on a violet tint on standing). The product was soluble in chloroform and acetone and hot benzene and isooctane, but insoluble in petroleum ether and diethyl ether. Found: C 74.5; H 5.2; N 14.4%. $C_{18}H_{15}N_3O$. Calculated: C 74.7; H 5.2; N 14.5%. The yield of IIIa was much lower under the conditions of benzoylation of 2-phenyl derivative **Ib**, and the reaction was accompanied by the formation of side products.

B) A 0.25-ml sample of dry triethylamine was added to a solution of 0.39 g (1 mmole) of hydrobromide VIIIa in 5 ml of DMF, and the mixture was refluxed for 5 h. It was then cooled, and 10 ml of water was gradually added to it. The resulting precipitate was removed by filtration and purified successively by chromatography and recrystallization from benzene to give 0.14 g (48%) of a product that was identical to the compound isolated via method A.

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RESEARCH ON IMIDAZO[1,2-a]BENZIMIDAZOLE DERIVATIVES

XIII.* SYNTHESIS AND PROPERTIES OF ALCOHOLS OF THE IMIDAZO[1,2-a]BENZIMIDAZOLE SERIES

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UDC 547.785.5.07

Various hydroxy derivatives of imidazo[1,2-a]benzimidazole were synthesized from its 3-bromo, 3-formyl, and 3-acetyl derivatives. The properties and pharmacological activity of the products were studied.

It is well known [2-5] that carbinols in the benzimidazole series display a rather broad spectrum of physiological activity; thus they have antivirus, hypotensive, and local anesthetic properties. The hydroxy-benzyl grouping is primarily responsible, for example,

*See [1] for communication XII.

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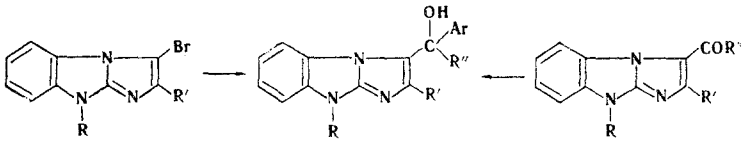
Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 1, pp. 126-134, January, 1976. Original article submitted May 21, 1975.

for the selective inhibiting action of 2-α-hydroxybenzylbenzimidazoles with respect to polio virus infection [6, 7]. Considering these data as well as the high pharmacological activity of imidazo[1,2-a]benzimidazole derivatives [8, 9], we set out to synthesize various alcohols in this heterocyclic series.

Secondary alcohols (IV) of 2-phenylimidazo[1,2-]benzimidazole were obtained in good yield by reaction of aromatic aldehydes with 3-lithio-2-phenylimidazo[1,2-a]benzimidazole, synthesized from the 3-bromo derivative (I, R = CH_3, R' = C_6H_5) by the method in [10]. It was not possible to exclude this bromination step, inasmuch as direct metallation of 3-unsubstituted imidazo[1,2-a]benzimidazole, as in the imidazo[1,2-a]pyridine series [11], proceeds ambiguously, and the yields of carbinols are low in this case. The tertiary alcohol cannot be synthesized by reaction of the organolithium compound of imidazo[1,2-a]benzimidazole with benzophenone, apparently because of steric hindrance.

