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Research in the Field of Imidazo[1,2-*a*]benzimidazole Derivatives: XXVII.* 1-Acylmethyl-2-(ω-hydroxyalkylamino)-benzimidazoles and Their Transformation into Derivatives of Tricyclic Systems

V. A. Anisimova, I. E. Tolpygin, and G. S. Borodkin

Research Institute of Physical and Organic Chemistry at the Southern Federal University, Rostov-on-Don, 344090 Russia
e-mail; e-mail: anis@ipoc.rsu.ru

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Abstract—1-Acylmethyl-2-(ω-hydroxyalkylamino)benzimidazoles were synthesized and their behavior under various conditions was investigated: at the thermolysis without solvent, at heating in DMF or in 2-aminoethanol, hydrohalic acids, and acetic anhydride, in the presence of chlorinating agents ($SOCl_2$, $POCl_3$). Depending on the reaction conditions derivatives were obtained of 1*H*-imidazo[1,2-*a*]-benzimidazole, 9*H*-2,3-dihydroimidazo[1,2-*a*]benzimidazole, and 10*H*-2,3,4,10-tetrahydropyrimido[1,2-*a*]-benzimidazole that were suitable synthons for the synthesis of functionally substituted derivatives of these tricyclic systems.

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The 1-alkyl(aralkyl,aryl)-2-(ω-hydroxyalkylamino)-benzimidazoles were formerly shown to be convenient initial compounds for the synthesis of N^9-substituted 2,3-dihydroimidazo- and N^{10}-substituted 2,3,4,10-tetrahydro-pyrimido[1,2-*a*]benzimidazoles [2–4]. It is also known that 3-acylmethyl-2-aminobenzimidazolium halides at the treatment with cyclizing agents form 9*H*-imidazo[1,2-*a*]-benzimidazole derivatives [5–7] many of which exhibit biological activity [8–10].

The goal of this study consisted in the synthesis of 2-(ω-hydroxyalkylamino)benzimidazoles containing in the position *1* acylmethyl groups of various structure and in establishing the possibility to transform them into new derivatives of the above-mentioned systems that could be potential biologically active substances or serve as convenient synthons for their synthesis.

Unlike the 2-aminobenzimidazole that in the reaction with acylmethylbromides [11, 12] and with esters of haloacetic acids [13] even in a neutral medium and under mild conditions (acetone, room temperature [12]) formed mixtures of *N*-acyl-(alkoxycarbonyl)methyl-substituted and of the corresponding *N,N*'-disubstituted 2-amino-benzimidazoles, the alkylation of 2-hydroxyalkylamino-benzimidazoles **Ia** and **Ib**, with haloketones **IIb–IIe** proceeded under more stringent conditions and resulted only in monosubstituted **III** and **IV**.

This course of the reaction may be due to the reduced basicity of the endocyclic nitrogen atom caused by the introduction of hydroxyalkyl groups to the amino group in the position *2* [pK_a of 2-aminobenzimidazole 7.12, (**Ia**) 6.72, (**Ib**), 6.92**], and to the presence of hydrogen bonds in compounds **Ia** and **Ib** ($\nu_{N\cdots OH}$ 3200–3500 cm^{-1}) impeding the approach of alkylating agents to the pyridine nitrogen atom.

The reaction of aminoalcohols **Ia** and **Ib** with phenacyl bromides **IIb–IIe** can be performed in various solvents

* For Communication XXVI, see [1].

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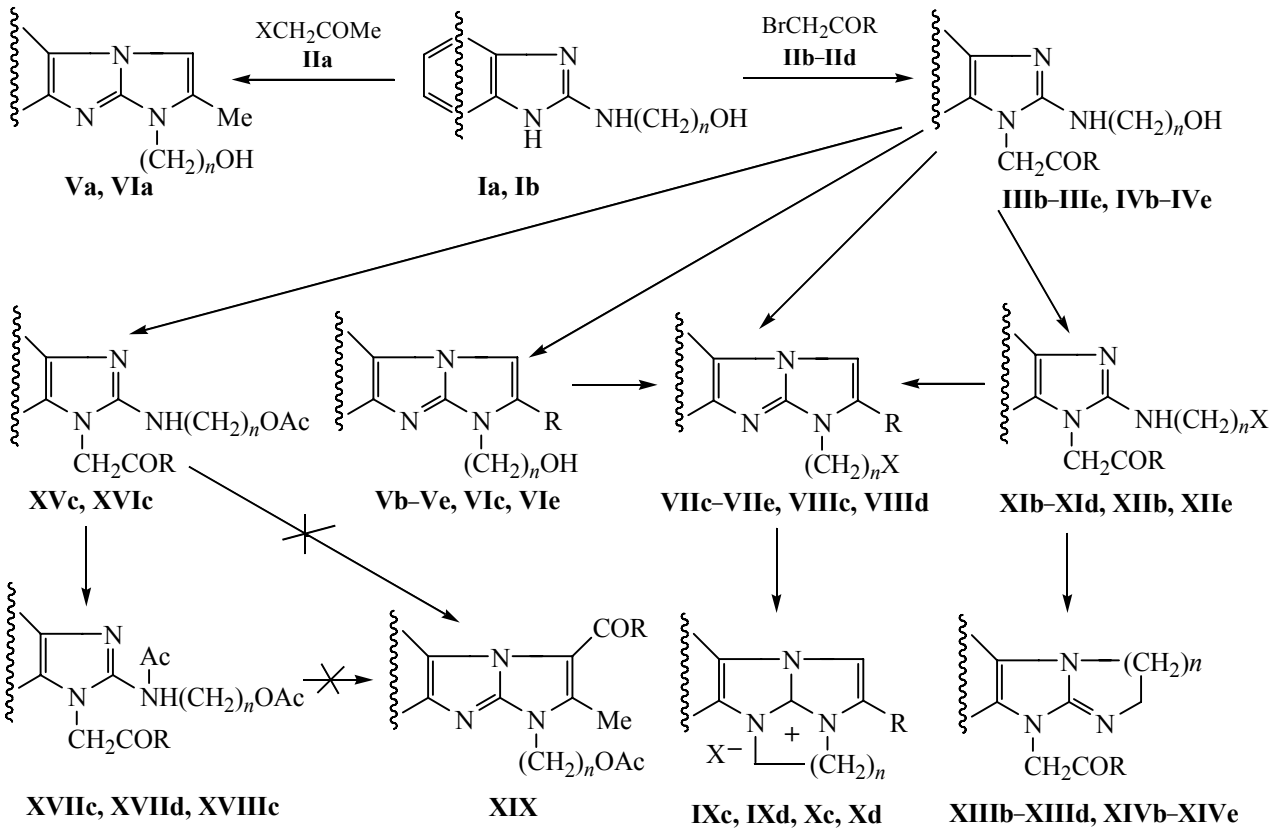


R = Me (**a**), *t*-Bu (**b**), Ph (**c**), C_6H_4Br-4 (**d**), 2-thienyl (**e**); X = Cl, Br; *n* = 2 (**Ia, III, V, VII, IX, XI, XIII, XV, XVII, XIX**), 3 (**Ib, IV, VI, VIII, X, XII, XIV, XVI, XVIII, XX**).

(**IIb**–**IId**) (acetone, acetonitrile, lower alcohols), therewith the reaction rate depends on the boiling point of the solvent. The IR spectra of salts **III** and **IV** contain the absorption bands of the carbonyl group (1700–1720 cm^{-1}), of NH and OH groups (3100–3560 cm^{-1}). In the ^1H NMR spectra the signals are present of the methylene groups of the hydroxyalkylamine moiety and a singlet signal of the CH_2 group from the acylmethyl substituents.

As a result of reactions of compounds **Ia** and **Ib** with the bromoacetone under the same conditions or by melting with chloroacetone we isolated substances whose IR spectra lacked the absorption bands of the carbonyl groups. The bands at 1555, 1580, and 1630 cm^{-1} are assignable to the absorption of the C=C and C=N bonds of the imidazo-[1,2-*a*]benzimidazole framework. The sharp peak in the region 3126–3140 cm^{-1} and the absorption bands at 1080 and 1250 cm^{-1} (C–O, O–H) indicates the presence of OH group in the compounds obtained. In the ^1H NMR spectrum of these compounds alongside the signals of four aromatic protons of the benzene ring singlets were observed of the proton in the position *3* and of CH_3 group, and also the signals of the methylene protons of the ethyl or propyl groups in the position *1*. Hence based on this data we established that in this case the reaction did not finish at the stage of alkylation, but further a cyclization occurred into 1-hydroxyalkyl-2-methylimidazo[1,2-*a*]benzimidazoles **Va** and **VIa**. Apparently the small size of the CH_3 group led to the decrease in the steric hindrances for the attack of the unshared electron pair of the amino group on the carbonyl atom of the keto group, and it favors the formation of the imidazole ring. In the case of the *tert*-butyl substituents the steric factors on the contrary prevent the cyclization.

