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Phendione in the Synthesis of Annelated Derivatives of 4,7-Phenanthroline

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Abstract—By condensation of 5-phenyl-1,3-cyclohexanedione with 6-quinolylamine and aldehydes of aromatic, heterocyclic, and cyclohexene series new 12-aryl(heteryl, cyclohexenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-ones were prepared. The presence of diastereomers in the target reaction products was determined by ^{1}H NMR spectroscopy.

Cyclic β-diketones due to their high reactivity are widely used in the synthesis of fused nitrogen-containing heterocycles [1–4]. Aiming at preparation of new biologically active 4,7-phenanthroline [5, 6] derivatives having two asymmetric carbon atoms we studied for the first time the reactions of phendione [5-phenyl-1,3-cyclohexanedione (**I**)] with 6-quinolylamine (**II**) and aldehydes of aromatic, heteroaromatic, and cyclohexene series **IIIa–IIIz, III**α–**III**γ. The condensation was performed by boiling at reflux of equimolar amounts or reagents in 1-butanol without catalyst. As a result 12-aryl(heteryl, cyclohexenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]-phenanthrolin-11-ones **IVa–IVz, IV**α–**IV**γ were obtained in 32–76% yield.

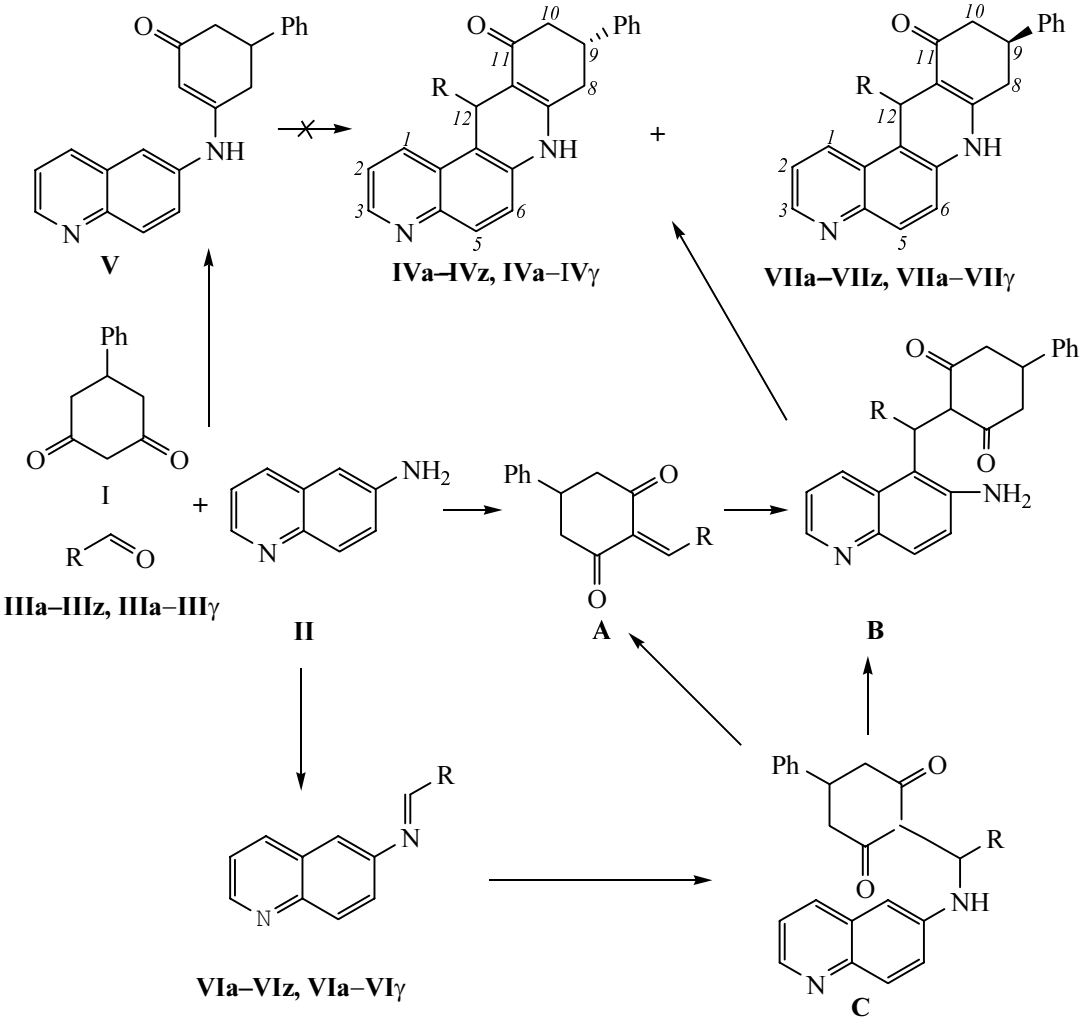
The formation of benzo[*b*]annelated products suggests that in the three-component reagents mixture first diketone **I** reacts with 6-quinolylamine (**II**) to give 5-phenyl-3-(6-quinolylamino)-2-cyclohexene-1-one (**V**) which further undergoes cyclocondensation with arylaldehydes **IIIa–IIIz, III**α–**III**γ into 4,7-phenanthrolines **IVa–IVz, IV**α–**IV**γ**.** We isolated previously unknown aminoenone **V** in condensation of phendione (**I**) with 6-quinolylamine (**II**) and *p*-tolualdehyde **III**δ**,** but aminoenone **V** did not enter into the reaction with arylaldehydes under the given condensation conditions.

