BROMINATION OF QUINOLINE DERIVATIVES WITH N-BROMOSUCCINIMIDE. ISOMERIC COMPOSITION OF THE BROMINATION PRODUCTS BY PMR AND GLC

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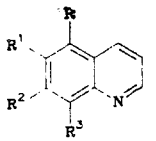
The bromination of quinoline and substituted quinolines with N-bromosuccinimide in concentrated H_2SO_4 takes place exclusively in the homocyclic part. Bromo-substituted quinolines can be obtained by this method. The bromination products were identified by PMR spectroscopy. The differences among the mono-, di-, and trisubstituted (in the benzene ring) compounds were established on the basis of the type of spectrum of the protons of the homocyclic part of the molecule. The compositions of the reaction mixtures were studied by GLC.

Relatively little study has been devoted to the preparation of bromo-substituted compounds of the quinoline series by direct bromination of the homocyclic ring [1]. The bromination of quinoline and substituted quinolines with molecular bromine can be carried out in the presence of aluminum chloride [2, 3] or silver sulfate in sulfuric acid [4]; bromine was introduced into the 5 position of 8-methylquinoline by the latter method [5]. Unidentified products that probably contain bromine in the benzene ring were obtained in the bromination of 6-methylquinoline [6]. The bromination of other methylquinolines in the homocyclic ring has not been described.

For the synthesis of quinolines that are substituted in the carbocyclic part of the molecule we studied the bromination of quinoline and some methyl- and nitro-substituted derivatives with N-bromosuccinimide (NBS) in concentrated sulfuric acid. The use of NBS in an acidic medium is an effective method of aromatic bromination [7]. In the quinoline series the use of NBS has thus far been limited to the bromination of 8-hydroxy- and 8-methoxyquinolines, which are readily brominated simply by bromine and without a catalyst [8]. The bromination of slightly activated and deactivated derivatives and quinoline itself by means of NBS has not been described.



I-XX

I $R=R^1=R^2=R^3=H$; II $R=R^2=R^3=H$, $R^1=CH_3$; III $R=R^1=R^3=H$, $R^2=CH_3$; IV $R=R^1=R^2=H$, $R^3=CH_3$; V $R=R^2=R^3=H$, $R^1=NO_2$; VI $R=NO_2$, $R^1=R^2=H$, $R^3=CH_3$; VII $R=R^1=H$, $R^2=Cl$, $R^3=CH_3$; VIII $R=Br$, $R^1=R^2=R^3=H$; IX $R=R^1=R^2=H$, $R^3=Br$; X $R=R^3=Br$, $R^1=R^2=H$; XI $R=Br$, $R^1=CH_3$, $R^2=R^3=H$; XII $R=R^3=Br$, $R^1=CH_3$, $R^2=H$; XIII $R=R^1=H$, $R^2=CH_3$, $R^3=Br$; XIV $R=R^3=Br$, $R^1=H$, $R^2=CH_3$; XV $R=Br$, $R^1=R^2=H$, $R^3=CH_3$; XVI $R=R^2=Br$, $R^1=H$, $R^3=CH_3$; XVII $R=R^2=H$, $R^1=NO_2$, $R^3=Br$; XVIII $R=NO_2$, $R^1=H$, $R^2=Br$, $R^3=CH_3$; XIX $R=Br$, $R^1=H$, $R^2=Cl$, $R^3=CH_3$, XX $R=CH_3$, $R^1=R^3=Br$, $R^2=H$

We studied the bromination of quinoline (I), 6-, 7-, and 8-methylquinoline (II-IV), 6-nitroquinoline (V), 5-nitro-8-methylquinoline (VI), and 7-chloro-8-methylquinoline (VII) with NBS. Bromo-substituted VIII-XX, which contain bromine exclusively in the homocyclic ring, are obtained as a result of the bromination of quinolines I-VII. Depending on the amount of NBS, primarily the corresponding mono- or dibromo-substituted compounds are formed in the bromination of quinoline and methylquinolines II-IV. The compositions of the reaction

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TABLE 1. Results of Bromination of Quinolines I, II, and IV with an Equimolar Amount of N-Bromosuccinimide in 93% Sulfuric Acid