The thermolysis of compounds **III** and **IV** hydrobromides proceeded at their melting points and resulted mostly in 1-hydroxyalkyl-substituted substances **V** and **VI**. Inasmuch as the melting points of initial compounds **III** and **IV** are relatively high, the reaction is accompanied with a partial decomposition of the reaction mixture. In event of hydroxypropylamines **IV** we isolated additionally small amounts of pyrimido[1,2-*a*]benzimidazole derivatives **XIV**. The analogous cyclization occurs in DMF

and 2-aminoethanol, and in the latter case the tarring is negligible.

The 2-amino-1-acylmethylbenzimidazole bromides are known to undergo cyclization under the action of alkaline reagents [15]. The treatment of compounds **III** and **IV** hydrobromides with alkaline agents ($NaHCO_3$, Na_2CO_3, and NaOH) in an ethanol-water solution led only to the isolation of the corresponding bases even after prolonged boiling (15–20 h).

The treatment with $SOCl_2$ of aminoalcohols **III** and **IV** resulted in the replacement by Cl atom of the hydroxy group (**XI, XII**), and the reaction proceeded both in the excess thionyl chloride at room temperature and at heating in $CHCl_3$ solution.

$POCl_3$ can serve simultaneously a chlorinating and cyclization (dehydration) agent. Its treatment of alcohols **III** and **IV** in the cold or at short boiling led only to chloroalkylamines **XI** and **XII**. At long heating with $POCl_3$ aminoalcohols **XI** and **XII** suffered cyclization into tricycles **VII** and **VIII** in nearly quantitative yield (TLC monitoring, R_f of compounds **VII** and **VIII**, X = Cl 0.9).

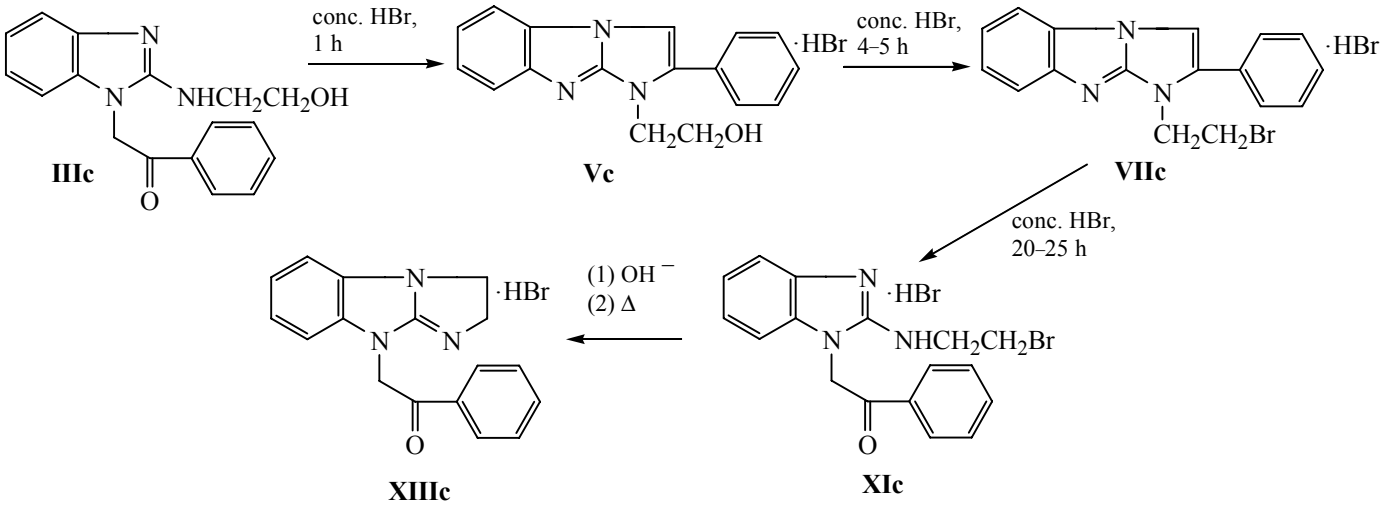
Benzimidazoles **III** and **IV** at heating in the polyphosphoric acid (150°C, 10–15 h) as show TLC data completely are converted into hydroxyalkyl derivatives **V** and **VI**, but since the latter are well soluble in water and sparingly soluble in solvents fit for the extraction we failed to isolate the tricycles in good yields.

The best results in isolation of cyclic derivatives **V** and **VI** were obtained at boiling in concn. HCl. However the reaction proceeded very slowly (25–40 h), and in some cases traces of chloroalkyl derivatives **VII**, **VIII**, X = Cl were detected.

At the use of concn. HBr the result of the reaction depended strongly on the nature of the substituent R in the acylmethyl group and on the length of the alkyl chain in the hydroxyalkylamino moiety. With donor substituents R (*t*-Bu, thienyl) in compounds **III** and **IV** the boiling in 46–48% HBr resulted in the substitution for bromine of the hydroxy group and in the formation of 2-(ω-bromoalkylamino)-benzimidazole hydrobromides **XIb, XIe, XIIb, XIIe**. The covalently bound bromine in these compounds is fairly labile, and at $n = 3$ the attempts to isolate bases**, XIIb, XIIe** failed for they at once underwent cyclization into 2,3,4,10-tetrahydropyrimido-[1,2-*a*]benzimidazole derivatives **XIVb, XIVe**. The corresponding 2,3-dihydroimidazo[1,2-*a*]benzimidazoles **XIIIb, XIIIe** can be obtained from more stable bromoethylamino derivatives **XIb, XIe** only by the thermal cyclization without solvent or at boiling in solvents with a high boiling point.

The boiling of phenacyl- and *p*-bromophenacyl-3-hydroxypropyl derivatives **IVc** and **IVd** in HBr over 3–5 h led to the formation of a mixture of bromopropylaminobenzimidazoles **XIIc**, **XIId** and 1-(3-bromopropyl)-2-phenyl(*p*-bromophenyl)-imidazo[1,2-*a*]benzimidazoles **VIIIc, VIIId**. A longer boiling (up to 20 h) afforded compounds **VIIIc, VIIId** in nearly quantitative yields. The bases of the bromopropyl compounds **VIIIc, VIIId** even at room temperature spontaneously converted into tetracycles **Xc, Xd**.

The cyclization of hydroxyethylamine **IIIc** in concn. HBr takes optional course. A short heating (~1 h) in concn.



HBr led to cyclization (by dehydration) giving 1-(2-hydroxyethyl)imidazo[1,2-*a*]-benzimidazole hydrobromide (**Vc**). After boiling for 4–5 h the hydroxy group was replaced by bromine resulting mainly in hydrobromide **VIIc**. However according to TLC data in the reaction mixture formed simultaneously one more compound which at further heating (20–25 h) became prevailing unlike bromoethyl derivative **VIIc** whose amount reduced to complete disappearance. The spectral investigations revealed that the final product was 2-(2-bromoethylamino)-1-phenacylbenzimidazole hydrobromide (**XIc**) formed by the opening of the external imidazole ring in compound **VIIc**. This process can be understood as the probable initial formation of kinetic reaction products **Vc** and **VIIc**, whereas the bromoethyl derivative **XIc** is the thermodynamically favorable product. A similar result was obtained at a prolonged heating of hydrobromide **Vc** in 48% HBr. The structure of hydrobromide **XIc** was confirmed the thermal cyclization of its base into 9-phenacyl-2,3-dihydroimidazo[1,2-*a*]benzimidazole hydrobromide (**XIIIc**) [16].

In the IR spectra of compounds **XI–XIV** like in the spectra **III** and **IV** absorption bands of the carbonyl group are present in the region 1690–1720 cm^{-1}; the absorption band of OH group disappears from the spectra of compounds **XI** and **XII**. In the IR spectra of compounds **XIII** and **XIV** the stretching vibrations of NH group are absent, and the group C=N absorbs at 1660–1665 cm^{-1} in the spectrum of imidazo[1,2-*a*]benzimidazoles **XIII** and at 1650–1655 cm^{-1} in the spectrum of pyrimido[1,2-*a*]-benzimidazoles **XIV**. In the ^1H NMR spectra of these compounds singlet signals of methylene protons of acylmethyl groups are retained, and in the proton signals of the alkyl chain in going from hydroxyalkylamines **III** and **IV** to bromoalkyl derivatives **XI** and **XII** a downfield shift is observed. Still greater shift occurs in tricyclic derivatives **XIII** and **XIV**. Besides in the spectra of the latter compounds also disappears the proton signal of NH group. The ^1H NMR spectra of 1-bromoalkyl derivatives **VII** and **VIII** are characterized by the appearance of a singlet belonging to the aromatic proton in the position *3* of imidazo-[1,2-*a*]benzimidazole framework and by the shift of the proton signals of the NCH_2 group downfield by 0.9 ppm. In the spectra of tetracyclic derivatives **Xc** and **Xd** the disappearance of signals from groups CH_2Br and NCH_2 at 3.46 and 4.48 ppm is observed and the appearance of a doublet of doublets at 4.47 ppm ($^2J_{HH}$ 5.31, $^3J_{HH}$ 3.59 Hz) from the four protons of two NCH_2 groups arising from the symmetrization of the structure.