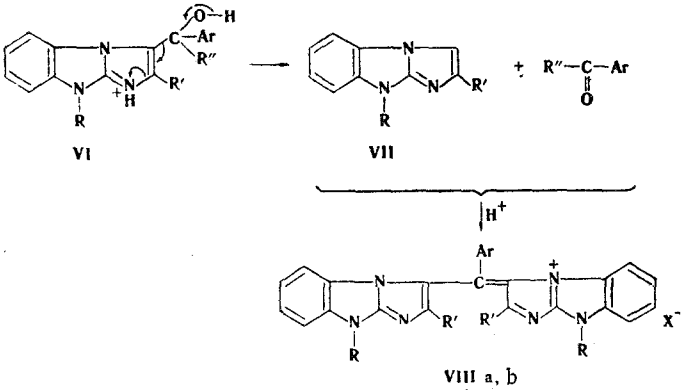


I IV, V II, III

II, IV R″ = H; III, V R″ = CH_3

The method for the synthesis of secondary alcohols that we developed in this research does not always give good results. Thus, because of the electron-donor effect of the methyl group in 2-methyl-substituted imidazo[1,2-a]benzimidazoles, the electron density on the C_3 atom increases as compared with 2-phenyl-substituted compounds, and this brings about a decrease in the lability of the bromine atom in these compounds, and, as a result, the alcohols are also formed in low yields (20-30%). The metallation of 3-bromoimidazo[1,2-a]benzimidazoles with dialkylaminoalkyl groupings in the 9 position also proceeds ambiguously and with pronounced resinification.

It is more convenient to obtain the desired alcohol by reaction of carbonyl compounds of imidazo[1,2-a]benzimidazole (aldehydes II and ketones III) with Grignard reagents. Considering the pronounced electron-donor character of the imidazo[1,2-a]benzimidazole ring, it was difficult to anticipate the high reactivity of the carbonyl group in II and III. In fact, in ether the reaction with organomagnesium compounds proceeds with quite some difficulty, but high yields (70-90%) of the alcohols were obtained in tetrahydrofuran (THF).



VI VII VIII a, b

VIII a, Ar = $C_6H_4N(CH_3)_2$-*p*; a R = R′ = CH_3; X = Br^-; b R = CH_3; R′ = C_6H_5; X = Cl^-

The stretching vibrations of the OH group appear in the IR spectra of alcohols IV and V as a broad band of medium intensity at 3000-3200 cm^{-1}, and bands of deformation vibrations of the OH group and stretching vibrations of the C–O bond are observed at 1020-1040 and

TABLE 1. Effect of Hydrochlorides VI on Arterial Pressure

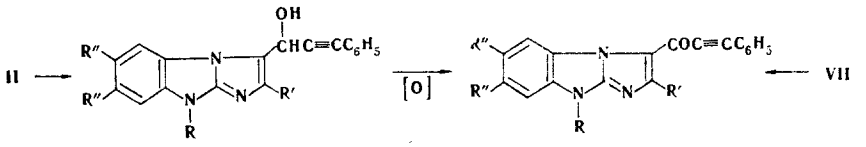
Compound	Dose, mg/kg	Lowering of the SAP* level in percent relative to the starting values after				
		5 min	15 min	30 min	45 min	60 min
VIa	3	50	50	40	33	33
VIc	5	0†	7	7	7	23
VId	20	45	45	40	30	30
VIe	5	17	15	17	44	58
VIf	10	0†	9	13	18	27
VIg	5	23	30	38	42	42

*The abbreviation SAP stands for the systemic arterial pressure. The averaged data are presented.
†The arterial pressure did not change.

1370 cm^{-1} for secondary alcohols and at 1080 and 1380 cm^{-1} for tertiary alcohols. Compounds IV and V are rather unstable and decompose on prolonged storage in air and light. The instability of the alcohols increases when the N_1 atom is protonated, i.e., in acidic media. Treatment of tertiary alcohols V with acids leads to complete splitting out of the alcohol grouping as a ketone. Similar ease of cleavage of the C–C bond in carbinols during acid hydrolysis has also been observed in the indolizine series [12, 13]. When secondary alcohols IV are heated in dilute or concentrated acids, they give deeply colored dyes, probably due to condensation of the imidazo[1,2-a]benzimidazoles VII and the aromatic aldehydes liberated during decomposition of the alcohol.

Identical dyes were also obtained by alternative synthesis by the method in [14]. Their chromaticity, as in the case of monomethylidyne–cyanines [14], depends on the substituents in the 2 position. The introduction of a dimethylaminophenyl group in the monomethylidyne chain of the cyanine dye does not bring about a shift in the absorption maximum in the electronic spectra. Compounds IV and V are insoluble in water and alcohol, and the hydrochlorides of the alcohols (VI, Table 4) were obtained for pharmacological testing by careful treatment with dilute hydrochloric acid in the cold. However, the hydrochlorides were also only slightly soluble in water.