The second possible pathway of 4,7-phenanthrolines **IVa–IVz, IV**α–**IV**γ formation consists in phendione (**I**) reaction with aldehyde **IIIa–IIIz III**α–**III**γ followed by the addition of the arising 2-[aryl(heteryl, cyclohexenyl)-methylene]-5-phenyl-1,3-cyclohexanedione **A** to 6-quinolylamine (**II**) at the carbon atom possessing the highest electron density and situated in position *5* of the quinoline structure and thereafter by cyclization of the aminodiketone **B** obtained.

A reaction route thorough reaction between 6-quinolylamine (**II**) with aldehydes **IIIa–IIIz, III**α–**III**γ is also presumable affording arylmethylene-6-quinolylamines **VIa–VIz, VI**α–**VI**γ with further addition of phendione (**I**) to the C=N bond of the azomethine. The formed aminodiketone **C** suffers a hydramine cleavage into 6-quinolylamine and 2-arylmethylene-5-phenyl-1,3-cyclohexanedione **A** which react with each other as described above. Azomethines **VIa–VIz, VI**α–**VI**γ that we obtained in a preparative yield from 6-quinolylamine (**II**) and aldehydes **IIIa–IIIz, III**α–**III**γ [7, 8] cleanly react with phendione (**I**) under our conditions for three-component condensation to yield compounds **IVa–IVz, IV**α–**IV**γ. Inasmuch as we failed to isolate the intermediate products **A**–**C** we believe that they take part in the presumed processes *in situ.*

Aminodiketone **B** might arise as a result of intermediate **C** rearrangement through migration of an arylmethylenephendione fragment into the position *5* of the quinoline skeleton, similar to the transformation of halides of alkyl-, dialkylanilines, and trialkylphenylammonium salts known under the name of Hofmann–Martius rearrangement [9, 10]. A similar reaction mechanism involving aminodiketones **B** and **C** was described for reaction of 2-naphthylamine [analog of 6-quinolylamine (**II**)] with aromatic aldehydes and dimedone [2].

The substituent R in the aldehyde molecule slightly affects the yield of reaction products **IVa–IVz, IV**α–**IV**γ. Aldehydes **IIId, IIIe, IIIg, IIIi, IIIj, IIIn, IIIo, IIIq–IIIt, IIIv** containing halogen in the *ortho*-position of the benzene ring and in *meta*- and *para*-positions



