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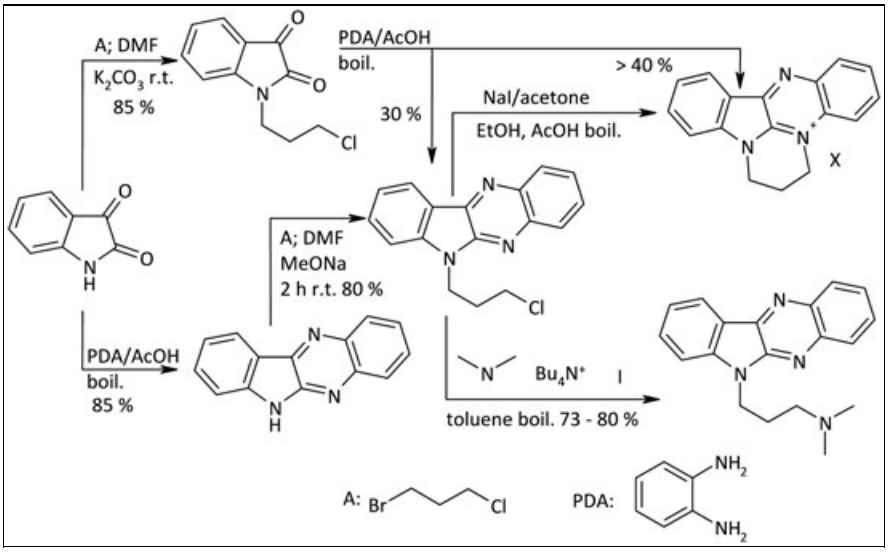

A series of 6-(3-aminopropyl)-6H-indolo[2,3-b]quinoxalines were synthesized with high yields by the reaction of 6-(3-chloropropyl)-6H-indolo[2,3-b]quinoxaline and corresponding amines in presence of tetrabutylammonium iodide in boiling toluene or dimethylformamide at room temperature. It was found that boiling of 6-(3-chloropropyl)-6H-indolo[2,3-b]quinoxaline in acetone with sodium iodide or in acetic acid lead to intramolecular cyclization product.

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INTRODUCTION

The indoloquinoxaline (Figure 1, n = 2) were synthesized by Bergman and coworkers [1,2] and shown as DNA intercalators [3,4] and antivirals against different species of Herpesviridae family [1]. These compounds have demonstrated antitumor [5] and antimicrobial activity [6,7] also. Regarding intercalation ability of the above compounds, we have synthesized some new 6-aminoethyl-6H-indolo[2,3-b]quinoxaline derivatives and resynthesized known ones and have shown that they are highly effective interferon inductors and demonstrate high antiviral activity against vesicular stomatitis virus [8]. It is known that interaction of the cationic side-chain amino group play very important role in the ligands' DNA affinity and their sequence selectivity [9,10]. That is why the side chain elongation retained our attention. For obtaining of new potential DNA intercalators and interferon inductors synthesis of 6-aminoalkyl-6H-indolo[2,3-b]quinoxalines (Figure 1, n = 3−6) is seemed as rational. The aim of this work was to synthesize 6-aminopropyl-6H-indolo[2,3-b] quinoxalines (n = 3).

RESULTS AND DISCUSSION

Isatin (**1**) alkylation according [8] with 1-bromo-3-chloropropane in DMF at room temperature in the presence

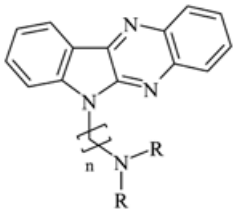
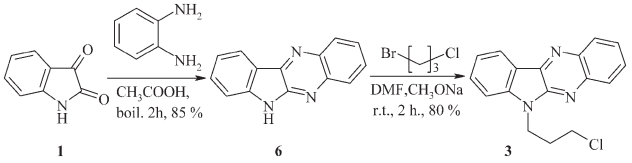


Figure 1. General structure of 6-aminoalkyl-6H-indolo[2,3-b]quinoxalines.

Scheme 2. Synthesis of 6-(3-chloropropyl)-6H-indolo-[2,3-b]quinoxaline.



of potassium carbonate gives the 1-chloropropylisatine (**2**) with 85% yield after recrystallization from heptane (Scheme 1).