Acetylenic alcohols IX are formed in the reaction of 3-formylimidazo[1,2-a]benzimidazoles II with phenylethynylmagnesium bromide under the conditions of the Iotsitsch reaction. The synthesis of tertiary acetylenic alcohols from ketones III is quite difficult in view of the high instability of the final compounds.



IX a-c X a-c

IX, X a R=R′=CH_3, R″=H; b R=CH_3, R′=C_6H_5, R″=H; c R=C_2H_5, R′=C_6H_5, R″=CH_3

On storage in air and, more rapidly under the influence of active manganese dioxide, alcohols IX are oxidized to ethynyl ketones X, which we also obtained by direct acylation of imidazo[1,2-a]benzimidazoles VII with phenylpropiolyl chloride.

The IR spectra of chloroform solutions of ethynyl carbinols IX contain a band of stretching vibrations of a free OH group at 3595 cm^{-1} and of associated OH groups at 3200-3300 cm^{-1}. The stretching vibrations of the C≡C bond give a band of weak intensity at 2240 cm^{-1}. The absorption of OH groups vanishes completely in the spectra of ketones X; very intense absorption of a triple bond appears at 2210-2215 cm^{-1}. Vibrations of the C=O group are observed at 1570-1575 cm^{-1}. The decrease in the carbonyl frequency as compared with 3-formyl and 3-acetyl derivatives of imidazo[1,2-a]benzimidazole [1, 10] indicates conjugation of the carbonyl group in X both with the π-electron-donor system of the heteroring and with the acetylenic bond.

TABLE 2. 3-Bromo and 3-Formylimidazo[1,2-a]benzimidazoles*

Compound	R	R′	mp, °C	Empirical formula	Found, %				Calc., %				Yield, %
					C	H	Br	N	C	H	Br	N	
Ia·HBr	CH_3	CH_3	274**	$C_{11}H_{10}BrN_3 \cdot HBr$	38,1	3,5	46,0	12,0	38,3	3,2	46,3	12,2	89
Ia	CH_3	CH_3	148	$C_{11}H_{10}BrN_3$	50,2	4,0	30,0	15,6	50,0	3,8	30,3	15,9	
IbHBr	$CH_2C_6H_5$	C_6H_5	244	$C_{22}H_{16}BrN_3 \cdot HBr$	54,8	3,4	32,8	8,8	54,7	3,5	33,1	8,7	88
Ib	$CH_2C_6H_5$	C_6H_5	172	$C_{22}H_{16}BrN_3$	65,6	3,8	19,5	10,3	65,7	4,0	19,9	10,4	
Ic·HBr	$CH_2CH_2N(C_2H_5)_2$	C_6H_5	167—168	$C_{21}H_{23}BrN_4 \cdot 2HBr$	44,2	4,7	42,2	9,5	44,0	4,4	41,8	9,8	82
Ic	$CH_2CH_2N(C_2H_5)_2$	C_6H_5	oil	$C_{21}H_{23}BrN_4$	61,6	5,9	19,6	13,8	61,3	5,7	19,2	13,6	
IIa	CH_3	α-$C_{10}H_7$	254—255	$C_{21}H_{15}N_3O$	77,1	4,5		12,7	77,1	4,6		12,9	80
IIa—H	CH_3	α-$C_{10}H_7$	330	$C_{27}H_{19}N_7O_4$	64,1	4,0		19,3	64,2	3,8		19,4	
IIb	$CH_2C_6H_5$	C_6H_5	153—154	$C_{23}H_{17}N_3O$	78,3	5,1		12,3	78,6	4,9		12,0	98
IIb—H	$CH_2C_6H_5$	C_6H_5	248—250	$C_{29}H_{21}N_7O_4$	65,3	4,2		18,7	65,5	4,0		18,5	
IIc	CH_3	p-BrC_6H_4	199—201	$C_{17}H_{12}BrN_3O$	57,9	3,7	22,8	11,6	57,7	3,4	22,6	11,9	40
IIc—H	CH_3	p-BrC_6H_4	307—308	$C_{23}H_{16}BrN_7O_4$	52,0	3,3	15,4	18,7	51,7	3,0	15,0	18,4	
IId‡	C_2H_5	C_6H_5	215—216	$C_{20}H_{19}N_3O$	75,6	6,2		13,3	75,7	6,0		13,2	90
IId—H	C_2H_5	C_6H_5	288 †	$C_{26}H_{23}N_7O_4$	62,6	4,8		19,5	62,8	4,7		19,7	