The acetic anhydride is often used for preparation of imidazo[1,2-*a*]benzimidazoles functionally substituted at the position *3*. The anhydride served in these reactions both as acylating and cyclization agent [17–19] especially in the events where the common cyclization is impeded (the presence of donor substituents in the acylmethyl moiety) [19]. The treatment of bases **III** and **IV** with acetic anhydride at room temperature gave in high yields monoacetyl derivatives **XV** and **XVI** whose IR spectra contained a band of an ester group in the region 1710–1750 cm^{-1} indicating the acylation of the OH group. At boiling compounds **III** and **IV** both in pure Ac_2O and in the presence of anhydrous AcONa diacetylation occurred providing acetyl-substituted compounds **XVII** and **XVIII** (see the acetylation of 1-alkyl-(arylalkyl)-2-hydroxyalkylaminobenzimidazoles [4]). The absorption band of NCOMe group appeared in the IR spectra in the region 1675–1685 cm^{-1}. No further cyclization to compound **XIX** was observed in this case.

EXPERIMENTAL

IR spectra were recorded on a spectrophotometer Specord 75IR from mulls in mineral oil. ^1H NMR spectra were registered on a spectrometer Varian Unity-300 (300 MHz). The monitoring of reaction progress and checking the homogeneity of compounds synthesized was performed by TLC on plates with Al_2O_3 of the III grade of activity, eluent $CHCl_3$, development in iodine vapor. 2-(2-Hydroxyethylamino)benzimidazole (**Ia**) was obtained by procedure [20], aminoalcohol **Ib** was prepared similarly.

2-(3-Hydroxypropylamino)benzimidazole (Ib). A mixture of 5 g (25 mmol) of benzimidazole-2-sulfonic acid and 5.7 ml (75 mmol) of 3-aminopropan-1-ol was heated for 2 h at 145–150°C (bath temperature). Then to the melt cooled to ~90°C was poured at vigorous stirring 20 ml of cold water, the mixture was stirred to the complete crystallization of the separated oily substance and then left overnight in a refrigerator at 3–5°C. The precipitate was filtered off, washed on the filter with cold water (3×10 ml), and dried at 105°C. Yield 4.5 g (94%), mp 139–140°C (MeCN). IR spectrum, ν, cm^{-1}: 3070–3240 (OH, NH), 1650 (C=N), 1600, 1580, 1500 (C=C), 1250, 1050 (C–O, OH), 730 ($C–H_{arom}$). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 2.70 quintet (2H, CH_2), 3.35 q (2H, CH_2O), 3.47 t (2H, NCH_2), 4.40–5.20 br.s (1H, OH), 6.52 t (1H, NH), 6.83 q ($2H_{Ar}$), 7.08 q ($2H_{Ar}$), 10.00–11.40 br.s (1H, $N_{Ar}H$). Found, %: C 62.66; H 6.95;

N 22.1. $C_{10}H_{13}N_3O$. Calculated, %: C 62.81; H 6.85; N 21.97.

1-Acylmethyl-2-(ω-hydroxyalkylamino)-benzimidazoles IIIb–IIIe, IVb–IVe. Into a hot solution of 10 mmol of aminoalcohol **I** in 15–20 ml of 2-propanol was added 10 mmol of bromomethyl ketone **II**, and the mixture was boiled at stirring over 3–4 h. In the course of boiling a wide precipitate of compounds **III, IV** hydrobromide separated, that on cooling the reaction mixture it was filtered off, washed with cold 2-propanol and with acetone. Yield 89–95%. Analogous yields were obtained at boiling the mixture of initial compounds in acetone for 8–10 h, in ethanol for 5–6 h, in butanol for 1.5–2 h. Hydrobromides of compounds **IIIb, IIIc**, **IVb–IVd** were described in [21, 22].

By treating hot water solutions of the obtained hydrobromides or solutions in 70–80% ethanol with 22% NH_4OH till pH 8–9 we isolated the corresponding bases **III, IV** which after cooling the reaction mixture were filtered off, washed with water, and dried at 100–105°C. Yields 96–100%.

2-(2-Hydroxyethylamino)-1-pivaloylmethyl-benzimidazole (IIIb), mp 119–120°C (EtOAc). IR spectrum, ν, cm^{-1}: 3565, 3285 (NH, OH), 1720 (C=O). ^1H NMR spectrum coincides with the published in [21]. Found, %: C 65.30; H 7.87; N 15.35. $C_{15}H_{21}N_3O_2$. Calculated, %: C 65.43; H 7.69; N 15.26.

2-(3-Hydroxypropylamino)-1-pivaloylmethyl-benzimidazole (IVb), mp 186–187°C (MeCN). IR spectrum, ν, cm^{-1}: 3273, 3100 (NH, OH), 1720 (C=O). ^1H NMR spectrum coincides with the published in [21]. Found, %: C 66.50; H 8.12; N 14.35. $C_{16}H_{23}N_3O_2$. Calculated, %: C 66.41; H 8.01; N 14.52.

2-(2-Hydroxyethylamino)-1-phenacylbenz-imidazole (IIIc), mp 167–168°C (EtOH). IR spectrum, ν, cm^{-1}: 3310, 3060 (NH, OH), 1700 (C=O). ^1H NMR spectrum of compound **IIIc** hydrobromide (DMSO-d_6), δ, ppm: 3.50 q (2H, CH_2), 3.65 q (2H, CH_2), 4.60–5.40 br.s (1H, OH), 5.98 s (2H, CH_2CO), 7.10–7.80 m ($7H_{Ar}$), 8.12 d ($2H_{Ar}$), 9.05 t (1H, NH), 12.0–14.0 br.s (1H, N^+H). Found, %: C 69.05; H 5.93; N 14.38. $C_{17}H_{17}N_3O_2$. Calculated, %: C 69.14; H 5.80; N 14.23.

2-(3-Hydroxypropylamino)-1-phenacylbenzimid-azole (IVc), mp 205–206°C (MeCN). IR spectrum, ν, cm^{-1}: 3240, 3120 (NH, OH), 1700 (C=O). ^1H NMR spectrum of compound **IVc** hydrobromide (DMSO-d_6), δ, ppm: 1.85 quintet (2H, CH_2), 2.80–3.20 br.s (1H, OH), 3.55–3.64 m (4H, NCH_2, CH_2O), 6.05 s (2H, CH_2CO), 7.15–8.05 m ($9H_{Ar}$), 9.10 t (1H, NH), 12.50–14.50 br.s (1H, N^+H). Found, %: C 69.74; H 6.34; N 13.73. $C_{18}H_{19}N_3O_2$. Calculated, %: C 69.88; H 6.19; N 13.58.

1-(4-Bromophenacyl)-2-(2-hydroxyethylamino)-benzimidazole (IIId), mp 214–215°C (decomp., EtOH–DMF). IR spectrum, ν, cm^{-1}: 3270, 3140 (NH, OH), 1700 (C=O). ^1H NMR spectrum of compound **IIId** hydrobromide (DMSO-d_6), δ, ppm: 3.56 t (2H, CH_2), 3.68 t (2H, CH_2), 6.07 s (2H, CH_2CO), 7.10–7.57 m (4H, $H^{5,6,7,8}$), 7.76 d (2H, $H^{2',6'}$), 8.08 d (2H, $H^{3',5'}$), 9.12 t (1H, NH). Found, %: C 54.40; H 4.23; Br 21.18; N 11.07. $C_{17}H_{16}BrN_3O_2$. Calculated, %: C 54.56; H 4.31; Br 21.35; N 11.23.