Further condensation of **2** with 1,2-diaminobenzene under the boiling in acetic acid leads to the 6-chloropropyl-6H-indolo-[2,3-b]quinoxaline (**3**) with low yield (30%), whereas the condensation of bromoethylisatine (**4**) with 1,2-diaminobenzene under the same conditions leads to appropriate tetracycle **5** with 80% yield [8].

On the other hand, 6-chloropropyl-6H-indolo-[2,3-b] quinoxaline (**3**) may be synthesized *via* indoloquinoxaline alkylation by 1-bromo-3-chloropropane. 6H-Indolo-[2,3-b] quinoxaline (**6**) was prepared according to a published method [11] with 85% yield (Scheme 2). Alkylation of **6** was carried out in dimethylformamide at room temperature in the presence of equimolar quantity of sodium methylate in methanol, and the product **3** was obtained in such manner with 80% yield (Scheme 2).

Aminodechlorination of **3** under treating with excess of dipropylamine in boiling benzene or DMF under room temperature during 70 h leads to 6-dipropylaminopropyl-indoloquinoxaline (**11**) with yield less then 10%. Using of ethanol as a solvent in this synthesis yielded 30% of **11**, therewith insoluble in benzene compound was isolated with nearly 40% yield. In consideration of low reactivity of **3**, chlorine replacement by iodine was attempted *via* boiling of **3** in acetone in presence of sodium iodide (Scheme 3). But, obtainment the iododerivative **7** was failed, because the reaction led to another product highly soluble in polar solvents (water, methanol, and ethanol) and insoluble in nonpolar ones (heptane, benzene, and chloroform) and similar to the analogues in the previous case. In addition it was found, that compound **8** formed by boiling in acetic acid during 2 h 6-chloropropyl-6H-indolo-[2,3-b]quinoxaline (**3**) (Scheme 3). It is possible, this product formation is a main reason of the compound **3** low yields while condensation of **2** with 1,2-diaminobenzene in the acetic acid media.

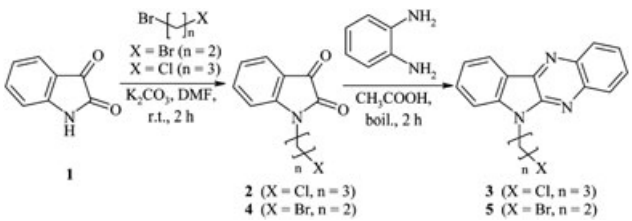
The molecular ions peak with *m/z* = 260, which may be corresponded to the intramolecular cyclization product **8**, is present in FAB mass-spectra of both obtained side products. The structure of product **8** was proved by single-crystal X-ray diffraction analysis. View of **8** (X = I) is shown in Figure 2. Molecules with the exception of hydrogen atoms of methylene groups attached to nitrogen atoms and methylene group associated with C10 is flat. The deviations of nonhydrogen atoms (except C10) from the common plane are in the range −0.073(3) to −0.126(3) Å with a root mean square deviation of fitted atoms equals to 0.061 Å. Atom C10 deviates from this plane on 0.628(4) Å, thus six-membered N1, C8, N2, C9, C10, and C11 cycle has envelop conformation. Bond length of N1 and N2 atoms, Table 1, reveals the delocalization of double N=C bond, the distances N1−C8 = 1.336(4) Å and N2−C8 = 1.324(4) Å coincide within three standard deviations. The bond length N3−C7 = 1.292 (4) corresponds to double bond. The average C—C bond length in benzene rings equals 1.400 Å. Bond angles [°] for compound **8** are listed in Table 2.

Avoiding compound **8** formation, we carried out obtaining of amines **9**−**17** *via* two-step one-pot synthesis of compound **3** with corresponding amine excess in presence of 10 mol % of tetrabutylammonium iodide in boiling toluene (compounds **10**−**17**) or dimethylformamide (compound **9**) at room temperature (Scheme 4).

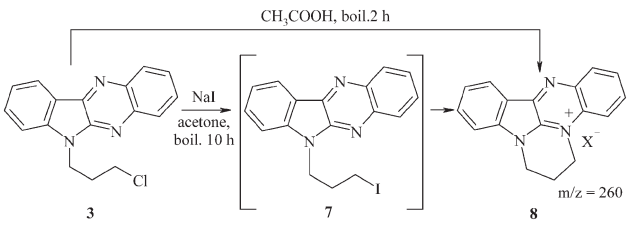
Purity of all synthesized compounds was controlled by thin-layer chromatography on precoated silica gel F_{254} plates using eluents of different composition.