*Compounds Ia, b, Ib·HBr, and IIb, c, d were purified by recrystallization from alcohol, the hydrobromides of Ia, c were purified by crystallization from alcohol—ether, and aldehyde IIa was purified by crystallization from DMF—alcohol. The letter "H" designates the 2,4-dinitrophenylhydrazones of aldehydes II. All of the hydrazones were crystallized from DMF.

†With decomposition.

‡Compound IId contains methyl groups in the 6 and 7 positions of the imidazo[1,2-a]benzimidazole ring.

In microbiological studies the acetylenic alcohols and ketones showed weak bacteriostatic activity with respect to a tuberculosis inducer.

The effect of hydrochlorides VI on the arterial pressure level was studied in experiments on nembutal-narcotized rats. The systemic arterial pressure was recorded in the carotid artery by the usual method. Alcohol solutions of the investigated compounds were administered intravenously and the animals were allowed to breathe spontaneously at their normal temperatures. Compound VIa was introduced in doses of 1, 3, and 5 mg/kg, and the remaining compounds were administered in doses of 5, 10, and 20 mg/kg. A clearly expressed hypotensive effect was observed for all of the investigated compounds (Table 1). Compounds VIa, g, which are extremely effective even in doses of 3-5 mg/kg, displayed the highest activity. However, salt VIa was found to be very toxic, inasmuch as the animals perished when intravenous doses of 5 mg/kg were administered. Compounds VIc, f, g also proved to be quite toxic substances: The animals began to perish when doses of 10, 20, and 20 [sic] mg/kg, respectively, were administered. The utilization of ethanol as the solvent, which itself is a hypotensive agent and, as shown by the investigations, intensifies the hypotensive action of the tested compounds, greatly hinders the evaluation of the activity of the compounds. Thus, water-soluble and less toxic analogs of these compounds are necessary for a more objective comparative evaluation of the effect of the alcohols on the cardiovascular system.

EXPERIMENTAL

The IR spectra of mineral oil suspensions and chloroform solutions of the compounds were recorded with a UR-20 spectrometer. The UV spectra of methanol solutions were recorded with an SF-4A spectrophotometer.

9-Methyl-2-(α-naphthyl)imidazo[1,2-a]benzimidazole (VII, R = CH_3, R' = α-C_7H_{10}). 1-Methyl-3-(α-naphthoxyl)methyl-2-iminobenzimidazoline hydrobromide was obtained in 92% yield as snow-white crystals with mp 262-263° (dec.) by reaction of equivalent amounts of 2-amino-1-methylbenzimidazole and α-bromacetylnaphthalene in alcohol. Found: C 60.3; H 4.5; Br 20.5; N 10.6%. N 10.6%. $C_{20}H_{17}N_3O \cdot HBr$. Calculated: 60.6; H 4.6; Br 20.1; N 10.6%.

A 1-g sample of the above salt was refluxed in a mixture of 40 ml of concentrated HCl and 5 ml of phosphorus oxychloride for 12-15 h, after which the mixture was cooled, and the resulting precipitate was removed by filtration, treated with ammonium hydroxide, and extracted with chloroform. The chloroform extract was dried with anhydrous sodium sulfate, concentrated to a small volume, and passed through a column filled with aluminum oxide (elution with chloroform). The fraction with R_f 0.9 was collected. The chloroform was evaporated from this fraction to give 2-naphthylimidazo-[1,2-a]benzimidazole as a transparent viscous oil that did not crystallize even on prolonged standing in a desiccator over P_2O_5. The yield was 83%. The hydrochloride was obtained by the addition of concentrated HCl to a solution of the base in acetone. The resulting long, silky, acicular crystals had mp 262° (dec., from aqueous alcohol). Found: C 72.1; H 4.7; Cl 10.8; N 12.6%. $C_{20}H_{15}N_3 \cdot HCl$. Calculated: C 72.0; H 4.8; Cl 10.6; N 12.6%. The picrate was obtained as lemon-yellow fibrous crystals with mp 248° (dec., from DMF—alcohol). Found: C 59.0; H 3.3; N 16.2%. $C_{20}H_{15}N_3 \cdot C_6H_3N_3O_7$. Calculated: C 59.3; H 3.4; N 16.0%.