1-(4-Bromophenacyl)-2-(3-hydroxypropyl-amino)benzimidazole (IVd), mp 201–202°C (decomp., EtOH–DMF). IR spectrum, ν, cm^{-1}: 3260, 3100 (NH, OH), 1700 (C=O). ^1H NMR spectrum of compound **IVd** hydrobromide (DMSO-d_6), δ, ppm: 1.80 quintet (2H, CH_2), 2.90–3.10 br.s (1H, OH), 3.45–3.67 m (4H, NCH_2, CH_2O), 6.00 s (2H, CH_2CO), 7.03–7.94 m ($9H_{Ar}$), 9.40 t (1H, NH), 13.00–14.00 br.s (1H, N^+H). Found, %: C 58.32; H 4.44; Br 21.52; N 11.41. $C_{18}H_{16}BrN_3O$. Calculated, %: C 58.39; H 4.36; Br 21.58; N 11.35.

2-(2-Hydroxyethylamino)-1-thenoylmethyl-benzimidazole (IIIe) hydrobromide, mp 255–256°C (decomp., EtOH). IR spectrum, ν, cm^{-1}: 3370, 3210, 3150 (NH, OH, N^+H), 1685 (C=O), 1673 (C=N^+H). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.62 t (2H, CH_2), 3.73 t (2H, CH_2), 6.03 s (2H, CH_2CO), 7.13–7.26 m (2H, $H^{6,7}$), 7.30 d (1H, $H^{4'}$), 7.39 d (1H, H^5), 7.48 d (1H, H^8), 7.93 d (1H, $H^{3'}$), 8.24 C (1H, $H^{5'}$), 9.15 t (1H, NH). Found, %: C 47.19; H 4.30; Br 20.73; N 10.84; S 8.28. $C_{15}H_{15}N_3O_2S{\cdot}HBr$. Calculated, %: C 47.13; H 4.22; Br 20.90; N 10.99; S 8.39. mp of base **IIIe** 179–180°C.

2-(3-Hydroxypropylamino)-1-thenoylmethyl-benzimidazole (IVe) hydrobromide, mp 257–258°C (decomp., EtOH). IR spectrum, ν, cm^{-1}: 3365, 3220, 3155 (NH, OH, N^+H), 1685 (C=O), 1673 (C=N^+H). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 1.86 quintet (2H, CH_2), 3.50–3.64 m (4H, NCH_2, CH_2O), 6.00 s (2H, CH_2CO), 7.12–7.26 m (2H, $H^{6,7}$), 7.28–7.35 m (1H, $H^{4'}$), 7.42 d (1H, H^5), 7.47 d (1H, H^8), 7.96 d (1H, $H^{3'}$), 8.26 s (1H, $H^{5'}$), 9.05 t (1H, NH). Found, %: C 48.41; H 4.70; Br 20.38; N 10.76; S 7.93. $C_{16}H_{17}N_3O_2S{\cdot}HBr$. Calculated, %: C 48.49; H 4.58; Br 20.16; N 10.60; S 8.09.

1-(2-Hydroxyethyl)-2-methylimidazo[1,2-*a*]-benzimidazole (Va). *a.* A mixture of 1.77 g (10 mmol) of aminoalcohol **Ia** and 1 ml (12 mmol) of bromoacetone

in 20 ml of 2-propanol was boiled for 5 h. Then a half of alcohol volume was distilled off, the mixture was cooled, 7 ml of acetone and 15 ml of ether was added. After 2 h the precipitate of compound **Va** hydrobromide was filtered off, washed with acetone, and dried in air. Yield 88%, mp 211°C (decomp., EtOH). Found, %: C 48.52; H 4.91; Br 27.18; N 14.00. $C_{12}H_{13}N_3O\cdot HBr$. Calculated, %: C 48.67; H 4.76; Br 26.98; N 14.19.

By treating the hydrobromide with 22% solution of NH_4OH we obtained base **Va**. Yield 89%, mp 162–163°C (EtOAc). IR spectrum, ν, cm^{-1}: 3160–3130 (OH), 1630, 1570, 1550 (C=C, C=N), 740 (*ortho*-substituted benzene). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 2.28 s (3H, CH_3), 3.77 t (2H, CH_2), 4.02 t (2H, CH_2), 3.30–4.30 br.s (1H, OH), 7.00 t (1H, H^6), 7.15 t (1H, H^7), 7.42 s (1H, H^3), 7.46 d (1H, H^5), 7.66 d (1H, H^8). Found, %: C 66.81; H 5.93; N 19.71. $C_{12}H_{13}N_3O$. Calculated, %: C 66.96; H 6.09; N 19.52.

b. A mixture of 1.77 g (10 mmol) of aminoalcohol **Ia** and 4.0 ml (~50 mmol) of chloroacetone was boiled for 15–20 min, cooled, and the separated precipitate of compound **Va** hydrochloride was filtered off and washed with dry acetone. Yield 2.26 g (90%). After recrystallization from a mixture of acetone (or acetonitrile) with ethanol and drying at 105–110°C mp was 180–181°C (the capillary with the substance should be placed in the hot device). Found, %: C 57.09; H 5.53; Cl 14.21; N 16.85. $C_{12}H_{13}N_3O\cdot HCl$. Calculated, %: C 57.26; H 5.61; Cl 14.08; N 16.69. The base obtained by the treatment of this hydrochloride with ammonia solution was identical to compound **Va** obtained by procedure *a*.

1-(3-Hydroxypropyl)-2-methylimidazo[1,2-*a*]-benzimidazole (VIa) hydrobromide was obtained similarly to compound **Va** hydrobromide. Yield 84%, mp 202–203°C (decomp., EtOH–Et_2O). Found, %: C 50.50; H 5.24; Br 25.51; N 13.67. $C_{13}H_{15}N_3O\cdot HBr$. Calculated, %: C 50.34; H 5.20; Br 25.76; N 13.55.

Compound (VIa) hydrochloride. Yield 83%, mp 173–174°C (MeCN–EtOH). Found, %: C 58.91; H 6.14; Cl 13.21; N 15.71. $C_{13}H_{15}N_3O\cdot HCl$. Calculated, %: C 58.76; H 6.07; Cl 13.34; N 15.81.

Base VIa hydrate. Yield 92%, mp 114–115°C (MεCN). IR spectrum, ν, cm^{-1}: 3200–3160 (H_2O), 3126 (OH), 1626, 1580, 1553 (C=C, C=N), 1230, 1078 (C–O, O–H). ^1H NMR spectrum (DMSO-d_6), δ, ppm: 1.93 quintet (2H, CH_2), 2.32 s (3H, CH_3), 3.40 t (2H, CH_2O), 4.03 t (2H, NCH_2), 4.76 br.s (1H, OH), 6.98 t (1H, H^6), 7.14 t (1H, H^7), 7.40–7.50 m (2H, $H^{3,5}$), 7.66 d (1H, H^8). Found, %: C 63.30; H 6.81; N 17.17. $C_{13}H_{15}N_3O\cdot H_2O$. Calculated, %: C 63.14; H 6.93; N 16.99.

2-*tert*-Butyl-1-(2-hydroxyethyl)imidazo[1,2-*a*]-benzimidazole (Vb). In an open heat-resistant test tube was heated 1.07 g (3 mmol) of compound **IIIb** hydrobromide at 220–225°C for 10 min. The melt was treated with 10 ml of 22% aqueous ammonia and with chloroform (3 × 5 ml). The chloroform layer was separated, evaporated to a volume 5 ml and passed through a bed of Al_2O_3 (4 × 2.5 cm), eluent $CHCl_3$. On evaporating solvent from the eluate the residue was ground with petroleum ether. Yield 0.6 g (78%), mp 157–158°C (EtOAc). IR spectrum, ν, cm^{-1}: 3065–3205 (associated OH), 1640 (C=N). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 1.46 s (9H, *t*-Bu), 4.18 t (2H, CH_2O), 4.35 t (2H, CH_2N), 6.97 s (1H, H^3), 7.10 t (1H, H^6), 7.26 t (1H, H^7), 7.49 d (1H, H^5), 7.61 d (1H, H^8). Found, %: C 70.16; H 7.60; N 16.21. $C_{15}H_{19}N_3O$. Calculated, %: C 70.01; H 7.44; N 16.33. The compound obtained was identical to the substance prepared by the cyclization in 2-aminoethanol [21].

1-(2-Hydroxyethyl)-2-phenylimidazo[1,2-*a*]-benzimidazole (Vc). The cyclization of the base **IIIc** was carried out at 170–175°C. Om completion of the reaction (1–1.5 h) the melt was cooled, dissolved in a minimal volume of $CHCl_3$, and passed through a bed of Al_2O_3 to get rid of decomposition products. Yield 78–80%, mp 168–169°C (EtOAc) (mp 166–168°C [23]). IR spectrum, ν, cm^{-1}: 3100–3180 (OH), 1640 (C=N). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.77 t (2H, CH_2), 4.08 t (2H, CH_2), 5.10 br.s (1H, OH), 7.03 t (1H, H^6), 7.22 t (1H, H^7), 7.40–7.80 m ($8H_{Ar}$). Found, %: C 73.48; H 5.33; N 15.02. $C_{17}H_{15}N_3O$. Calculated, %: C 73.63; H 5.45; N 15.15.