The structure of the synthesized compounds was proved by mass-spectrometry, NMR-spectroscopy, and elemental analyses.

Scheme 1. Synthesis of 6-(3-chloropropyl)- and 6-(2-bromoethyl)-6H-indolo-[2,3-b]quinoxalines.



Scheme 3. Synthesis of 6-iodopropyl-6H-indolo-[2,3-b]quinoxaline.



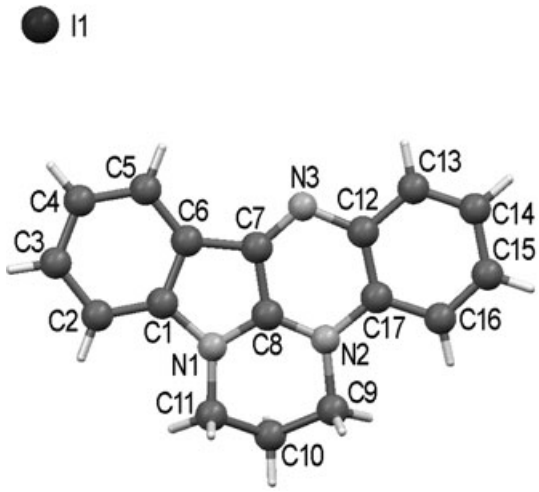


Figure 2. Molecular structure of **8** with numbering scheme.

Molecular ions peaks (MH^+) with intensity 100% are present in mass-spectra with ionization method of fast atom bombardment (FAB). Fragment ions set correspond to suggested structures. The signals of aromatic and aliphatic protons are observed in ^{1}H NMR-spectra of synthesized indoloquinoxaline derivatives. The integral intensity and multiplicity of signals correspond to assigned structures.

EXPERIMENTAL

All melting points are uncorrected. ^{1}H NMR spectra were recorded on a "Bruker Avance II" (400 MHz) spectrometer in $CDCl_3$ solutions with TMS as an internal standard. Mass-spectra with FAB ionization were recorded on a VG 70-70 EQ spectrometer. Ionization was realized using beam of argon-atoms with energy 10 kV (the compounds were dissolved in 3-nitrobenzyl alcohol). Thin-layer chromatography was performed on precoated silica gel F_{254} plates (Merck).

X-ray structure determination. Crystal data for **8**, $C_{17}H_{14}I_1N_3$: M = 387.21, crystal dimensions 0.15 × 0.10 × 0.10 mm^3, monoclinic, space group $P2_1/n$ (no. 14), a = 7.0937(2) Å, b = 16.4411(5), c = 12.8016(3), β = 94.4618(13), Å, V = 1488.50(7) Å^3, Z = 4, F(000) = 760, Dc = 1.728 g/m^3, T = 100(2) K, μ (Mo − Kα) = 2.148 mm^{-1}, Nonius Kappa-CCD diffractometer, θ max = 28.49, 3760 [R(int) = 0.0336] unique reflections, completeness = 99.9%. The structure was solved by direct methods refined by full-matrix least squares based on F^2 using the program SHELXL97 [12]. The structure reveals disorder, which may be treated as packing defect. Molecules related by mirror reflection occupy in the crystal the same place with probability 66.6 and 33.3%. The positions of peripheral atoms of overlapping molecules coincide within the resolution of data, whereas two different positions of some internal atoms (N1, N2, N3, C7, and C8) were well defined and unambiguously identified. Two mirror-like overlapping molecules (all atoms) were included in the model and restrains were applied during refinement to make these molecules geometrically equal. All nonhydrogen atoms were refined with anisotropic displacement parameters. The hydrogen atoms were included in the models in calculated positions and were refined as constrained to the bonding atoms with isotropic temperature factors equal to 1.2 times the value of the equivalent isotropic displacement parameter of the parent carbon atom. Refinement converged at R_1 = 0.0250, wR_2 = 0.0646 for all data and 263 parameters [R_1 = 0.0234, wR_2 = 0.0636 for 3587 reflections with $Io > 2\sigma(Io)$]. The goodness-of-fit on F2 was equal 1.004. A weighting scheme $w = [\sigma 2(Fo^2 + (0.0329P)^2 + 2.30P]^{-1}$ where $P = (\max(Fo^2, 0) + 2Fc^2)/3$ was used in the final stage of refinement. The residual electron density largest different peak and hole = 0.679 and −0.523 eÅ^{-3}. Crystallographic data for the structures in this article have been deposited with the Cambridge Crystallographic Centre as supplementary publication numbers CCDC 787810. Copies of data can be obtained, free of charge, on application to CCDC, 12 Union Road, Cambridge CB2 1EZ, UK.