2,9-Disubstituted 3-Bromomidazo[1,2-a]benzimidazole (I). These compounds were obtained by bromination of 2,9-disubstituted imidazo[1,2-a]benzimidazole (VII) with an equivalent amount of bromine in chloroform by the method in [15]. The physical characteristics of the products are presented in Table 2.

9-Alkyl(aralkyl)-2-aryl-3-formylimidazo[1,2-a]benzimidazoles (II). These compounds were obtained by formylation of VII with DMF in the presence of phosphorus oxychloride as in [10]. IR spectra ($CHCl_3$): ν_{CO} 1640-1645 cm^{-1}. The physical characteristics of the products are presented in Table 2.

9-Methyl-3-α-hydroxybenzyl-2-phenylimidazo[1,2-a]benzimidazole (IVc). A solution of 2 g (6 mmole) of 3-bromo-9-methyl-2-phenylimidazo[1,2-a]benzimidazole in 50 ml of toluene was added in portions to a cooled (to −75°) solution of butyllithium, obtained from 0.35 g (0.05 g-atom) of lithium and 7.2 g (0.053 mole) of butyl bromide in ether in a nitrogen atmosphere at 0°, after which the mixture was stirred at −75° for 5 h. A solution of 2 g (18 mmole)

TABLE 3. Imidazo[1,2-a]-3-benzimidazolylcarbinols (IV, V)

Compound	R	R′	Ar	mp, °C*	Empirical formula	Found, %			Calc., %			Yield, %
						C	H	N	C	H	N	
IVa	CH_3	CH_3	C_6H_5	199	$C_{18}H_{17}N_3O$	74,3	5,8	14,5	74,2	5,9	14,4	90
IVb	CH_3	CH_3	$C_6H_4N(CH_3)_2$-*p*	193	$C_{20}H_{22}N_4O$	71,5	6,6	16,6	71,8	6,6	16,8	75
IVc	CH_3	C_6H_5	C_6H_5	192	$C_{23}H_{19}N_3O$	78,0	5,6	12,0	78,1	5,4	11,9	72
IVd	CH_3	C_6H_5	$C_6H_4N(CH_3)_2$-*p*	181—182	$C_{25}H_{24}N_4O$	75,7	6,4	14,2	75,7	6,1	14,1	55
IVe	CH_3	C_6H_5	$C_6H_4OC_2H_5$-*p*	174—175	$C_{25}H_{23}N_3O_2$	75,6	5,9	10,6	75,6	5,8	10,6	75
IVf	CH_3	*p*-BrC_6H_4	C_6H_5	183—184	$C_{23}H_{18}BrN_3O$ †	63,6	4,5	9,6	63,9	4,2	9,7	70
IVg	CH_3	α-$C_{10}H_7$	C_6H_5	197—199	$C_{27}H_{21}N_3O$	80,7	5,5	10,5	80,4	5,3	10,4	90
IVh	$CH_2C_6H_5$	C_6H_5	C_6H_5	171—172	$C_{29}H_{23}N_3O$	81,4	5,4	9,7	81,1	5,4	9,8	63
Va	CH_3	CH_3	C_6H_5	160—161	$C_{19}H_{19}N_3O$	74,8	6,1	14,1	74,7	6,3	13,8	70
Vb	CH_3	C_6H_5	C_6H_5	156—157	$C_{24}H_{21}N_3O$	78,3	5,7	11,8	78,4	5,8	11,4	85
Vc	CH_3	*p*-BrC_6H_4	C_6H_5	137—138	$C_{24}H_{20}BrN_3O$ ‡	64,5	4,1	9,2	64,6	4,5	9,4	63

*All of the compounds melted with decomposition. They were purified by recrystallization from methanol or ethanol (alcohol IVc was purified by recrystallization from DMF).