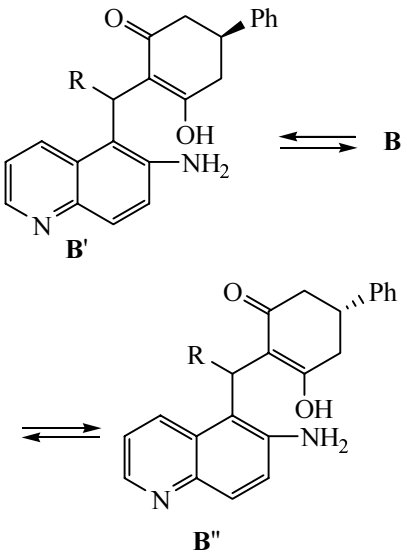
III, IV, VI, VII, R = Ph (**a**), 2-MeC_6H_4 (**b**), 4-*i*-PrC_6H_4 (**c**), 2,3-$Cl_2C_6H_3$ (**d**), 2-BrC_6H_4 (**e**), 3-BrC_6H_4 (f), 2-IC_6H_4 (**g**), 2-$CF_3C_6H_4$ (**h**), 3-HOC_6H_4 (**i**), 4-HOC_6H_4 (**j**), 2-$MeOC_6H_4$ (**k**), 2,4-$(MeO)_2C_6H_3$ (**l**), 2,5-$(MeO)_2C_6H_3$ (**m**), 3,4-$(MeO)_2C_6H_3$ (**n**), 3,4,5-$(MeO)_3C_6H_2$ (**o**), 2-MeO, 5-BrC_6H_3 (**p**), 3,4-$(OCH_2O)C_6H_3$ (**q**), 4-$EtOC_6H_4$ (**r**), 4-$PrOC_6H_4$ (**s**), 4-$MeOCOC_6H_4$ (**t**), 4-PhC_6H_4 (**u**), 4-$PhCH_2OC_6H_4$ (**v**), 2-pyridyl (**w**), 3-pyridyl (**x**), 4-$MeSC_6H_4$ (**y**), 2-thienyl (**z**), 2-(3-methyl)thienyl (α), cyclohex-3-enyl (β), 4-MeC_6H_4 (γ).

a methoxycarbonyl, a hydroxy, and alkoxy groups that activate the aldehyde molecule by–*I*- or –*I*- and –*M*-effect afford in high yields the reaction products **IVd, IVe, IVg, IVi, IVj, IVm–IVo, IVq–t, IVv** disregarding the possible sterical hindrances from the *ortho*-substituent. A sufficiently high yield of phenanthrolines **IVw** and **IVx** was obtained at the use of pyridinecarbaldehydes **IIIw** and **IIIx**. In this case the increase in the polarization and in the reactivity of the C=O bond of the aldehyde was due to the–*I*-effect of the nitrogen in the pyridine ring. The lower yield of reaction products **IVb, IVk**, and **IVl** observed at the use of 2-methyl, 2-methoxy, and 2,4-dimethoxybenzaldehyde was apparently caused by the sterical hindrance by the *ortho*-substituent.

In the IR spectra of compounds **IVa–IVz, IV**α**–IV**γ strong bands are present at 1665 and 1525 cm^{-1} that should be assigned to a vinylog amide fragment (1580, 1520 cm^{-1}) [2]. Strong bands at 3280 and 1640 cm^{-1} correspond to the stretching and bending vibrations respectively of the secondary amino group. The stretching vibrations of alkyl groups and cycloaliphatic CH bonds appear in the region of 2960–2870 cm^{-1}, the absorption bands belonging to vibrations of CH bonds in the aromatic rings are located at 3060–3030 cm^{-1}. In the IR spectra of compounds **IVk–IVt** and **IVv** the bands corresponding to the fragment C–O–C appear in the region 1240–1230 cm^{-1}, in the spectrum of compound **IVy** the strong band of the stretching vibrations of the C–S bond is observed at 1125 cm^{-1}, in the spectrum of

phenanthroline **IVt** the ν(C=O) band of the ester group is seen at 1725–1720 cm^{-1}.

^{1}H NMR spectra of compounds **IVa–IVz, IV**α–**IV**γ are identical to the previously measured spectra of 4,7-phenanthrolines [11] with respect to the position and multiplicity of signals of aromatic protons attached to the phenanthroline skeleton. The analysis of the aliphatic region of the spectrum revealed that the isolated reaction products consist of a mixture of two isomers either with pseudoaxial position of the phenyl group at C^9 atom (isomers **IVa–IVz, IV**α–**IV**γ) or with the pseudoequatorial position of the same substituent (isomers **VIIa–VIIz, VII**α–**VII**γ). The obvious reason of formation of diastereomeric phenanthrolines **IV** and **VII** originates from the fact that although the intermediate molecule **B** is formally symmetrical in the phendione part, actually it exists in a ketoenol form characteristic of β-diketones. Therewith the two equally probable enol forms **B'** and **B"** are chiral and enantiomeric with respect to each other.