1-(3-Chloropropyl)-1H-indole-2,3-dione (2). Potassium carbonate 33.5 g (0.17 mole) was added to a stirred solution of 10 g (0.068 mole) 1H-indole-2,3-dione (**1**) in 100-mL dimethylformamide, then 7 mL (10.7 g, 0.068 mole) 1-bromo-3-chloropropane was added. After stirring at room temperature for 2 h, the inorganic precipitate was filtered and washed with DMF 3 × 7 mL. Filtrate was evaporated under reduced pressure, and the residue was washed with water and filtered.

The product was dried and crystallized from heptane to yield 13.0 g (85%), mp 94−95°C; ^{1}H NMR ($CDCl_3$): δ 2.108−2.337 (m, 2H, CH_2CH$_2$Cl), 3.613 (t, J = 6.3 Hz, 2H, CH_2Cl), 3.860−3.915 (m, 2H, CH_2(CH$_2$)$_2$Cl), 6.983−7.023 (m, 1H, ArH), 7.119 (t, J = 7.5 Hz, 1H, ArH), 7.559−7.637 (m, 2H, ArH); MS: m/z = 225, 223 (M^+). Anal. calcd. for $C_{11}H_{10}ClNO_2$: C, 59.07; H, 4.51; N, 6.26. Found: C, 59.13; H, 4.58; N, 6.19.

6-(3-Chloropropyl)-6H-indolo[2,3-b]quinoxaline (3). Method 1. A mixture of 5.0 g (0.022 mole) 1-(3-chloropropyl)-1H-indole-2,3-dione (**2**), 2.38 g (0.022 mole) *o*-phenylenediamine, and 60 mL of acetic acid was boiled under reflux for 2 h. Then to a reaction mixture was added 500 mL of water, and the product was extracted with chloroform (4 × 20 mL). The organic layer was separated,

Table 1

Bond lengths [Å] for the major occupancy position of disordered atoms for compound **8**.

N1-C8	1.336 (4)	C1–C2	1.392 (4)	C9–C10	1.540 (6)
N1-C1	1.411 (5)	C1–C6	1.414 (5)	C10–C11	1.512 (6)
N1-C11	1.449 (5)	C2–C3	1.421 (5)	C12–C13	1.401 (5)
N2-C8	1.324 (4)	C3–C4	1.406 (6)	C12–C17	1.416 (5)
N2-C17	1.394 (5)	C4–C5	1.407 (6)	C13–C14	1.361 (6)
N2-C9	1.508 (5)	C5–C6	1.404 (5)	C14–C15	1.404 (6)
N3-C7	1.292 (4)	C6–C7	1.479 (5)	C15–C16	1.364 (6)
N3-C12	1.379 (4)	C7–C8	1.446 (4)	C16–C17	1.407 (4)

Table 2

Bond angles [°] for the major occupancy position of disordered atoms for compound **8**.

C8-N1-C1	108.2 (3)	C5-C4-C3	120.3 (4)	C11-C10-C9	113.5 (3)
C8-N1-C11	120.9 (3)	C4-C5-C6	119.0 (4)	N1-C11-C10	108.3 (4)
C1-N1-C11	130.7 (3)	C5-C6-C1	120.2 (4)	C13-C12-C17	119.2 (3)
C8-N2-C17	117.2 (3)	C5-C6-C7	134.4 (3)	C13-C12-N3	116.0 (3)
C8-N2-C9	119.1 (3)	C1-C6-C7	105.5 (3)	C17-C12-N3	124.8 (3)
C17-N2-C9	123.5 (3)	N3-C7-C8	123.2 (3)	C14-C13-C12	120.5 (4)
C7-N3-C12	114.8 (3)	N3-C7-C6	131.9 (3)	C13-C14-C15	119.3 (4)
C2-C1-N1	128.2 (3)	C8-C7-C6	104.8 (3)	C16-C15-C14	122.3 (4)
C2-C1-C6	121.6 (3)	N2-C8-N1	126.6 (3)	C15-C16-C17	118.2 (4)
N1-C1-C6	110.2 (3)	N2-C8-C7	122.1 (3)	N2-C17-C16	122.1 (3)
C1-C2-C3	117.7 (4)	N1-C8-C7	111.3 (3)	N2-C17-C12	117.8 (3)
C2-C3-C4	121.1 (3)	C10-C9-N2	108.6 (3)	C16-C17-C12	120.1 (3)

dried over anhydrous sodium sulphate, and the solvent evaporated under reduced pressure to afford the crude product. The crude product was purified by column chromatography over silica gel using benzene as eluent.