†Found: Br 18.8%. Calculated: Br 18.5%.

‡Found: Br 18.0%. Calculated: Br 17.9%.

TABLE 4. Hydrochlorides of Imidazo[1,2-a]benzimidazolylcarbinols (IV)

Hydrochloride	Starting compound	mp, °C*	Empirical formula	Found, %				Calc., %			
				C	H	Cl	N	C	H	Cl	N
VIa	IVc	134†	$C_{23}H_{19}N_3O \cdot HCl$	71,1	4,7	9,0	11.0	70,9	4,9	9,1	10,8
VIb	IVd	142†	$C_{25}H_{24}N_4O \cdot 2HCl$	63,9	5,5	14,8	11,8	64,2	5,2	15,2	12,0
VIc	IV g	290—293	$C_{27}H_{21}N_3O \cdot HCl$	73,3	5,2	8,6	9,8	73,7	5,0	8,1	9,5
VId	IV h	276—277	$C_{25}H_{33}N_3O \cdot HCl$	74,6	5,3	9,3	9,2	74,8	5,2	9,6	9,0
VIe	IVe	286—287	$C_{25}H_{23}N_3O \cdot HCl$	68,9	5,8	8,6	10,0	69,2	5,6	8,2	9,7
VIf	IVf	300	$C_{23}H_{18}BrN_3O \cdot HCl$	58,6	4,2	23,0	9,2	58,9	4,1	22,5	9,0
VIg	Vb	285	$C_{24}H_{21}N_3O \cdot HCl$	71,1	5,3	9,2	10,6	71,4	5,5	8,8	10,4

*The compounds melted with decomposition. They were recrystallized from alcohol or alcohol—ether.

†The compounds began to darken at this temperature and were gradually converted to a dye.

of benzaldehyde in 20 ml of ether was then added, and the mixture was allowed to stand at this temperature for 1 h. The temperature was then allowed to rise gradually (in the course of 2 h) to room temperature, and the mixture was allowed to stand overnight in a nitrogen atmosphere. It was then decomposed with 30 ml of water, and the resulting precipitate was removed by filtration and washed with ether to give 1.55 g of IVc. An additional amount of carbinol contaminated with VII (R = CH_3, R' = C_6H_5) was isolated from the organic layer by extraction with dilute hydrochloric acid and alkalization of the hydrochloric acid extract.

Alcohol IVd (Table 3) was similarly obtained. The yield of alcohol IVb under these conditions was 22%. The physical characteristics of IV are presented in Table 3.

Aryl(imidazo[1,2-a]-3-benzimidazolyl)carbinols (IVa, b, e-h, Va-c). A solution of 0.01 mole of 3-formyl- or 3-acetylimidazo[1,2-a]benzimidazole [1] in 20-25 ml of tetrahydrofuran (THF) was added with stirring to a Grignard reagent obtained from 0.35 g (0.015 g-atom) of magnesium previously activated with iodine vapors and 0.02 mole of bromobenzene, p-bromodimethylaniline, or p-bromophenetole in 50 ml of absolute THF, after which the mixture was refluxed for 3 h and decomposed the following day with 10% aqueous ammonium chloride solution. The organic layer was separated and evaporated to dryness, and the residue was triturated with diethyl ether. The solid material was removed by filtration and washed on the filter with a small amount of alcohol and ether. The physical characteristics of the alcohols are presented in Table 3.