The heterocyclization of each enantiomer results in an individual phenanthroline. Inasmuch as both carbonyl groups of intermediate **B** are equivalent the ketoenols **B′** and **B″** form with equal probability, and the reaction products should contain isomers with the axial and equatorial phenyl group in equal amounts.

In the ^{1}H NMR spectra of the reaction products signals of protons attached to C^9 were identified as two multiplets in the region 3.24–3.61 ppm. According to the chemical shift value and the half-width of the signal the more upfield resonance was assigned to H^9 proton with the axial orientation (isomer **VII**), and more downfield signal was assigned to H^9 proton with the equatorial orientation (isomer **IV**). The half-width of signal belonging to C^{9}H$_a$ is larger than that of proton signal from C^{9}H$_e$, since the value $J_{a,a'}$ (~9 Hz) is significantly greater than $J_{a,e'}$ and $J_{e,e'}$ (~6 Hz).

In the spectra of isomer mixture **IV** and **VII** the singlet signals of protons were revealed attached to the nitrogen and to C^{12} whose integral intensities corresponded to the intensities of proton signals at C^9 atom. In isomer (**IV**) with the axial phenyl group attached to C^9 the protons of the NH group and H^{12} occur in the region of shielding from the benzene ring and thus these signals appear more upfield than in isomer **VII** with the equatorially oriented phenyl.

It should be noted that only from the product obtained applying *o*-bromobenzaldehyde **IIIe** was successfully isolated from the isomer mixture by crystallization individual compound **IVe**.

In the ^{1}H NMR spectra of compounds **IVd–IVh, IVk–IVm, IVp, VIId–VIIh, VIIk–VIIm, VIIp** containing in the *ortho*-position of the benzene ring a halogen atom, trifluoromethyl, or methoxy group, and also in the spectra of 2-pyridyl- and 2-thienyl-substituted 4,7-phenanthrolines **IVw, IVz** and **VIIw, VIIx** a downfield shift was observed for the signals of protons H^1 and H^{12} attached to the phenanthroline skeleton. This shift for proton H^{12} is due to reduced shielding of this atom because of the *–I*-effect of the above mentioned substituents and of the nitrogen or sulfur in the position *2* of the pyridine or thiophene ring. In the case of 4,7-phenanthrolines having as *ortho*-substituents a halogen or a trifluoromethyl group a clear compliance is observed for proton H^{12} with the data on the electronegativity and shielding: With the growing size of the halogen atom and decrease in its electronegativity the deshielding effect of the atom and the chemical shift value diminish in the series of the *ortho*-derivatives: CF_3>Cl>Br>I. The chemical shift of signal from proton H^1 is virtually insensitive to the growing size of atoms and groups. The downfield shift of this signal is apparently caused by the sterical effect of the substituent in the *ortho*-position of the benzene ring: this substituent affects the position of the benzene ring and thus decreases the shielding of the H^1 proton attached to the phenanthroline skeleton.

In the mass spectra of benzophenanthrolines **IVa–IVz, IV**α–**IV**γ and **VIIa–VIIz, VII**α–**VII**γ appeared molecular ion peaks $[M]^+$ (*I* 14–36%). The most abundant (100%) in the spectra was ion peak $[M - R]^+$ (*m/z* 325). In the spectra of all phenanthrolines a peak is present with *m/z* 193 (12–25%) originating from the elimination of $PhCHCH_2CO$ fragment from the ion $[M - R]^+$.

EXPERIMENTAL

IR spectra were measured on a Fourier spectrometer Nicolet Protege-460. NMR spectra were registered on spectrometers Bruker AC-500 (500 MHz) and Tesla BS-567 (100 MHz) in DMSO-d_6; internal reference TMS. Mass spectra were taken on a Finnigan MAT. INCOS 50 instrumant at ionizing electrons energy 70 eV. Melting points of compounds were determined on the Koeffler heating block.

5-Phenyl-1,3-cyclohexanedione (phendione) (**I**) was prepared from diethyl malonate and benzylideneacetone via isolation of 6-phenyl-2,4-dioxocyclohexanecarboxylic acid [12], mp 184–185°C. N-Arylmethylene-6-quinolylamines **IIIa–IIIz, III**α–**III**γ were prepared by methods [7, 8].