Yield: 1.95 g (30%), mp 141−142°C (decomp.); ^{1}H NMR ($CDCl_3$): δ 2.434−2.499 (m, 2H, CH_2CH$_2$Cl), 3.625 (t, J = 7.8 Hz, 2H, CH_2Cl), 4.636 (t, J = 7.8 Hz, 2H, CH_2(CH$_2$)$_2$Cl), 7.381 (t, J = 8.4 Hz, 1H, ArH), 7.568 (d, J = 8.0 Hz, 1H, ArH), 7.656−7.771 (m, 3H, ArH), 8.125 (dd, J_1 = 0.8 Hz, J_2= 8.4 Hz, 1H, ArH), 8.302 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.474 (d, J = 8.6 Hz, 1H, ArH); MS: m/z = 298, 296 (M^+). Anal. calcd. for $C_{17}H_{14}ClN_3$: C, 69.04; H, 4.77; N, 14.21. Found: C, 69.10; H, 4.75; N, 14.20.

6H-Indolo[2,3-b]quinoxaline (6). 6H-Indolo[2,3-b]quinoxaline (6) was prepared by Schunck and Marchlewski's method [11]. After recrystallization from dimethylformamide, it formed yellow needles. Yield: 85%, mp 294−295°C.

6-(3-Chloropropyl)-6H-indolo[2,3-b]quinoxaline (3). Method 2. To a suspension of 10 g (0.046 mole) 6H-indolo[2,3-b]quinoxaline (**6**) in dimethylformamide (200 mL) was added 9.1-mL 5 M solution of sodium methylate in methanol, and the mixture was stirred at room temperature for 10 min. Then, 4.5-mL (7.2 g, 0.046 mole) 1-bromo-3-chloropropane was added, and reaction mixture was stirred at room temperature for 2 h. After reaction completion reaction mixture was evaporated under reduced pressure to dryness, the residue was washed with water (5 × 50 mL) and dried. The crude product was purified by crystallization from heptane to yield 10.8 g (80%), mp 140−141°C (decomp.).

2,3-Dihydro-1H-3a,8-diaza-12b-azonia-benzo[e]acephenanthrylene iodide (8). A mixture of 5g (0.017 mole) 6-(3-chloropropyl)-6H-indolo[2,3-b]quinoxaline (**3**), 2.57 g (0.017 mole) sodium iodide and 200-mL acetone was boiled under reflux for 10 h. The reaction mixture was cooled, and the orange precipitate was collected, washed with acetone 3 × 5 mL and crystallized from ethanole to yield 5.9 g (90%), mp > 250°C; MS: m/z = 260 (M^+).

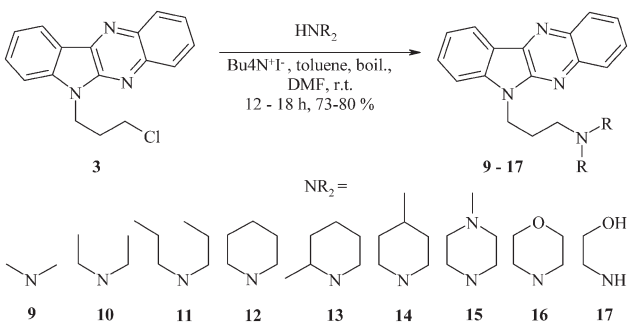
(3-Indolo[2,3-b]quinoxalin-6-ylpropyl)-dimethylamine (9). A mixture of 1.37 mL (0.010 mole) 33% water solution of dimethylamine, 1.0 g (0.0034 mole) 6-(3-chloropropyl)-6H-indolo [2,3-b]quinoxaline (**3**), 0.13 g (0.00034 mole) tetrabutylammonium iodide, and 30-mL dimethylformamide was stirred at room temperature for 12−14 h. The completion of reaction was followed by TLC. After completion, a mixture was evaporated under reduced pressure. The residue was dissolved in 30-mL benzene and extracted with 10% acetic acid (4 × 20 mL). This acetous extract was neutralized with saturated solution of sodium carbonate to pH = 9 and extracted with chloroforme (4 × 20 mL). The organic layer was separated, dried over anhydrous sodium sulphate, and the solvent evaporated under reduced pressure to afford the crude product. The crude product was purified by column chromatography over silica gel using benzene: triethylamine (20:1) as eluent.