Compound brominated	Reaction temp., °C	Compositions of the reaction mixtures: monobromo-substituted compounds: compound	yield,* %	retention time, min	amt. in the mixture,** %	dibromo-substituted compounds: compound	yield,* %	retention time, min	amt. in the mixture,** %	unchanged quinoline: retention time, min	amt. in the mixture,** %	unidentified products: amt. in the mixture,** %	Molar ratio of the mono- and dibromo-substituted compounds**
I	20	VIII	44	0,95	33	X	8	3,21	7	0,34	39	2	10,4 : 1
		IX	25	1,44	19								
I	60	VIII	35	0,95	38	X	17	3,21	27	0,34	4	7	3,2 : 1
		IX	22	1,44	24								
II	20	XI	74	1,66	68	XII	11	4,47	15	0,63	6	11	6,2 : 1
	60		71		68		10		13		3	16	7,1 : 1
IV	20	XV	58	1,07	62	XVI	8	2,84	11	0,4	8	19	7,8 : 1
	60		53		52		11		14		15	19	5,0 : 1

*The yields of bromo-substituted VIII-XII, XV, and XVI are based on the unchanged starting quinolines.
**According to GLC data.

mixtures were studied by means of GLC and TLC, and the individual compounds were isolated by crystallization or distillation in vacuo and in some cases by preparative TLC.

The bromination of quinoline itself with 1 mole of NBS at 20°C leads to a mixture of 5- and 8-bromoquinoline (VIII and IX) and 5,8-dibromoquinoline (X) in a ratio of 6.6:3.8:1 (Table 1) as in the bromination of quinoline in the presence of silver sulfate [7]; the amount of the 5,8-dibromo-substituted compound in the mixture increases with an increase in the reaction temperature to 60°C, and VIII:IX:X = 2:1.2:1.

Since the orienting effects of the quinoline ring and methyl group in 6- and 8-methylquinoline (II and IV) coincide, monobromination takes place in the 5 position and leads to the formation of 5-bromo-6-methylquinoline (XI) and 5-bromo-8-methylquinoline (XV) in 74% and 58% yields, respectively. In addition to the latter, 5,8-dibromo-6-methylquinoline (XII) and 5,7-dibromo-8-methylquinoline (XVI), which are formed in the further bromination of quinolines XI and XV, were also detected in the reaction mixture. The formation of 5,7-dibromo-8-methylquinoline (XVI) from 5-bromo-8-methylquinoline (XV) constitutes evidence for the known activation of the 7 position of quinoline under the influence of a methyl group, which is usually hindered in electrophilic substitution [1]. The bromination of crude 7-methylquinoline containing 25% 5-methylquinoline with NBS (2 moles) leads chiefly to 5,8-dibromo-7-methylquinoline (XIV), in addition to 6,8-dibromo-5-methylquinoline (XX). Monobromination of the same 7-methylquinoline gives a mixture of products that could not be identified unequivocally. The reductive debromination of dibromoquinoline XIV with hydrazine hydrate was used to obtain 7-methylquinoline without the admixed 5-methyl isomer. 8-Bromo-7-methylquinoline (XIII) was obtained in 64% yield with a small amount of admixed 5,8-dibromo-7-methylquinoline (XIV) in the bromination of pure 7-methylquinoline. 8-Bromo-7-methylquinoline (XIII) has been previously described as a crystalline substance [9]; however, the product of monobromination of 7-methylquinoline was an uncrystallized oil but, with respect to its PMR spectrum, was completely identical to the 8-bromo-7-methylquinoline obtained by alternative synthesis from 8-nitro-7-methylquinoline [10].

The bromination of nitro-substituted quinolines V and VI could be realized only in 100% sulfuric acid at 60°C; bromonitroquinolines XVII (51%) and XVIII (69%) were formed. The activating effect of the methyl group is also retained for 5-nitro-8-methylquinoline (VI), which is brominated in the 7 position.

The bromination of 7-chloro-8-methylquinoline (VII) proceeds smoothly and leads to 5-bromo-7-chloro-8-methylquinoline (XIX) in 93% yield.