12-Aryl(heteryl, cyclohexenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]-phenanthrolin-11-ones IVa–IVz, IVα–**IV**γ and **VIIa–VIIz, VII**α–**VII**γ. *a.* A solution of 5 mmol of phendione (**I**), 5 mmol of 6-quinolylamine (**II**), and 5 mmol of an appropriate aldehyde **IIIa–IIIz, III**α–**III**γ in 20 ml of 1-buranol was boiled for 3–4 h. The separated precipitate of the reaction product **IVa–IVz, IV**α–**IV**γ and **VIIa–VIIz, VII**α–**VII**γ was filtered off, washed with ether, and recrystallized from a mixture ethanol–benzene, 2:1.

b. A solution of 5 mmol of phendione (**I**) and 5 mmol of azomethine **IIIa–IIIz, III**α–**III**γ in 20 ml of 1-butanol was boiled for 2.5–3 h. The reaction products **IVa–IVz, IV**α–**IV**γ and **VIIa–VIIz, VII**α–**VII**γ were isolated as described in procedure *a.*

9,2-Diphenyl-8,9,10,12-tetrahydro-7*H*-benzo-[*b*][4,7]phenanthrolin-11-one (IVa, VIIa). Yield 54%, mp 291–292°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.53 m (2H^{8}), 2.85 m (2H^{10}), 3.24 m, 3.44 m (H^{9}), 5.87 s, 5.91 s (H^{12}), 6.96–7.33 m (H^{2}, 2Ph), 7.50 d, 7.82 d (H^{5,6}, ^3J 8.8), 8.26 d (H^{1}, ^3J 8.4), 8.60 d (H^{3}, ^3J 4.9), 9.51 s, 9.61 s (NH). Found, %: C 83.23; H 5.31; N 6.72. $C_{28}H_{22}N_2O$. Calculated, %: C 83.58; H 5.47; N 6.97.

12-(2-Methylphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVb, VIIb). Yield 32%, mp 215–216°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.41 s (Me), 2.56 m (2H^{8}), 2.81 m (2H^{10}), 3.21 m, 3.45 m (H^{9}), 5.82 s, 5.89 s (H^{12}), 6.80–7.31 m (H^{2}, Ph, 4H$_{arom}$), 7.49 d, 7.80 d (H^{5,6}, ^3J 8.8), 8.18 d (H^{1}, ^3J 8.4), 8.59 d (H^{3}, ^3J 4.5), 9.54 s, 9.65 s (NH). Found, %: C 84.01; H 5.38; N 6.62. $C_{29}H_{24}N_2O$. Calculated, %: C 84.06; H 5.77; N 6.73.

12-[4-(Isopropylphenyl)]-9-phenyl-8,9,10,12-tetrahydro-7H-benzo[b][4,7]phenanthrolin-11-one (IVc, VIIc). Yield 58%, mp 241–242°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.55 m (2H^{8}), 2.70 m (*i*-Pr), 2.85 m (2H^{10}), 3.27 m, 3.42 m (H^{9}), 5.81 s, 5.87 s (H^{12}), 6.91–7.30 m (H^{2}, Ph, 4H$_{arom}$), 7.50 d, 7.81 d (H^{5,6}, ^3J 9.0), 8.28 d (H^{1}, ^3J 8.1), 8.61 d (H^{3}, ^3J 4.3), 9.51 s, 9.60 s (NH). Found, %: C 83.43; H 5.98; N 6.29. $C_{31}H_{28}N_2O$. Calculated, %: C 83.78; H 6.36; N 6.36.

12-(2,3-Dichlorophenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVd, VIId). Yield 70%, mp 270–271°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.50 m (2H^{8}), 2.86 m (2H^{10}), 3.25 m, 3.44 m (H^{9}), 6.12 s, 6.20 s (H^{12}), 7.00 m, 7.14–7.40 m (H^{2}, Ph, 3H$_{arom}$), 7.48 d, 7.81 d (H^{5,6}, ^3J 8.9), 8.41 d (H^{1}, ^3J 7.8), 8.61 d (H^{3}, ^3J 4.2), 9.70 s, 9.79 s (NH). Found, %: C 71.19; H 4.07; C1 14.79; N 5.64. $C_{28}H_{20}C1_2N_2O$. Calculated, %: C 71.35; H 4.25; C1 15.06; N 5.95.