Yield: 0.78 g (75%), mp 106−107°C; ^{1}H NMR ($CDCl_3$): δ 2.074−2.168 (m, 2H, CH_2CH$_2$N(CH$_3$)$_2$), 2.247 (s, 6H, N(CH_3)$_2$), 2.389 (t, 2H, J = 7.5 Hz, CH_2N(CH$_3$)$_2$), 4.515 (t, J = 6.9 Hz, 2H, CH_2(CH$_2$)$_2$N(CH$_3$)$_2$), 7.341 (t, J = 7.5 Hz, 1H, ArH), 7.523 (d, J = 8.1 Hz, 1H, ArH), 7.618−7.750 (m, 3H, ArH), 8.122 (dd, J_1 = 1.5 Hz, J_2 = 8.1 Hz, 1H, ArH), 8.288 (dd, J_1 = 1.5 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.454 (d, J = 7.8 Hz, 1H, ArH); MS: m/z = 305 (MH^+). Anal. calcd. for $C_{19}H_{20}N_4$: C, 74.97; H, 6.62; N, 18.41. Found: C, 74.92; H, 6.58; N, 18.35.

General procedure for the synthesis of compounds 10−17. A mixture of 1.0 g (0.0034 mole) 6-(3-chloropropyl)-6H-indolo[2,3-b]quinoxaline (**3**), 0.13 g (0.00034 mole) tetrabutylammonium iodide, 30-mL toluene, and 0.010 mole corresponding amine was boiled under reflux for 12−18 h. The completion of reaction was followed by TLC. After completion, a reaction mixture was extracted with water (6 × 30 mL) to pH = 7, then with 10% acetic acid (4 × 20 mL). The acetous extract was neutralized with saturated solution of sodium carbonate to pH = 9 and extracted with chloroforme (4 × 20 mL). The organic layer was separated, dried over anhydrous sodium sulphate, and the solvent evaporated under reduced pressure to afford the crude product. The crude product was purified by column chromatography over silica gel using benzene:triethylamine (20:1) as eluent.

Diethyl-(3-indolo[2,3-b]quinoxalin-6-ylpropyl)-amine (10). Yield: 0.89 g (79%), mp 85−86°C; ^{1}H NMR ($CDCl_3$): δ 0.999 (t, J = 7.2 Hz, 6H, N(CH$_2$CH_3)$_2$), 2.070−2.166 (m, 2H, CH_2CH$_2$N(C$_2$H$_5$)$_2$),

Scheme 4. Synthesis of 6-aminopropyl-6H-indolo-[2,3-b]quinoxalines.



2.506−2.603 (m, 6H, $CH_2N(CH_2CH_3)_2$), 4.506 (t, J = 7.2 Hz, 2H, $CH_2(CH_2)_2N(C_2H_5)_2$), 7.346 (t, J = 7.5 Hz, 1H, ArH), 7.509 (d, J = 7.2 Hz, 1H, ArH), 7.621−7.755 (m, 3H, ArH), 8.123 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.290 (dd, J_1 = 1.5 Hz, J_2 = 7.8 Hz, 1H, ArH), 8.460 (d, J = 7.8 Hz, 1H, ArH); MS: m/z = 333 (MH^+). Anal. calcd. for $C_{21}H_{24}N_4$: C, 75.87; H, 7.28; N, 16.85. Found: C, 75.89; H, 7.24; N, 16.90.

(3-Indolo[2,3-b]quinoxalin-6-ylpropyl)-dipropylamine (11). Yield: 0.94 g (77%), mp 66−67°C; ^{1}H NMR ($CDCl_3$): δ 0.873 (t, J = 7.5 Hz, 6H, $N(CH_2CH_2CH_3)_2$), 1.417−1.543 (m, 4H, $N(CH_2CH_2CH_3)_2$), 2.103−2.198 (m, 2H, $CH_2CH_2N(C_3H_7)_2$), δ 2.440 (t, J = 7.8 Hz, 4H, $N(CH_2CH_2CH_3)_2$), 2.633 (m, J = 6.6 Hz, 2H, $CH_2N(C_3H_7)_2$), 4.533 (t, J = 6.9 Hz, 2H, $CH_2(CH_2)_2N(C_3H_7)_2$), 7.366 (t, J = 6.9 Hz, 1H, ArH), 7.531 (d, J = 8.7 Hz, 1H, ArH), 7.614−7.795 (m, 3H, ArH), 8.129 (dd, J_1 = 0.9 Hz, J_2 = 8.1 Hz, 1H, ArH), 8.301 (dd, J_1 = 1.2 Hz, J_2 = 8.1 Hz, 1H, ArH), 8.476 (d, J = 8.1 Hz, 1H, ArH); MS: m/z = 361 (MH^+). Anal. calcd. for $C_{23}H_{28}N_4$: C, 76.63; H, 7.83; N, 15.54. Found: C, 76.55; H, 7.78; N, 15.55.