TABLE 2. Chemical Shifts of the Protons of Quinolines I-VI and VIII-XVIII in $CDCl_3$

Compound	Chemical shift (δ, ppm)							
	2-H	3-H	4-H	5-H	6-H	7-H	8-H	CH_3
I	8,77	7,05	7,79	7,78	7,46	7,73	8,13	—
Monosubstituted quinolines								
II	8,74	7,14	7,82	7,51	—	7,50	8,00	2,36
III	8,76	7,11	7,88	7,50	7,18	—	7,83	2,40
IV	9,05	7,43	8,18	7,61	7,37	7,53	—	2,88
V*	9,11	7,72	8,70	9,04	—	8,43	8,21	—
VIII	8,90	7,44	8,48	—	7,77	7,51	8,06	—
IX	9,04	7,44	8,15	7,78	7,38	8,04	—	—
Disubstituted quinolines								
VI	8,80—8,94	7,60	8,80—8,94	—	8,27	7,61	—	2,87
X	9,03	7,54	8,57	—	7,88**	7,65**	—	—
XI	8,80	7,36	8,48	—	—	7,49	7,92	2,55
XIII	9,00	7,37	8,09	7,64**	7,40**	—	—	2,66
XV	8,99	7,52	8,55	—	7,74	7,45	—	2,76
XVII*	9,20	7,82	8,75	9,07**	—	8,72**	—	—
XVII	9,20	7,64	8,38	8,80**	—	8,75	—	—
Trisubstituted quinolines								
XII	8,98	7,51	8,60	—	—	7,96	—	2,60
XIV	9,02	7,49	8,50	—	7,74	—	—	2,66
XVI	8,03	7,49	8,48	—	7,98	—	—	2,87
XVIII	8,93	7,50	8,48	—	8,25	—	—	2,83
XX	9,02	7,50	8,35	—	—	8,21	—	2,68

*In d_6-DMSO.
**Within the limits of the line the assignment may be inverted.

Thus, in our opinion, the bromination of quinolines with NBS in sulfuric acid may find application as a simple and quite effective method for the synthesis of various bromo-substituted quinolines that are often difficult to obtain.

The structures of the individual bromo-substituted and starting compounds were established by PMR spectroscopy taking into account the data previously obtained for quinoline and a number of its derivatives [11-15].

It is apparent from the data in Tables 2 and 3 that the bromination of I-IV does not involve the heterocyclic part. The spectra of the protons of this fragment in all cases pertain to the spectra of three-spin systems of the AA'X type for VI, of the ABX type for VIII, and of virtually the AMX type for all of the remaining compounds. Signals of a two-spin system that would be observed for products of substitution in the 2, 3, and 4 positions are also absent in the PMR spectra of the bromination reaction mixtures. We have previously noted [16] marked deshielding of the 4-H proton under the influence of the γ effect of substituents in the 5 position, which leads in a number of cases to an AA'X spectrum because of overlapping of the 2-H and 4-H resonance signals.

The PMR spectra of the monosubstituted homocyclic part are spectra of a three-spin system that are characterized by one $^3J_{(H,H)}$ constant (8.2-9.2 Hz) in the case of 6- and 7-substituted quinolines II, III, and V, whereas they are characterized by two $^3J_{(H,H)}$ constants (6.8-7.5 and 8.2-8.4 Hz) in the case of 5- and 8-substituted quinolines IV, VIII, and IX (Table 3).

The protons of the disubstituted homocyclic part give an AX or AB spectrum with a $^4J_{(H,H)}$ constant for XVII (2.4 Hz) with 6-nitro and 8-bromo substituents, which are meta-oriented relative to one another, and a $^3J_{(H,H)}$ constant (7.6-8.5 Hz) in the case of compounds with para or ortho substituents (VI, X, XI, XIII, XV). The $^3J_{(H,H)}$ values, which are smaller (7.7-8.1 Hz) for p-substituted quinolines than for o-substituted quinolines (8.4-8.5 Hz), make it possible to distinguish p- and o-substituted quinolines.

The spectra of the trisubstituted homocyclic part of XII, XIV, XVI, XVIII, and XX are singlets with a relative integral intensity corresponding to one proton.

TABLE 3. Spin–Spin Coupling Constants of the Protons of Quinolines I-VI and VIII-XVIII ($^nJ_{(H,H)}$, Hz)