1-(3-Hydroxypropyl)-2-phenylimidazo[1,2-*a*]-benzimidazole (VIc). In 8 ml of monoethanolamone was heated 10 mmol of compound **IVc** hydrobromide over 4 h at 160°C, cooled to ~80°C, and poured into 40 ml of cold water. The separated precipitate was filtered off, washed with water, dried, and recrystallized from EtOH. Yield 82%, mp 155–156°C. IR spectrum, ν, cm^{-1}: 3120 (OH), 1630, 1580, 1555 (C=C, C=N). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 1.98 quintet (2H, CH_2), 3.46 t (2H, CH_2O), 4.25 t (2H, NCH_2), 7.10–7.75 m ($10H_{Ar}$). Found, %: C 74.41; H 5.72; N 14.58. $C_{18}H_{17}N_3O$. Calculated, %: C 74.21; H 5.88; N 14.42.

2-(4-Bromophenyl)-1-hydroxyethylimidazo[1,2-*a*]benzimidazole (Vd). A solution of 1.12 g (3 mmol) of

compound **IIId** in 30 ml of concn. HCl was boiled till the initial compound was totally consumed (~25 h). The reaction mixture was cooled, neutralized with 22% aqueous NH_4OH, the precipitate was filtered off. Yield 1.02 g (95%), mp 197–198°C (decomp., dioxane or MεCN). IR spectrum, ν, cm^{-1}: 3150 (broad band of associated OH), 1635 (C=N), 1600, 1565 (C=C). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 4.08 s [4H, $(CH_2)_2$], 5.40–6.30 br.s (1H, OH), 7.10–7.60 m ($9H_{Ar}$). Found, %: C 57.14; H 4.15; Br 22.31; N 11.70. $C_{17}H_{14}BrN_3O$. Calculated, %: C 57.32; H 3.96; Br 22.43; N 11.80.

The melting of aminoalcohol **IIId** (215°C, 1 h) occurred with partial decomposition. Yield of compound **Vd** in this case was 72%.

1-(2-Hydroxyethyl)-2-(2-thienyl)imidazo[1,2-*a*]-benzimidazole (Ve). In 12 ml of DMF was boiled 3.82 g (10 mmol) of compound **IIIe** hydrobromide for 4 h, then the solution was cooled and poured into 50 ml of water, alkalinized with 22% aqueous NH_4OH to pH 9, the separated precipitate was filtered off and thoroughly washed with water. On recrystallization from 10 ml of EtOH yellowish crystals were obtained, mp 161–162°C (decomp.). Yield 2.07 g (73%). IR spectrum, ν, cm^{-1}: 3110–3180 (OH), 1640 (C=N). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.88 t (2H, CH_2O), 4.17 t (2H, NCH_2), 5.08 br.s (1H, OH), 7.01 t (1H, H^6), 7.12–7.23 m (2H, $H^{7,4'}$), 7.42–7.51 m (2H, $H^{3',5'}$), 7.54 d (1H, H^5), 7.67 d (1H, H^8), 7.78 s (1H, H^3). Found, %: C 63.42; H 4.50; N 14.97; S 11.11. $C_{15}H_{13}N_3OS$. Calculated, %: C 63.58; H 4.62; N 14.83; S 11.32.

1-(3-Hydroxypropyl)-2-(2-thienyl)imidazo-[1,2-*a*]benzimidazole (VIe) was similarly obtained. Yield 72%, mp 137–138°C (decomp., MeCN). IR spectrum, ν, cm^{-1}: 3110–3180 (OH), 1640, 1600 (C=N). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 1.91 quintet (2H, CH_2), 3.57–3.69 m (4H, NCH_2, CH_2O), 5.14 br.s (1H, OH), 7.13–7.54 m ($6H_{Ar}$), 7.61 d (1H, H^8), 7.85 s (1H, H^3). Found, %: C 64.47; H 5.21; N 14.02; S 10.63. $C_{16}H_{15}N_3OS$. Calculated, %: C 64.62; H 5.08; N 14.13; S 10.78.

1-Pivaloylmethyl-2-(2-chloroethylamino)benz-imidazole (XIb). With 5 ml of freshly distilled $POCl_3$ was thoroughly stirred 1.07 g (3 mmol) of compound **IIIb** hydrobromide. The mixture was left standing at 20–24°C with intermittent shaking till the precipitate dissolved completely (6–8 h). Then the solution was poured on a crushed ice, cautiously at cooling it was neutralized with 22% aqueous NH_4OH or with Na_2CO_3 and chloroethyl-amine was extracted **XIb** with chloroform (3×10 ml). The extract was evaporated, the residue was recrystallized from EtOAc. Yield 0.81 g (92%), mp 141–142°C. IR spectrum, ν, cm^{-1}: 3325 (NH), 1720 (C=O), 1660 (C=N). ^1H NMR spectrum of compound **XIb** hydrochloride (DMSO-d_6–CCl_4), δ, ppm: 1.28 s (9H, *t*-Bu), 3.75–3.96 m [4H, $(CH_2)_2$], 5.67 s (2H, CH_2CO), 7.13–7.35 m (3H, $H^{5,6,7}$), 7.44 d (1H, H^8), 9.91 t (1H, NH), 13.54 br.s (1H, N^+H). Found, %: C 61.50; H 6.81; Cl 12.23; N 14.17. $C_{15}H_{20}ClN_3O$. Calculated, %: C 61.32; H 6.86; Cl 12.07; N 14.30.

1-Phenacyl-2-(2-chloroethylamino)benzimidazole (XIc). To a dispersion of 1.5 g (5 mmol) of base **IIIc** in 25 ml of anhydrous $CHCl_3$ was added dropwise at stirring 0.7 ml (10 mmol) of freshly distilled $SOCl_2$. The formed solution was boiled for 1 h, cooled, the separated precipitate of compound **XIc** hydrochloride was filtered off and washed with petroleum ether. Yield 1.71 g (97%). Large colorless crystals, mp 207–208°C (decomp., 2-PrOH). ^1H NMR spectrum of compound **XIc** hydrochloride (DMSO-d_6–CCl_4), δ, ppm: 3.64 t (2H, CH_2Cl), 3.87 s (2H, NCH_2), 6.07 s (2H, CH_2CO), 7.15–7.74 m ($7H_{Ar}$), 8.01 d (1H, H^8), 8.08 s (1H, H^3), 9.71 t (1H, NH), 13.85 br.s (1H, N^+H). Found, %: C 58.11; H 5.07; Cl 20.04; N 12.16. $C_{17}H_{16}ClN_3O{\cdot}HCl$. Calculated, %: C 58.30; H 4.89; Cl 20.24; N 12.00.

After treating the salt with NH_4OH solution base **XIb** was obtained. Yield 87%, mp 115–116°C (from benzene). IR spectrum, ν, cm^{-1}: 1580, 1600, 1610 (C=C, C=N), 1680 (C=O), 3300 (NH). Found, %: C 65.24; H 5.09; Cl 11.12; N 13.50. $C_{17}H_{16}ClN_3O$. Calculated, %: C 65.07; H 5.14; Cl 11.30; N 13.39.

1-(4-Bromophenacyl)-2-chloroethylaminobenz-imidazole (XId) hydrochloride was analogously prepared. Yield 95%, mp 216–218°C (decomp., EtOH–Et_2O). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.76–4.00 m (4H, NCH_2, CH_2Cl), 6.13 s (2H, CH_2CO), 7.10–7.56 m ($4H_{Ar}$), 7.75 d (1H, H^5), 8.00–8.10 m (2H, $H^{8,3}$), 9.90 t (1H, NH), 14.17 br.s (1H, N^+H). Found, %: C 47.42; H 3.84; Br + Cl 35.37; N 9.90. $C_{17}H_{15}BrClN_3O{\cdot}HCl$. Calculated, %: C 47.58; H 3.76; Br + Cl 35.14; N 9.79.

By treating the obtained hydrochloride with NH_4OH solution base **XId** was obtained whose melting point we failed to determine for the compound without melting slowly converted at heating into compound **XIIId** hydrochloride, mp ~275°C. IR spectrum, ν, cm^{-1}: 3190 (NH), 1700 (C=O), 1605, 1580, 1510 (C=C, C=N). Found,

%: C 52.12; H 3.75; Br + Cl 29.18; N 10.79. $C_{17}H_{15}BrClN_3O$. Calculated, %: C 52.00; H 3.85; Br + Cl 29.38; N 10.70.