12-(2-Bromophenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVe). Yield 65%, mp 292–293°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.52 m (2H^{8}), 2.88 m (2H^{10}), 3.48 m (H^{9}), 6.00 s (H^{12}), 6.88 s, 7.05 s, 7.12–7.32 m, 7.38 d (H^{2}, Ph, 4H$_{arom}$, ^3J 7.8), 7.47 d, 7.80 d (H^{5,6}, ^3J 9.0), 8.60 d (H^{1,3}, ^3J 8.4), 9.61 s (NH). Found, %: C 69.63; H 4.19; Br 16.51; N 5.87. $C_{28}H_{21}BrN_2O$. Calculated, %: C 69.87; H 4.37; Br 16.60; N5.82.

12-(3-Bromophenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVf, VIIf). Yield 45%, mp 319–320°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.50 m (2H^{8}), 2.85 m (2H^{10}), 3.26 m, 3.46 m (H^{9}), 5.87 s, 5.92 s (H^{12}), 7.00 s, 7.11–7.34 m (H^{2}, Ph, 4H$_{arom}$), 7.49 d, 7.80 d (H^{5,6}, ^3J 9.0), 8.31 d (H^{1}, ^3J 8.0), 8.61 d (H^{3}, ^3J 4.8), 9.50 s, 9.59 s (NH). Found, %: C 69.58; H 4.23; Br 16.42; N 5.59. $C_{28}H_{21}BrN_2O$. Calculated, %: C 69.87; H 4.37; Br 16.60; N 5.82.

12-(2-Iodophenyl)-9-phenyl-8,9,10,12-tetra-hydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVg, VIIg). Yield 60%, mp 275–276°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.53 m (2H^{8}), 2.78 m (2H^{10}), 3.23 m, 3.44 m (H^{9}), 5.89 s, 5.96 s (H^{12}), 6.70 m, 7.05–7.35 m (H^{2}, Ph, 4H$_{arom}$), 7.48 d, 7.81 d (H^{5,6}, ^3J 8.9), 8.60 d (H^{3}, ^3J 4.4), 8.65 d (H^{1}, ^3J 8.1), 9.60 s, 9.70 s (NH). Found, %: C 63.45; H 4.03; I 23.81; N 5.37. $C_{28}H_{21}IN_2O$. Calculated, %: C 63.65; H 3.98; I 24.04; N 5.30.

12-(2-Trifluoromethylphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVh, VIIh). Yield 41%, mp 192–193°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.50 m (2H^{8}), 2.87 m (2H^{10}), 3.22 m, 3.42 m (H^{9}), 6.32 s, 6.40 s (H^{12}),

7.12–7.42 m (H^2, Ph, $4H_{arom}$), 7.50 d, 7.82 d ($H^{5,6}$, ^3J 8.8), 8.22 d (H^1, ^3J 8.3), 8.60 d (H^3, ^3J 5.1), 9.61 s, 9.71 s (NH). Found, %: N 6.06. $C_{29}H_{21}F_3N_2O$. Calculated, %: N 5.22.

12-(3-Hydroxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVi, VIIi). Yield 65%, mp 327–328°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.55 m ($2H^8$), 2.80 m ($2H^{10}$), 3.28 m, 3.42 m (H^9), 5.78 s, 5.82 s (H^{12}), 6.40 m, 6.62 m, 6.88 m, 7.15–7.31 m (H^2, Ph, $4H_{arom}$), 7.50 d, 7.82 d ($H^{5,6}$, ^3J 8.8), 8.30 d (H^1, ^3J 7.9), 8.61 d (H^3, ^3J 4.5), 8.69 s, 8.72 s (OH), 9.53 s, 9.62 s (NH). Found, %: C 80.45; H 5.34; N 6.58. $C_{28}H_{22}N_2O_2$. Calculated, %: C 80.38; H 5.26; N 6.70.

12-(4-Hydroxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVj, VIIj). Yield 60%, mp 325–326°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.53 m ($2H^8$), 2.81 m ($2H^{10}$), 3.26 m, 3.41 m (H^9), 5.72 s, 5.79 s (H^{12}), 6.50 d, 7.00 d 7.1.3–7.32 m (H^2, Ph, $4H_{arom}$, ^3J 7.3), 7.48 d, 7.81 d ($H^{5,6}$, ^3J 9.1), 8.28 d (H^1, ^3J 7.8), 8.60 d (H^3, ^3J 4.7), 8.63 C (OH), 9.48 s, 9.56 s (NH). Found, %: C 80.17; H 5.19; N 6.44. $C_{28}H_{22}N_2O_2$. Calculated, %: C 80.38; H 5.26; N 6.70.