Compound	$^3J_{(2,3)}$	$^4J_{(2,4)}$	$^3J_{(3,4)}$	$^3J_{(5,6)}$	$^4J_{(5,7)}$	$^3J_{(6,7)}$	$^4J_{(6,8)}$	$^3J_{(7,8)}$	$^5J_{(4,8)}$
I	4,2	1,8	8,2	8,2	1,4	7,0	1,1	8,5	0,9
Monosubstituted quinolines									
II	4,2	1,8	8,2	—	1,9	—	—	9,1	0,9
III	4,2	1,8	8,2	8,2	—	—	1,8	—	0,8
IV*	4,2	1,8	8,2	8,2	2,0	6,8	—	—	—
V	4,2	1,8	8,2	—	2,5	—	—	9,2	0,8
VIII	4,2	1,8	8,5	—	—	7,5	1,2	8,4	0,9
IX	4,2	1,8	8,2	8,2	1,4	7,4	—	—	—
Disubstituted quinolines									
VI*	—**	—**	—**	—	—	7,8	—	—	—
X	4,2	1,7	8,5	—	—	8,1	—	—	—
XI	4,2	1,7	8,5	—	—	—	—	8,5	0,9
XIII	4,2	1,7	8,2	8,4	—	—	—	—	—
XV*	4,2	1,8	8,5	—	—	7,6	—	—	—
XVII	4,2	1,7	8,2	—	2,4	—	—	—	—
Trisubstituted quinolines									
XII	4,2	1,6	8,5	—	—	—	—	—	—
XIV	4,2	1,6	8,5	—	—	—	—	—	—
XVI	4,2	1,7	8,5	—	—	—	—	—	—
XVIII	4,2	1,7	8,5	—	—	—	—	—	—
XX	4,2	1,6	8,5	—	—	—	—	—	—

*$^4J_{(7\text{-H},CH_3)}$ = 0.9 Hz.
**The spectrum of these protons is of the AA^1X type.

EXPERIMENTAL

Pure-grade quinoline from the Kharkov Coal-Tar Chemical Plant and pure-grade 6-, 7-, and 8-methylquinoline from the Riga "Reagent" Plant were used in the research.

The PMR spectra were recorded with a Tesla BS-567 spectrometer (100 MHz) (Czechoslovakian SSR) without accumulation. The spectrum of IV was obtained with a Bruker-250 spectrometer. Except for stipulated cases, the solvent was $CDCl_3$, and the internal standard was tetramethylsilane.

The compositions of the bromination products were studied with a Perkin-Elmer Sigma-1 chromatograph with a stainless-steel column with a length of 2 m and a diameter of 2 mm packed with OV-17 on chromosorb W; the carrier gas was nitrogen, the gas-flow rate was 30 ml/min, the column temperature was 230°C, and the detector was a flame-ionization device. The melting points (uncorrected) were determined on a Boetius heating stage (East Germany); with the exception of XV and XVIII, the substances were recrystallized from alcohol. The course of the reactions and the purity of the compounds obtained were monitored on Silufol UV-254 plates. Preparative TLC was carried out on LS 5/40 silica gel in benzene–ethyl acetate–acetic acid (100:50:1) (A) or (200:50:1) (B); except for the stipulated cases, the R_f values are presented for system A.

Bromination of Quinolines with NBS. A mixture of 10 mmole of quinoline (I) or 6-, 7-, or 8-methylquinoline (II-IV) with 10 mmole of NBS in 20 ml of 93% H_2SO_4 was maintained for 3 h at 20°C or 60°C, after which the reaction mixture was poured into 200 ml of water, the aqueous mixture was made alkaline to pH 10 with 45% potassium hydroxide solution, and the precipitate was extracted with chloroform (four 50-ml portions). The extract was dried with magnesium sulfate, the solvent was evaporated, and the resulting mixture of reaction products and unchanged starting compounds was investigated by GLC. Identification by GLC was accomplished by the addition of the known compound to the mixture to be analyzed.

Synthesis of Individual Bromo-Substituted Compounds. 5- and 8-Bromoquinoline (VIII, IX) and 5,8-Dibromoquinoline (X). The reaction of 1.29 g of quinoline (I) and 1.78 g (10 mmole) of NBS in 20 ml of 93% sulfuric acid at 20°C by the method described above gave 1.5 g of a mixture of bromination products. Chromatography in system A gave 0.5 g (44%) of 5-bromoquinoline [mp 47-48°C (mp 48°C [4]), R_f 0.42] and 0.27 g (25%) of 8-bromoquinoline [oil, picrate mp 167-168°C [4] mp 168°C, R_f 0.66], as well as 0.11 g (8%) of dibromoquinoline X [mp 127-128°C (mp 128°C [4]), R_f 0.81].

5-Bromo-6-methylquinoline (XI). A 26.7-g (0.15 mole) sample of NBS was added to a solution of 21.4 g (0.15 mole) of 6-methylquinoline in 120 ml of 93% sulfuric acid, and the mixture was maintained for 3 h at 20°C. It was then poured into 900 ml of ice water, and the aqueous mixture was made alkaline to pH 10 with 45% KOH solution. The precipitated salts were removed by filtration and extracted with chloroform (four 100-ml portions). The extract was dried with magnesium sulfate, the solvent was evaporated, and the product (34 g) was distilled in vacuo to give 24 g (73%) of bromoquinoline XI with Rf 0.43, mp 48.5-49°C, and bp 126-130°C (3 mm). Found: Br 36.1; N 6.4%. $C_{10}H_8BrN$. Calculated: Br 36.1; N 6.3%.