6-(3-Piperidin-1-ylpropyl)-6H-indolo[2,3-b]quinoxaline (12). Yield: 0.89 g (76%), mp 116−117°C; ^{1}H NMR ($CDCl_3$): δ 1.337−1.486 (m, 2H, $N(CH_2CH_2)_2CH_2$), 1.523−1.683 (m, 4H, $N(CH_2CH_2)_2CH_2$), 2.161−2.255 (m, 2H, $CH_2CH_2N(CH_2CH_2)_2CH_2$), 2.303−2.538 (m, 6H, $CH_2N(CH_2CH_2)_2CH_2$), 4.540 (t, J = 6.9 Hz, 2H, $CH_2(CH_2)_2N(CH_2CH_2)_2CH_2$), 7.355 (t, J = 7.2 Hz, 1H, ArH), 7.572 (d, J = 8.1 Hz, 1H, ArH), 7.614−7.783 (m, 3H, ArH), 8.121 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.296 (dd, J_1 = 1.5 Hz, J_2 = 7.8 Hz, 1H, ArH), 8.463 (d, J = 7.8 Hz, 1H, ArH); MS: m/z = 345 (MH^+). Anal. calcd. for $C_{22}H_{24}N_4$: C, 76.71; H, 7.02; N, 16.26. Found: C, 76.69; H, 7.11; N, 16.27.

6-[3-(2-Methylpiperidin-1-yl)propyl]-6H-indolo[2,3-b]quinoxaline (13). Yield: 0.90 g (74%), mp 95−96°C; ^{1}H NMR ($CDCl_3$): δ 1.110 (d, J = 6.3 Hz, 3H, $CHCH_3$), 1.144−1.302 (m, 6H, $NCH(CH_3)CH_2(CH_2)_3$), 1.590−1.908 (m, 4H, $NCH_2(CH_2)_2NCH(CH_3)CH_2(CH_2)_3$), 2.444−2.619 (m, 2H, $NCH(CH_3)CH_2(CH_2)_3$), 2.729−2.829 (m, 1H, $CHCH_3$), 4.601 (t, J = 7.8 Hz, 2H, $CH_2(CH_2)_2NCH(CH_3)CH_2(CH_2)_3$), 7.402 (t, J = 7.5 Hz, 1H, ArH), 7.580 (d, J = 8.1 Hz, 1H, ArH), 7.650−7.804 (m, 3H, ArH), 8.107 (dd, J_1 = 1.5 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.317 (dd, J_1 = 1.8 Hz, J_2 = 8.1 Hz, 1H, ArH), 8.486 (d, J = 7.8 Hz, 1H, ArH); MS: m/z = 359 (MH^+). Anal. calcd. for $C_{23}H_{26}N_4$: C, 77.06; H, 7.31; N, 15.53. Found: C, 77.11; H, 7.33; N, 15.69.

6-[3-(4-Methylpiperidin-1-yl)propyl]-6H-indolo[2,3-b] quinoxaline (14). Yield: 0.96 g (79%), mp 97−98°C; ^{1}H NMR ($CDCl_3$): δ 0.909 (d, J = 6.0 Hz, 3H, $CHCH_3$), 1.234−1.346 (m, 3H, $N(CH_2CH_2)_2CHCH_3$), 1.619−1.662 (m, 2H, $N(CH_2CH_2)_2CHCH_3$), 2.156−2.227 (m, 2H, $N(CH_2'CH_2)_2CHCH_3$), 2.910 (t, J = 7.2 Hz, 2H, $CH_2N(CH_2CH_2)_2CHCH_3$), 3.094−3.131 (m, 2H, $N(CH_2CH_2')_2CHCH_3$), 4.651 (t, J = 7.2 Hz, 2H, $CH_2CH_2N(CH_2CH_2)_2CHCH_3$), 7.353 (t, J = 6.9 Hz, 1H, ArH), 7.585 (d, J = 8.1 Hz, 1H, ArH), 7.624−7.757 (m, 3H, ArH), 8.116 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.289 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.454 (d, J = 7.5 Hz, 1H, ArH); MS: m/z = 359 (MH^+). Anal. calcd. for $C_{23}H_{26}N_4$: C, 77.06; H, 7.31; N, 15.63. Found: C, 77.06; H, 7.41; N, 15.65.