9-Methyl-3-α-hydroxyphenylpropargyl-2-phenylimidazo[1,2-a]benzimidazole (IXb). A solution of 1.9 g (7 mmole) of 9-methyl-2-phenyl-3-formylimidazo[1,2-a]benzimidazole [10] in 80 ml of ether was added slowly with virogous stirring at room temperature to an emulsion of phenylethynylmagnesium bromide [16], obtained from 0.7 g (0.03 g-atom) of magnesium, 3.33 g (37 mmole) of ethyl bromide, and 3.82 g (37 mmole) of phenylacetylene in 40 ml of absolute ether, after which the mixture was allowed to stand at this temperature for 15-20 min. It was then refluxed for 4 h, cooled, and treated with 50 ml of saturated aqueous NH_4Cl solution. The resulting precipitate (1.75 g) was removed by filtration and washed with ether and water. Evaporation of the solvent from the ether layer and chromatography of the residue with a column filled with Al_2O_3 (elution with chloroform, R_f 0.8) yielded an additional 0.15 g of the alcohol. The overall yield was 71%. The snow-white needles, with mp 192-193° (dec., from alcohol), were only slightly soluble in alcohol, chloroform, acetone, and ether. Found: 79.2; H 5.3; N 11.4%. $C_{25}H_{19}N_3O$. Found: C 79.5; H 5.1; N 11.2%.

6,7-Dimethyl-3-α-hydroxyphenylpropargyl-2-phenyl-9-ethylimidazo[1,2-a]benzimidazole (IXc). This compound was obtained in 68% yield from aldehyde IId as in the experiment described above. The snow-white crystals had mp 208-209° (dec., from alcohol). Found: C 80.3; H 5.9; N 10.1%. $C_{28}H_{25}N_3O$. Calculated: 80.2; H 6.0; N 10.0%.

2-9-Dimethyl-3-α-hydroxyphenylpropargylimidazo[1,2-a]benzimidazole (IXa). This compound, with mp 197-198° (dec., from benzene—petroleum ether), was obtained in 75% yield by reaction

of 2,9-dimethyl-3-formylimidazo[1,2-a]benzimidazole [10] with phenylethynylmagnesium bromide in THF. Found: C 76.2; H 5.6; N 13.2%. $C_{20}H_{17}N_3O$. Calculated: C 76.2; H 5.4; N 13.3%. The yield of the alcohol was 57% when the reaction was carried out in absolute ether.

9-Methyl-3-α-oxophenylpropargyl-2-phenylimidazo[1,2-a]benzimidazole (Xb). A) A 3-g sample of active manganese dioxide was added to a stirred solution of 0.4 g (1 mmole) of alcohol IXb in 15 ml of dry chloroform, and the mixture was then refluxed for 3 h, during which the reaction was monitored by means of thin-layer chromatography (TLC). A yellow spot (R_f 0.95), which appears above the spot from the starting compound, appeared on the chromatogram 0.5 h after the start of the reaction. At the end of the reaction, the MnO_2 was removed by filtration and washed several times on the filter with chloroform. Evaporation of the chloroform gave 0.35 g (87%) of lemon-yellow needles of the ketone with mp 195-196° (from alcohol). The product was soluble in chloroform, benzene, diethyl ether, and petroleum ether. Found: C 80.0; H 4.8; N 10.8%. $C_{25}H_{17}N_3O$. Calculated: C 80.0; H 4.6; N 10.9%. The 2,4-dinitrophenylhydrazone was obtained as dark-cherry-red crystals with mp 272° (from DMF). Found: N 17.5%. $C_{31}H_{21}N_7O_4$. Calculated: N 17.6%.

B) A thoroughly ground mixture of 0.5 g (2 mmole) of 9-methyl-2-phenylimidazo[1,2-a]-benzimidazole and 0.33 g (2 mmole) of phenylpropiolyl chloride was heated on an oil bath at 40° for 20 min, after which the resulting melt was triturated with ether, and the solid material was removed by filtration and treated on the filter with dilute ammonium hydroxide. The yield of Xb, with mp 195°, was 0.35 g (47%). The product was identical to the product obtained by method A.

6,7-Dimethyl-3-α-oxophenylpropargyl-2-phenyl-9-ethylimidazo-[1,2-a]benzimidazole (Xc). This compound was obtained in 95% yield by oxidation of carbinol IXc with active MnO_2. The bright-yellow, small, fluffy needles had mp 210° (dec., from alcohol). Found: 80.6; H 5.4; N 9.9%. $C_{28}H_{23}N_3O$. Calculated: C 80.5; H 5.5; N 10.1%. The 2,4-dinitrophenylhydrazone was obtained as cherry-red crystals with mp 269-270° (dec., from DMF). Found: N 16.4%. $C_{34}H_{27}N_7O_4$. Calculated: N 16.4%.