9-Pivaloylmethyl-2,3-dihydro-imidazo[1,2-*a*]benzimidazole (XIIIb) hydrochloride. In 10 ml of dry *o*-xylene was boiled 3 mmol of chloroethylamine **XIb** till the completion of conversion (TLC monitoring). On cooling the precipitate was filtered off and washed with petroleum ether. Yield 87%, mp 248–249°C (decomp., 2-PrOH). IR spectrum, ν, cm^{-1}: 2530–2600 (C=N$^+$H), 1715 (C=O), 1670 (C=N$^+$). ^{1}H NMR spectrum (DMSO-d_6), δ, ppm: 1.30 s (9H, *t*-Bu), 4.35–4.54 m [4H, $(CH_2)_2$], 5.77 s (2H, CH_2CO), 7.21 t (1H, H^6), 7.28 t (1H, H^7), 7.33 d (1H, H^5), 7.40 d (1H, H^8), 10.15 s (1H, N$^+$H). Found, %: C 61.18; H 7.01; Cl 12.00; N 14.25. $C_{15}H_{19}N_3O{\cdot}HCl$. Calculated, %: C 61.32; H 6.86; Cl 12.07; N 14.30.

Base XIIIb is a light-yellow oily substance. IR spectrum, ν, cm^{-1}: 1720 (C=O), 1660 (C=N), 1600, 1580, 1490 (C=C). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 1.18 s (9H, *t*-Bu), 3.81 t (2H, CH_2), 4.09 t (2H, CH_2), 4.65 s (2H, CH_2CO), 6.42–6.85 m ($4H_{Ar}$). Found, %: C 69.92; H 7.51; N 16.37. $C_{15}H_{19}N_3O$. Calculated, %: C 70.01; H 7.44; N 16.33.

9-Phenacyl-2,3-dihydroimidazo[1,2-*a*]-benzimidazole (XIIIc). Base **XIc** (0.96 g, 3 mmol) was heated for 15 min on an oil bath at 135–140°C. The compound first fully melted, then crystallized. The melt was cooled, treated with 10 ml of 22% NH_4OH and $CHCl_3$ (3×6 ml). The chloroform layer was separated, evaporated to a small volume, and passed through a bed of Al_2O_3, elution of phenacyl derivative **XIIIc** with chloroform. Evaporating the eluate provided yellow needle crystals. Yield 0.74 g (88%), mp 178–179°C (decomp., MεCN). IR spectrum, ν, cm^{-1}: 1690 (C=O), 1665 (C=N), 1600, 1580, 1505 (C=C). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 3.85 m (2H, CH_2), 4.12 m (2H, CH_2), 5.10 s (2H, CH_2CO), 6.75–7.90 m ($9H_{Ar}$). Found, %: C 73.44; H 5.52; N 15.03. $C_{17}H_{15}N_3O$. Calculated, %: C 73.63; H 5.45; N 15.15.

9-(4-Bromophenacyl)-2,3-dihydroimidazo[1,2-*a*]benzimidazole (XIIId). A mixture of 1.29 g (3 mmol) of compound **XId** hydrochloride and 0.42 ml (3 mmol) of NEt_3 in 15 ml of anhydrous toluene was heated till the completion of conversion (TLC monitoring). Triethylamine hydrochloride was separated, and the toluene solution was passed through a bed of Al_2O_3, elution with toluene or chloroform. The residue after evaporating the solvent from the eluate was recrystallized from EtOAc to obtain 0.86 g (80%) of colorless crystals, mp 141–142°C (decomp., MeCN). IR spectrum, ν, cm^{-1}: 1695 (C=O), 1600, 1580, 1510 (C=C), 1660 (C=N). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 3.92 t (2H, CH_2), 4.25 t (2H, CH_2), 5.26 s (2H, CH_2CO), 6.67 d (1H, H^5), 6.76 d (1H, H^8), 6.89 t (1H, H^6), 6.97 t (1H, H^7), 7.62 d (2H, H$^{3',5'}$), 7.88 d (2H, H$^{2',6'}$). Found, %: C 57.50; H 3.91; Br 22.29; N 12.00. $C_{17}H_{14}BrN_3O$. Calculated, %: C 57.32; H 3.96; Br 22.43; N 11.80.

10-Phenacyl-2,3,4,10-tetrahydropyrimido[1,2-*a*]-benzimidazole (XIVc). The chlorination of 1.95 g (5 mmol) of compound **IVc** hydrobromide in 25 ml of anhydrous $CHCl_3$ was performed by treating with 0.72 ml (10 mmol) of thionyl chloride. The mixture was boiled till complete disappearance of initial aminoalcohol, then it was evaporated, the residue was treated with 22% aqueous NH_4OH (10 ml), and the product was extracted into chloroform (2×15 ml). The extract was evaporated, the residue (a mixture of chloroamine **XIIc** and tricycle **XIVc**) was heated for 20 min at 110–120°C, treated again with ammonia solution and chloroform (10 ml). The chloroform extract was passed through a bed of Al_2O_3 (5 × 3.5 cm), elution of compound **XIVc** with chloroform. The solution was evaporated, the residue was recrystallized from MeCN. Yield 1.26 g (83%), mp 168–169°C (decomp.). IR spectrum, ν, cm^{-1}: 1695 (C=O), 1650 (C=N), 1610, 1600, 1490 (C=C). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm: 1.89 quintet (2H, CH_2), 3.45 t (2H, NCH_2), 3.76 t (2H, NCH_2), 5.15 s (2H, CH_2CO), 6.88–7.35 m ($9H_{Ar}$). Found, %: C 74.11; H 5.73; N 14.28. $C_{18}H_{17}N_3O$. Calculated, %: C 74.21; H 5.88; N 14.42.

10-(4-Bromophenacyl)-2,3,4,10-tetrahydro-pyrimido[1,2-*a*]benzimidazole (XIVd) was obtained similarly. Yield 82%, mp 146–147°C (decomp.) IR spectrum, ν, cm^{-1}: 1700 (C=O), 1655 (C=N), 1610, 1593, 1500 (C=C). ^{1}H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 1.89 quintet (2H, 3-CH_2), 3.45 t (2H, 4-CH_2), 3.75 t (2H, 2-CH_2) 5.10 s (2H, CH_2CO), 6.80–7.24 m ($4H_{Ar}$), 7.35 d (2H, H$^{3',5'}$), 7.93 d (2H, H$^{2',6'}$). Found, %: C 58.50; H 4.27; Br 21.42; N 11.24. $C_{18}H_{16}BrN_3O$. Calculated, %: C 58.39; H 4.36; Br 21.58; N 11.35.

2-Phenyl-1-(2-chloroethyl)imidazo[1,2-*a*]-benzimidazole (VIIc, X = Cl). In 20 ml of $POCl_3$ was boiled 10 mmol of aminoalcohol **IIIc** or its hydrobromide till the completion of the reaction (1.5–2 h). Then $POCl_3$ was distilled off in a vacuum of a water-jet pump. The residue was treated with NH_4OH solution till neutral reaction, and the separated base **VIIb** was extracted with chloroform or benzene. The extract was passed through

a bed of γ-Al_2O_3 eluting with the same solvents and collecting the fraction with R_f 0.9. Yield 95%, mp 147°C (MeCN). IR spectrum, cm^{-1}: 1650 (C=N), 1610, 1600, 1500 (C=C). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.80 t (2H, CH_2Cl), 4.30 t (2H, NCH_2), 7.10–7.70 m ($10H_{Ar}$). Found, %: C 68.85; H 4.90; Cl 11.88; N 14.37. $C_{17}H_{14}ClN_3$. Calculated, %: C 69.04; H 4.77; Cl 11.99; N 14.21.

2-(2-Thienyl)-1-(2-chloroethyl)imidazo[1,2-*a*]-benzimidazole (VIIe, X = Cl) was obtained analogously. Yield 93%, mp 123–124°C (MeCN). IR spectrum, ν, cm^{-1}: 1640 (C=N), 1610, 1600, 1520 (C=C). ^1H NMR spectrum of compound **VIIe** hydrochloride (DMSO-d_6–CCl_4), δ, ppm: 4.02 t (2H, CH_2Cl), 4.73 t (2H, NCH_2), 7.20–7.85 m ($6H_{Ar}$), 8.07 d (1H, H^8), 8.48 s (1H, H^3), 13.40–15.00 br.s (1H, N^+H). Found, %: C 59.61; H 4.07; Cl 11.62; N 13.99; S 10.71. $C_{15}H_{12}ClN_3S$. Calculated, %: C 59.70; H 4.01; Cl 11.75; N 13.92; S 10.62.