6-[3-(4-Methylpiperazin-1-yl)-propyl]-6H-indolo[2,3-b]quinoxaline (15). Yield: 0.95 g (78%), mp 129−130°C; ^{1}H NMR ($CDCl_3$): δ 2.085−2.176 (m, 2H, $CH_2CH_2N(CH_2CH_2)_2N$), 2.313 (s, 3H, NCH_3), 2.412−2.456 (m, 10H, $CH_2N(CH_2CH_2)_2N$), 4.540 (t, 2H, J = 6.9 Hz, $NCH_2(CH_2)_2N(CH_2CH_2)_2N$), 7.327 (t, J = 7.2 Hz, 1H, ArH), 7.542 (d, J = 8.7 Hz, 1H, ArH), 7.610−7.777 (m, 3H, ArH), 8.108 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.295 (dd, J_1 = 1.8 Hz, J_2 = 8.1 Hz, 1H, ArH), 8.465 (d, J = 8.1 Hz, 1H, ArH); MS: m/z = 360 (MH^+). Anal. calcd. for $C_{22}H_{25}N_5$: C, 73.51; H, 7.01; N, 19.48. Found: C, 73.48; H, 6.95; N, 19.39.

6-(3-Morpholin-4-ylpropyl)-6H-indolo[2,3-b]quinoxaline (16). Yield: 0.94 g (80%), mp 90−91°C; ^{1}H NMR ($CDCl_3$): δ 2.101−2.168 (m, 2H, $CH_2CH_2N(CH_2CH_2)_2O$), 2.356−2.415 (m, 6H, $CH_2N(CH_2CH_2)_2O$), 3.641 (t, J = 4.8 Hz, 4H, $N(CH_2CH_2)_2O$), 4.558 (t, 2H, J = 6.8 Hz, $CH_2(CH_2)_2N(CH_2CH_2)_2O$), 7.358 (t, J = 7.6 Hz, 1H, ArH), 7.549 (d, J = 8.4 Hz, 1H, ArH), 7.643−7.682 (m, 3H, ArH), 8.111 (dd, J_1 = 1.2 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.299 (dd, J_1 = 0.8 Hz, J_2 = 8.4 Hz, 1H, ArH), 8.473 (d, J = 7.6 Hz, 1H, ArH); MS: m/z = 360 (MH^+). MS: m/z = 347 (MH^+). Anal. calcd. for $C_{21}H_{22}N_4O$: C, 72.81; H, 6.40; N, 16.17. Found: C, 72.75; H, 6.37; N, 16.17.

2-(3-Indolo[2,3-b]quinoxalin-6-ylpropylamino)-ethanol (17). Yield: 0.58 g (73%), mp 125−126°C; ^{1}H NMR ($CDCl_3$): δ 2.017−2.172 (m, 2H, $CH_2CH_2NHCH_2CH_2MH$), 2.397−2.629 (m, 3H, NCH_2CH_2MH), 2.702 (t, J = 5.1 Hz, 2H, $NHCH_2CH_2OH$), 3.651 (t, J = 7.8 Hz, 2H, $CH_2NCH_2CH_2OH$), 4.557 (t, 2H, J = 6.3 Hz, $CH_2(CH_2)_2NHCH_2CH_2OH$), 7.362 (t, J = 7.5 Hz, 1H, ArH), 7.474 (d, J = 8.4 Hz, 1H, ArH), 7.601−7.784 (m, 3H, ArH), 8.125 (d, J = 8.4 Hz, 1H, ArH), 8.282 (d, J = 8.1 Hz, 1H, ArH), 8.468 (d, J = 7.8 Hz, 1H, ArH); MS: m/z = 321 (MH^+). Anal. calcd. for $C_{19}H_{20}N_4O$: C, 71.23; H, 6.29; N, 17.49. Found: C, 71.30; H, 6.20; N, 17.41.

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