2,9-Dimethyl-3-α-oxophenylpropargylimidazo[1,2-a]benzimidazole (Xa). This compound was prepared by the method used to obtain ketone Xb: The yield by method A was 75%, and the yield by method B was 40%. The pale-yellow needles had mp 203-204° (from alcohol). Found: C 76.4; H 5.1; N 13.5%. $C_{20}H_{15}N_3O$. Calculated: C 76.6; H 4.8; N 13.4%.

2,9-Dimethyl-3-α-methyl-α-hydroxyphenylpropargylimidazo[1,2-a]benzimidazole. This compound was obtained by reaction of ketone III (R = R' = R'' = CH_3) with phenylethynylmagnesium bromide in ether as in the preparation of alcohol IXb. The ether layer was evaporated to half its original volume, and the precipitated starting III was removed by filtration. Further evaporation of the ether mother liquor gave the desired alcohol in 55% yield. The colorless crystals had mp 122-123° (from alcohol) and were soluble in alcohol, chloroform, and benzene. Found: C 77.3; H 5.9; N 12.9%. $C_{21}H_{19}N_3O$. Calculated: C 77.0; H 5.9; N 12.8%.

Dyes VIIIa, b. A 1-mmole sample of alcohol IVd was heated in 2 ml of dilute hydrochloric acid (1:1) on a boiling-water bath for 5 h, after which the intensely colored solution was evaporated to dryness, and the residue was dissolved in a small volume of chloroform and passed through a layer of Al_2O_3. The upper layer of aluminum oxide on which the dye was adsorbed was removed and extracted repeatedly with acetone. The acetone was evaporated, and the residue was purified by reprecipitation from alcohol solution by the addition of ether. The yield of dye VIIIb was 50%. The dark-blue crystals had mp 256-257°. No melting-point depression was observed for a mixture of this dye with the dye obtained by the method in [14]. Found: N 14.6%. $C_{41}H_{34}ClN_7$. Calculated: N 14.8%. Electronic spectrum, λ_{max}, nm (log ε): 440 (3.78) and 622 (4.57).

Dye VIIIa was similarly obtained in 35% yield by refluxing alcohol IVb with hydrobromic acid. The dark-violet crystals had mp 230-232° (from alcohol–ether). Found: N 17.0%. $C_{31}H_{30}BrN_7$. Calculated: N 16.9%. Electronic spectrum, λ_{max}, nm (log ε): 365 (3.61) and 560 (3.77).

The residue remaining after evaporation of the chloroform eluate obtained by passing the dye through a layer of aluminum oxide was treated with ammonia and purified by chromatography (Al_2O_3, elution with chloroform) to give the corresponding 3-unsubstituted imidazo-[1,2-a]benzimidazoles (VII).

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SYNTHESIS OF 1-ARYLSULFONYL-4-ARYLPIPERAZINES WITH A STERICALLY HINDERED NITROGEN ATOM

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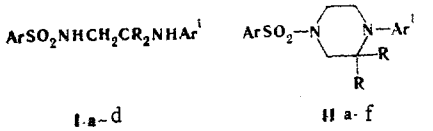
UDC 547.861.3.07

The corresponding piperazines are formed in high yields by alkylation of 1-arenesulfamido-2-arylaminoethanes with dichloroethane in an aqueous alkaline solution of triethylbenzylammonium chloride. Some properties of the synthesized compounds were investigated.

We have previously shown [1] that arylsulfonylarylamides are alkylated at the nitrogen atom by 1,2-dihaloethanes in the presence of small amounts of a triethylbenzylammonium salt, the addition of which raises the yield and increases the reaction rate. We have carried out the reaction of dichloroethane with a number of 1-arenesulfamido-2-arylaminoethanes (Ia-d), and in this case, both the amine and amide nitrogen atoms are alkylated in an aqueous alkaline solution of triethylbenzylammonium chloride to give high yields of the corresponding piperazines (IIa-f).



I a-d II a-f

Dnepropetrovsk Chemical-Engineering Institute. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 1, pp. 135-137, January, 1976. Original article submitted January 3, 1975.