2-(3-Bromopropylamino)-1-pivaloylmethyl-benzimidazole (XIIb, X = Br) hydrobromide. In 10 ml of concn. HBr was boiled 1.11 g (3 mmol) of salt **IVb** over 5–6 h. On cooling the slightly colored precipitate was filtered off and washed with acetone. Yield 1.20 g (92%). On crysatallyzation from EtOH colorless crystals were obtained, mp 206–207°C. IR spectrum, ν, cm^{-1}: 3240, 3100 (NH, N^+H), 1690 (C=O). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 1.28 s (9H, *t*-Bu), 2.24 quintet (2H, CH_2), 3.49–3.68 m (4H, NCH_2, CH_2Br), 5.61 s (2H, $COCH_2$), 7.13–7.54 m ($4H_{Ar}$), 9.11 t (1H, NH), 13.13 br.s (1H, N^+H). Found, %: C 44.47; H 5.30; Br 36.97; N 9.58. $C_{16}H_{22}BrN_3O$·HBr. Calculated, %: C 44.36; H 5.35; Br 36.89; N 9.70.

2-(3-Bromopropylamino)-1-thenoylmethylbenz-imidazole (XIIe, X = Br) hydrobromide was isolated in 91% yield after boiling salt **IVe** in concn. HBr. On crysatallyzation from EtOH with carbon colorless crystals were obtained, mp 211–212°C. IR spectrum, ν, cm^{-1}: 3210, 3150 (NH, N^+H), 1680 (C=O), 1670 (C=N^+H). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 2.22 quintet (2H, CH_2), 3.52–3.68 m (4H, NCH_2, CH_2Br), 5.93 s (2H, $COCH_2$), 7.15–7.57 m ($5H_{Ar}$), 8.03 d (2H, H^4), 8.24 d (1H, H^7), 9.06 t (1H, NH), 13.26 br.s (1H, N^+H). Found, %: C 41.90; H 3.68; Br 34.93; N 9.11; S 6.90. $C_{16}H_{16}BrN_3OS$·HBr. Calculated, %: C 41.85; H 3.73; Br 34.80; N 9.15; S 6.98.

10-Pivaloylmethyl-2,3,4,10-tetrahydropyrimido-[1,2-*a*]benzimidazole (XIVb). With excess NH_4OH solution was treated 0.87 g (2 mmol) of compound **XIIb** hydrobromide, after 1 h the precipitate was extracted with chloroform. The extract was passed through a bed of Al_2O_3, elution of base **XIVb** with chloroform. On evaporating the eluate the residue was recrystallized from EtOAc or hexane. Yield 0.5 g (93%), mp 76–77°C. IR spectrum, ν, cm^{-1}: 1710 (C=O), 1650 (C=N), 1610, 1500 (C=C). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 1.29 s (9H, *t*-Bu), 1.95 quintet (2H, CH_2), 3.50 t (2H, NCH_2), 3.81 t (2H, NCH_2), 4.77 s (2H, CH_2CO), 6.47 d (1H, H^7), 6.75 d (1H, H^8), 6.82–6.98 m (2H, $H^{6,9}$). Found, %: C 70.73; H 7.84; N 15.42. $C_{16}H_{21}N_3O$. Calculated, %: C 70.82; H 7.80; N 15.48.

10-(Thenoyl-2-methyl)-2,3,4,10-tetra-hydropyr-imido[1,2-*a*]benzimidazole (XIVe) hydrobromide was similarly obtained. Yield 91%, mp 290–291°C (decomp., EtOH). IR spectrum, ν, cm^{-1}: 1675(C=O), 1655 (C=N^+H), 1630, 1590, 1510 (C=C). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 2.30 quintet (2H, CH_2), 3.63 t (2H, NCH_2), 4.24 t (2H, NCH_2), 6.10 s (2H, CH_2CO), 7.20–7.55 m ($5H_{Ar}$), 7.95 d (1H, H^6), 8.28 d (1H, H^9), 9.96 br.s (1H, N^+H). Found, %: C 50.93; H 4.21; Br 21.20; N 11.04; S 8.42. $C_{16}H_{15}N_3OS$·HBr. Calculated, %: C 50.80; H 4.26; Br 21.12; N 11.11; S 8.48.

1-(2-Bromoethyl)-2-phenylimidazo[1,2-*a*]-benzimidazole (VIIc, X = Br) hydrobromide. The base of compound **VIIc** was isolated as an oily substance in 87% yield after boiling salt **IIIc** in concn HBr for 4–5 h, treating the separated precipitate with NH_4OH and its chromatography on a column packed with γ-Al_2O_3 (eluent $CHCl_3$). On acidifying its acetone solution with conc. HBr we obtained compound **VIIc** hydrobromide, mp 241–242°C. IR spectrum, ν, cm^{-1}: 1650 (C=N), 1610, 1600, 1510 (C=C). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.80 t (2H, CH_2Br, J_{HH} 6.2 Hz), 4.82 t (2H, NCH_2, J_{HH} 6.2 Hz), 7.40 t (1H, H^6, J_{HH} 7.4 Hz), 7.50 t (1H, H^7, J_{HH} 7.4 Hz), 7.54–7.66 m (5H, $H^{2',3',4',5',6'}$), 7.78 d (1H, H^5, J_{HH} 8.1 Hz), 8.08 d (1H, H^8, J_{HH} 8.0 Hz), 8.33 s (1H, H^3). Found, %: C 48.52; H 3.53; Br 38.05; N 9.90. $C_{17}H_{14}BrN_3$·HBr. Calculated, %: C 48.49; H 3.59; Br 37.95; N 9.98.

2-(2-Bromoethylamino)-1-phenacylbenzimid-azole (XIc, X = Br) hydrobromide was obtained by prolonged boiling (20–30 h) in 48% HBr of azoles **IIIc** or **Vc**. Yield 82%, mp 225–226°C (decomp., EtOH). IR spectrum, ν, cm^{-1}: 3310 (NH), 1680 (C=O), 1610, 1600, 1590 (C=C, C=N). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.66 t (2H, CH_2Br, J_{HH} 6.2 Hz), 3.91 q (2H, NCH_2, $^2J_{HH}$ 12.3, $^3J_{HH}$ 6.0 Hz), 6.02 s (2H, $COCH_2$), 7.12–7.78 m ($7H_{Ar}$), 8.12 d (2H, $H^{2',6'}$, J_{HH} 7.2 Hz), 9.32 t

(1H, NH, J_{HH} 5.8 Hz), 13.39 br.s (1H, N^+H). Found, %: C 46.44; H 3.85; Br 36.50; N 9.58. $C_{17}H_{16}BrN_3O \cdot HBr$. Calculated, %: C 46.50; H 3.90; Br 36.40; N 9.60.

1-(3-Bromopropyl)-2-phenylimidazo[1,2-*a*]-benzimidazole (VIIIc, X = Br) hydrobromide. In 10 ml of 48% HBr was boiled 0.98 g (2.5 mmol) of compound **IVc** hydrobromide until on TLC plates disappeared all spots save that with R_f 0.9 (6–7 h). The precipitate was filtered off and washed with acetone. Yield 1.03 g (96%). On recrystallization from EtOH and prolonged drying at 105–110°C to remove the crystallization water mp 213–214°C (decomp.). IR spectrum, ν, cm^{-1}: 1640 (C=N), 1600, 1520 (C=C). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 2.26 quintet (2H, CH_2), 3.44 t (2H, CH_2Br), 4.33 t (2H, NCH_2), 7.40–7.68 m ($7H_{Ar}$), 7.79 d (1H, H^5), 8.08 d (1H, H^8), 8.40 s (1H, H^3). Found, %: C 49.59; H 3.90; Br36.80; N 9.71. $C_{18}H_{16}BrN_3 \cdot HBr$. Calculated, %: C49.68; H 3.94; Br 36.72; N 9.66.

The base isolated after treating the salt obtained with ammonia solution was an oily substance that on standing in air spontaneously underwent an intramolecular cyclization giving **tetracyclic salt Xc,** R_f 0.1, insoluble in $CHCl_3$ and acetone. Yield quantitative, mp 282–283°C (EtOH). IR spectrum, ν, cm^{-1}: 1510, 1610 (C=C), 1635 (C=N). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 2.62 quintet (2H, CH_2), 4.47 q (4H, $2NCH_2$, $^2J_{HH}$ 5.3, $^3J_{HH}$ 3.6 Hz), 7.42–7.75 m ($7H_{Ar}$), 7.84 d (1H, H^5), 8.17 d (1H, H^8), 8.55 s (1H, H^3). Found, %: C 60.97; H 4.61; Br 22.45; N 11.97. $C_{18}H_{16}BrN_3$. Calculated, %: C 61.03; H 4.55; Br 22.56; N 11.86.

