 mole) of benzylamine was gently refluxed in 20 ml. of dry benzene for 2 hours. The reaction mixture was filtered from the precipitated benzylamine hydrochloride. The filtrate was then concentrated, an orange precipitate was obtained. Recrystallization from cyclohexane gave 1.9 g. (79% yield) of **6f** as orange needles m.p. 178-189°: ir ν max: 3420 (-NH stretching) and 1590 cm^{-1}

Table 1

Substituted-2,3,4,12-tetrahydro-6-methyl-14-nitro-1*H*-benzo[7,8]quino[3,4-*b*][1,4]benzoxazine (**7a-d**)

Compound	M.p. (°C)	Formula	Analysis %	Calcd.	Found
7a	216	$C_{20}H_{17}N_3O_3$	C	69.2	69.5
			H	4.9	4.7
			N	12.1	11.9
7b	218	$C_{20}H_{16}ClN_3O_3$ (a)	C	62.9	63.2
			H	4.2	4.4
			N	11.0	10.9
7c	205	$C_{21}H_{19}N_3O_4$	C	66.8	67.1
			H	5.1	5.4
			N	11.1	11.0
7d	184	$C_{25}H_{27}ClN_4O_3$ (b)	C	64.3	64.7
			H	5.8	5.5
			N	12.0	12.1

(a) Cl: Calcd. 9.3. Found: 9.5. (b) Cl: Calcd. 7.6. Found: 7.8.

(-NH bending); nmr (deuteriochloroform): τ 7.3 (CH_3 group, 3H, singlet); τ 5.3 (N-CH_2, doublet); τ 8.19 (CH_2 at C_8 and C_9, quintet); τ 7.05 and τ 6.75 (CH_2 at C_7 and C_{10}, triplet) and τ 2.72 (6H, aromatic).

Anal. Calcd. for $C_{21}H_{20}N_4O_4$: C, 64.3; H, 5.1; N, 14.3. Found: C, 64.1; H, 5.3; N, 14.6.

6,7,8,9-Tetrahydro-1-hydroxy-11-methyl-5-nitro-2-phenyl-1*H*-benz[*h*]imidazo[4,5-*c*]quinoline (**9a**).

A mixture of 0.5 g. (0.001 mole) of **6f** and 10 ml. of 5% alcoholic sodium hydroxide was refluxed for 3 hours. The reaction mixture after concentration was cooled, and neutralized with dilute hydrochloric acid until *p*H 7. The faint brown precipitate formed was filtered, washed with water and dried m.p. 233-236°. Recrystallization from ethanol gave 0.3 g. (65% yield) of **9a** m.p. 240-242° as yellow crystals; ir ν max: 3010 (-OH stretching), 1620 (-C=N) and 1460 cm^{-1} (-NO_2).

Anal. Calcd. for $C_{21}H_{19}N_4O_3$: C, 67.2; H, 5.1; N, 14.9. Found: C, 67.7; H, 5.4; N, 14.5.

3,6-Dinitro-4-(2'-hydroxyethylamine)-2-methyl-7,8,9,10-tetrahydrobenzo[*h*]quinoline (**6g**).

To a solution of 0.5 g. (0.001 mole) of **6b** in 10 ml. of dry benzene was added 0.25 ml. (0.002 mole) of ethanolamine. The mixture was gently warmed on a water bath for 2 hours. The benzene layer was gently separated and concentrated to give 0.36 g (66% yield) as yellow crystals of **6g**. The product was recrystallized from ethanol, m.p. 206-208°; ir ν max: 3360 (-OH stretching), 3340 (-NH stretching), 1590 (-NH bending) and 1280 cm^{-1} (-CH_2OH).

Anal. Calcd. for $C_{16}H_{18}N_4O_5$: C, 55.5; H, 5.2; N, 16.2. Found: C, 56.0; H, 5.4; N, 15.8.

6,7,8,9-Tetrahydro-1-hydroxy-11-methyl-5-nitro-1*H*-benz[*h*]-imidazo[4,5-*c*]quinoline-2-methanol (**9b**).

A mixture of 0.32 g. (0.0009 mole) of **6g** and 10 ml. of 5% alcoholic sodium hydroxide was refluxed on a water bath for 2 hours. The reaction mixture after concentration was cooled, and neutralized with dilute hydrochloric acid to *p*H 7. The precipitate formed was filtered and dried. Recrystallized from ethanol gave 0.2 g. (66% yield) of **9b**, m.p. 263-265°; ir ν max: 2950 (-OH stretching) and 1260 cm^{-1} (-CH_2OH).

Anal. Calcd. for $C_{16}H_{16}N_4O_4$: C, 58.5; H, 4.9; N, 17.1. Found: C, 59.0; H, 5.0; N, 17.6.

6,7,8,9-Tetrahydro-1-hydroxy-11-methyl-5-nitro-1*H*-benz[*h*]-imidazo[4,5-*c*]quinoline-2-carboxylic Acid (**9c**).

A mixture of 0.8 g. (0.002 mole) of **6b**, 0.4 g. (0.005 mole) of glycine and 0.7 g. of potassium carbonate in 10 ml. of ethanol was refluxed with stirring for 6 hours. The reaction mixture was cooled, poured onto cold water, neutralized with dilute hydrochloric acid until *p*H 7, then filtered, washed several times with water and dried. Recrystallization from chloroform-methanol mixture gave 0.5 g. (60% yield) of **9c** as faint brown crystals, m.p. 233-235° dec.; ir ν max: 3250 (-OH stretching) and 1590 cm^{-1} (C=N).

Anal. Calcd. for $C_{16}H_{14}N_4O_5$: C, 56.1; H, 4.1; N, 16.4. Found: C, 56.0; H, 4.4; N, 16.8.

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(13) The nomenclature of the compound described in this paper follows the rules of the American Chemical Society and the Chemical Abstracts.