5-Bromo-8-methylquinoline (XV). This compound was obtained from 21.45 g (0.15 mole) of 8-methylquinoline (IV) by a procedure similar to that used to prepare bromoquinoline XI. Workup gave 19 g (58%) of a product with Rf 0.62 and mp 38-39°C (from a mixture of methanol with ether) (mp 37-38°C [1]).

5,8-Dibromo-6-methylquinoline (XII). A 2.86-g (0.02 mole) sample of 6-methylquinoline was stirred for 3 h at 60°C with 7.12 g (0.04 mole) of NBS in 50 ml of 93% sulfuric acid, after which the mixture was cooled and poured into 400 ml of ice water. The precipitate was separated and dissolved in chloroform (four 30-ml portions) to give 1.48 g of quinoline XII. The acidic solution was made alkaline to pH 10 to give another 3.34 g of quinoline XII for an overall yield of 4.82 g (81%). The product had Rf 0.86 and mp 119-120°C. Found: Br 53.2; N 4.8%. $C_{10}H_7Br_2N$. Calculated: Br 53.7; N 4.7%.

5,7-Dibromo-8-methylquinoline (XVI). This compound was obtained from 2.86 g (0.02 mole) of 8-methylquinoline by a procedure similar to that used to prepare quinoline XII. Workup gave 1.36 g (23%) of a product with Rf 0.9 and mp 102-103°C. Found: Br 53.4; N 4.8%. $C_{10}H_7Br_2N$. Calculated: Br 53.1; N 4.7%.

5,8-Dibromo-7-methylquinoline (XIV) and 6,8-Dibromo-5-methylquinoline (XX). The starting 7-methylquinoline (III) was distilled twice in vacuo [bp 89-91.5°C (1 mm)] and, according to PMR spectroscopic data, contained 25% 5-methylquinoline (determined from the ratio of the CH_3 signals). A 120-g (0.67 mole) sample of NBS was added with stirring in the course of 0.5 h (with an increase in the temperature to 65°C) to a solution of 48.0 g (0.335 mole) of 7-methylquinoline in 270 ml of 93% sulfuric acid; after 4 h, another 10 g of NBS was added, and the mixture was maintained for 24 h at 20°C. It was then poured into 2.2 liters of cold water, the Br_2 was removed by means of sodium pyrosulfite, and 11.8 g of dibromide XIV was separated. The filtrate was diluted with an equal volume of water, the precipitated dibromide XIV (38.4 g) was separated, the mother liquor was neutralized partially with 200 g of sodium hydroxide, and 28.4 g of a mixture of dibromides XIV and XX (5:1 according to PMR data) was removed by filtration. Another 100 g of NaOH was added (pH 1.5), and the precipitated dibromide XX (4.8 g) was separated. The overall yield of dibromoquinoline XIV was 72.9 g (96% based on 7-methylquinoline). The substance was homogeneous in system A and had Rf 0.76 and mp 115-116°C. Found: Br 53.2; N 4.7%. $C_{10}H_7Br_2N$. Calculated: Br 53.1; N 4.7%. The yield of XX was 10.5 g (42% based on 5-methylquinoline), and it had Rf 0.67 and mp 152-154°C. Found: Br 53.2; N 4.8%. $C_{10}H_7Br_2N$. Calculated: Br 53.1; N 4.7%.

7-Methylquinoline (III). A mixture of 7.0 g (23.2 mmole) of dibromoquinoline XIV, 20 ml (0.5 mole) of hydrazine hydrate, 50 ml of dioxane, and Raney nickel (from 7 g of Raney alloy) was stirred for 21 h at 60°C, after which the catalyst was removed by filtration. The filtrate was evaporated, and the concentrate was diluted with 200 ml of water and extracted with chloroform (two 100-ml portions). The extract was dried with magnesium sulfate and evaporated, and the crude reaction product (3.5 g) was sublimed in vacuo (3 mm) to give 1.8 g of 7-methylquinoline containing traces of 8-bromo-7-methylquinoline. For final purification this product was chromatographed in system B to give 1.2 g (36%) of quinoline III with mp 24-25°C (mp 39°C [1]); the picrate decomposed at 170-173°C (mp 235-237°C [1]). This product was individual according to the PMR spectrum (see Tables 2 and 3).