2-(4-Bromophenyl)-1-(2-bromoethyl)imidazo-[1,2-*a*]benzimidazole (VIId, X = Br) was prepared in 79% yield after heating salt **IIId** in 48% HBr till the primarily separated oily substance completely crystallized and treating the obtained hydrobromide with 22% solution of NH_4OH. The product was purified by column chromatography on γ-Al_2O_3 (eluent benzene) and recrystallization from MeCN, mp 138–139°C. IR spectrum, ν, cm^{-1}: 1640 (C=N), 1600, 1520 (C=C). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 3.79 t (2H, CH_2Br, J_{HH} 6.5 Hz), 4,43 t (2H, NCH_2, J_{HH} 6.6 Hz), 7.08–7.76 m ($9H_{Ar}$). Found, %: C 48.72; H 3.08; Br 38.26; N 9.94. $C_{17}H_{13}Br_2N_3$. Calculated, %: C 48.72; H 3.13; Br 38.13; N 10.03.

1-(3-Bromopropyl)-2-(4-bromophenyl)imidazo-[1,2-*a*]benzimidazole (VIIId, X = Br) was obtained similarly to the base of compounds **VIIIc**. Yield 90%. On recrystallization from EtOH colorless crystals were obtained, mp 120–123°C (the capillary with the substance should be placed in the hot device). IR spectrum, ν, cm^{-1}: 1630 (C=N), 1610, 1600 (C=C). ^1H NMR spectrum of **VIIId** hydrobromide (DMSO-d_6–CCl_4), δ, ppm: 2.20 quintet (2H, CH_2), 3.55 t (2H, CH_2Br), 4.57 t (2H, NCH_2), 7.15–7.82 m ($7H_{Ar}$), 8.05 d (1H, H^8), 8.11 C (1H, H^3). Found, %: C 49.87; H 3.55; Br 36.83; N 9.75. $C_{18}H_{15}Br_2N_3$. Calculated, %: C 49.91; H 3.49; Br 36.90; N 9.70.

By heating 0.87 g (2 mmol) of compound **VIIId** base in 15 ml of *o*-xylene we isolated 0.87 g (quantitative yield) of **tetracycle Xd,** mp 293–294°C (decomp., EtOH). IR spectrum, ν, cm^{-1}: 1640 (C=N), 1600 (C=C). ^1H NMR spectrum (DMSO-d_6–CCl_4), δ, ppm: 2.61 quintet (2H, CH_2), 4.45 d (4H, $2NCH_2$, J_{HH} 3.7 Hz), 7.46 t (1H, H^8), 7.55 t (1H, H^7), 7.62–7.78 m (4H, $H^{2',3',5',6'}$), 7.83 d (1H, H^9), 8.15 d (1H, H^6), 8.60 s (1H, H^3). Found, %: C 49.75; H 3.57; Br 36.75; N 9.93. $C_{18}H_{15}Br_2N_3$. Calculated, %: C 49.91; H 3.49; Br 36.90; N 9.70.

2-(2-Acetoxyethylamino)-1-phenacylbenzimidazole (XVc). A solution of 0.59 g (2 mmol) of amino-alcohol **IIIc** in 6 ml of Ac_2O was maintained at room temperature to the completion of the reaction (3–4 h). The excess Ac_2O was carefully at cooling decomposed with 10 ml of water, and the solution was neutralized with 22% NH_4OH solution to pH 7–8. The separated precipitate was filtered off, washed with water, and dried in air. Yield 0.61 g (90%), mp 138–139°C (decomp., MeCN). The compound was hygroscopic, but easily eliminated water at 100°C (in 2–3 h). IR spectrum, ν, cm^{-1}: 3515 (NH), 1730 ($OCOCH_3$), 1695 (CH_2CO). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 2.00 s (3H, $OCOCH_3$), 3.57 q (2H, NCH_2), 4.20 t (2H, CH_2O), 5.68 s (2H, CH_2CO), 6.82–7.02 m (3H, $H^{5,8,4'}$), 7.10 d (1H, H^6), 7.24 d (1H, H^7), 7.63 t (2H, $H^{3',5'}$), 7.74 t (1H, NH), 8.10 d (2H, $H^{2',6'}$). Found, %: C 67.51; H 5.77; N 12.38. $C_{19}H_{19}N_3O_3$. Calculated, %: C 67.64; H 5.68; N 12.45.

2-(3-Acetoxypropylamino)-1-phenacylbenzimidazole (XVIc) was obtained similarly. Yield 91%. The compound was purified by column chromatography on Al_2O_3 (3×1.5 cm), eluent $CHCl_3$. The oily residue after the evaporation of the eluate was ground with hexane and dried in vacuum-desiccator over P_2O_5, mp 52°C. IR spectrum, ν, cm^{-1}: 3200–3450 (NH), 1720 ($OCOCH_3$), 1700 (CH_2CO), 1610, 1600, 1560, 1460 (C=C, C=N). Found, %: C 68.21; H 6.15; N 11.93. $C_{20}H_{21}N_3O_3$. Calculated, %: C 68.36; H 6.02; N 11.96.

2-(*N*-Acetylamino-2-acetoxyethyl)-1-phenacyl-

benzimidazole (XVIIc). A solution of 0.6 g (2 mmol) of base **IIIc** and 0.65 g (8 mmol) of anhydrous AcONa in 10 ml of Ac_2O was boiled for 1 h, and the hygroscopic diacetyl derivative **XVIIc** was isolated similarly to compound **XVc**. Yield 0.63 g (83%), mp 132–133°C (decomp., from octane). IR spectrum, ν, cm^{-1}: 1735 ($OCOCH_3$), 1690 (CH_2CO), 1675 ($NCOCH_3$). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 1.85 s (3H, $COCH_3$), 1.96 s (3H, $COCH_3$), 3.97 t (2H, CH_2O), 4.28 t (2H, NCH_2), 5.50 s (2H, CH_2CO), 7.07–7.85 m ($7H_{Ar}$), 8.02 d (2H, $H^{2',6'}$). Found, %: C 66.33; H 5.67; N 11.00. $C_{21}H_{21}N_3O_4$. Calculated, %: C 66.48; H 5.58; N 11.07.

The reaction in the absence of AcONa led to the same result.

2-(*N*-Acetylamino-3-acetoxypropyl)-1-phenacylbenzimidazole (XVIIIc). A mixture of 0.62 g (2 mmol) of base **IVc**, 0.65 g (8 mmol) of anhydrous AcONa, and 4 ml of Ac_2O was boiled for 1 h. Oily substance separated after the cautious decomposition of excess Ac_2O and the neutralization of the solution was extracted into $CHCl_3$, and the extract was passed through the bed of Al_2O_3 (eluent $CHCl_3$). The residue after the evaporation of the eluate was ground with hexane. Yield 0.67 g (87%). Hygroscopic crystals, mp 47–48°C (from octane). IR spectrum, ν, cm^{-1}: 1733 ($OCOCH_3$), 1700 (CH_2CO), 1680 ($NCOCH_3$). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 1.88–2.10 m (8H, $2CH_3$, CH_2), 3.94–4.15 m (4H, NCH_2, CH_2O), 5.46 s (2H, CH_2CO), 7.05–7.86 m ($7H_{Ar}$), 8.02 d (2H, $H^{2',6'}$). Found, %: C 67.03; H 5.75; N 10.74. $C_{22}H_{23}N_3O_4$. Calculated, %: C 67.16; H 5.89; N 10.68.

2-(*N*-Acetylamino-2-acetoxyethyl)-1-(2-thenoylmethyl)benzimidazole (XVIIe) was obtained by boiling 1.15 g (3 mmol) of compound **IIIe** hydrobromide and 1.5 g of anhydrous AcONa in 15 ml of AC_2O over 1–1.5 h. Yield 1.02 g (88%), mp 100–102°C (EtOAc). IR spectrum, ν, cm^{-1}: 1753 ($OCOCH_3$), 1720 (CH_2CO), 1686 ($NCOCH_3$), 1666 (C=N). ^1H NMR spectrum ($CDCl_3$), δ, ppm: 2.00 s (6H, $2CH_3$), 3.68 t (2H, CH_2), 4.25 t (2H, CH_2), 5.08 s (2H, CH_2CO), 7.00–7.80 m ($7H_{Ar}$). Found, %: C 59.39; H 5.21; N 11.17; S 8.12. $C_{19}H_{19}N_3O_4S$. Calculated, %: C 59.20; H 4.97; N 10.90; S 8.32.

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