8-Bromo-7-methylquinoline (XIII). The reaction of 143 mg (1 mmole) of individual 7-methylquinoline and 178 mg (1 mmole) of NBS at 20°C by the general method gave 170 mg of a mixture of bromination products, from which 140 mg (64%) of bromoquinoline XIII was obtained in the form of an oil with Rf 0.51 by chromatography in system B. Found: Br 36.1; N 6.3%. $C_{10}H_8BrN$. Calculated: Br 36.0; N 6.3%. According to its PMR spectrum, the substance was identical to the 8-bromo-7-methylquinoline obtained from 8-amino-7-methylquinoline. Also isolated was 20 mg (6.7%) of dibromoquinoline XIV with Rf 0.76. Reaction with NBS at 60°C gave 170 mg of a mixture of bromination products, from which 130 mg (58%) of monosubstituted XIII and 30 mg (10%) of dibromoquinoline XIV were isolated by chromatography in system B.

8-Nitro-7-methylquinoline (XXI). This compound was obtained by the method in [10] in 76% yield (based on 7-methylquinoline) and had mp 188-189°C (from ethyl acetate) (mp 185-186°C [10]).

8-Amino-7-methylquinoline (XXII). A 3.4-g (18.1 mmole) sample of nitro compound XXI was hydrogenated with 0.2 g of Pd black in 500 ml of methanol at 20°C and atmospheric pressure. The catalyst was removed by filtration, the filtrate was evaporated, and amine XXII was extracted with hexane. Workup gave 1.1 g (39%) of a product with mp 34-35°C (mp 38-62°C [17]). PMR spectrum: 8.6 (2-H, dd), 7.2 (3-H, dd), 7.9 (4-H, dd), 6.9 (7.1) (5-H, d), 7.1 (6.9) (6-H, d), 2.28 (CH_3, s).

8-Bromo-7-methylquinoline (XIII). A solution of 0.55 g (3.5 mmole) of amine XXII in 2 ml of concentrated H_2SO_4 was diazotized with nitrosylsulfuric acid (from 0.28 g of $NaNO_2$ and 2 ml of H_2SO_4), after which the solution of the diazonium compound was added to 1.44 g (10 mmole) of CuBr in 5 ml of 40% HBr at 20°C, and the mixture was allowed to stand overnight. It was then made alkaline and extracted with ether. Evaporation of the ether extract gave 0.55 g of an oil, which was extracted with hexane. The extract was evaporated, and the residue was sublimed in vacuo (2 mm); the sublimed substance was chromatographed in system B to give oily product XIII (mp 97.5°C [9]). According to the PMR spectrum, the product was individual (see Tables 2 and 3).

6-Nitro-8-bromoquinoline (XVII). A 1.64-g (0.01 mole) sample of nitroquinoline V was stirred for 6 h at 60°C with 3.58 g (0.02 mole) of NBS in 20 ml of 100% sulfuric acid, after which the mixture was cooled and poured into 200 ml of ice water. The aqueous mixture was made alkaline to pH 10 and extracted with chloroform (five 100-ml portions) to give 1.24 g (51%) of quinoline XVII with Rf 0.48 and mp 164°C (mp 164°C [1]).

5-Nitro-7-bromo-8-methylquinoline (XVIII). A 1.75-g (0.01 mole) sample of 5-nitro-8-methylquinoline (VI) was stirred for 6 h at 60°C with 1.78 g (0.01 mole) of NBS in 93% sulfuric acid, after which the mixture was worked up as described above to give 1.77 g (69%) of XVIII with Rf 0.81 and mp 128-129°C (from n-propyl alcohol). Found: Br 29.9 g; N 10.3%. $C_{10}H_7BrN_2O_2$. Calculated: Br 29.9; N 10.5%.

5-Bromo-7-chloro-8-methylquinoline (XIX). A 1.76-g (0.01 mole) sample of 7-chloro-8-methylquinoline (VII) was stirred for 3 h at 20°C with 1.78 g (0.01 mole) of NBS, after which the mixture was worked up as in the preceding experiments to give 2.4 g (93%) of quinoline XIX with Rf 0.43 and mp 104-105°C. Found: Br 45.1; N 5.3%. $C_{10}H_7BrClN$. Calculated: Br 45.0; N 5.5%.

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