12-(2-Methoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVk, VIIk). Yield 42%, mp 303–304°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.50 m ($2H^8$), 2.86 m ($2H^{10}$), 3.28 m, 3.46 m (H^9), 3.87 s, 3.94 s (OMe), 6.01 s, 6.10 s (H^{12}), 6.50–7.34 m (H^2, Ph, $4H_{arom}$), 7.47 d, 7.80 d ($H^{5,6}$, ^3J 8.9), 8.59 d (H^3, ^3J 4.9), 8.63 d (H^1, ^3J 7.7), 9.62 s 9.74 s (NH). Found, %: C 80.33; H 5.49; N 6.23. $C_{29}H_{24}N_2O_2$. Calculated, %: C 80.56; H 5.56; N 6.48.

12-(2,4-Dimethoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVl, VIIl). Yield 40%, mp 281–282°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.49 m ($2H^8$), 2.83 m ($2H^{10}$), 3.27 m, 3.44 m (H^9), 3.68 s (OMe), 3.91 s, 4.00 s (OMe), 6.04 s, 6.08 s (H^{12}), 7.01–7.31 m (H^2, Ph, $3H_{arom}$), 7.41 d, 7.73 d ($H^{5,6}$, ^3J 8.8), 8.56 d (H^3, ^3J 4.4), 8.62 d (H^1, ^3J 7.4), 9.39 s, 9.49 s (NH). Found, %: C 77.63, H 5.57, N 5.84. $C_{30}H_{26}N_2O_3$. Calculated, %: C 77.92, H 5.63, N 6.06.

12-(2,5-Dimethoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVm, VIIm). Yield 48%, mp 323–324°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.52 m ($2H^8$), 2.80 m ($2H^{10}$), 3.24 m, 3.40 m (H^9), 3.70 s (OMe), 3.90 s, 3.97 s (OMe), 6.00 C, 6.08 C (H^{12}), 6.80–7.30 m (H^2, Ph, $3H_{arom}$), 7.48 d, 7.79 d ($H^{5,6}$, ^3J 9.1), 8.59 d (H^3, ^3J 4.6), 8.63 d (H^1, ^3J 7.5), 9.51 s, 9.60 s (NH). Found, %: C 77.83; H 5.39; N 5.77. $C_{30}H_{26}N_2O_3$. Calculated, %: C 77.92; H 5.63; N 6.06.

12-(3,4-Dimethoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVn, VIIn). Yield 63%, mp 306–307°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.48 m ($2H^8$), 2.80 m ($2H^{10}$), 3.31 m, 3.44 m (H^9), 3.63 s (OMe), 3.70 s (OMe), 5.73 s, 5.83 s (H^{12}), 6.40–7.38 m (H^2, Ph, $3H_{arom}$), 7.49 d, 7.82 d ($H^{5,6}$, ^3J 9.0), 8.30 d (H^1, ^3J 7.7), 8.63 d (H^3, ^3J 5.0), 9.72 s, 9.82 s (NH). Found, %: C 77.75; H 5.42; N 5.71. $C_{30}H_{26}N_2O_3$. Calculated, %: C 77.92; H 5.63: N 6.06.

12-(3,4,5-Trimethoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVo, VIIo). Yield 65%, mp 301–302°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.51 m ($2H^8$), 2.80 m ($2H^{10}$), 3.30 m, 3.45 m (H^9), 3.61 s (2OMe) , 3.70 s (OMe), 5.80 s, 5.86 s (H^{12}), 6.41 C, 7.15–7.35 m (H^2, Ph, $2H_{arom}$), 7.50 d, 7.83 d ($H^{5,6}$, ^3J 8.9), 8.31 d (H^1, ^3J 7.6), 8.62 d (H^3, ^3J 4.8), 9.52 s, 9.62 s (NH). Found, %: C 5.39; H 5.47; N 5.43. $C_{31}H_{28}N_2O_4$. Calculated, %: C 75.61; H 5.69; N 5.69.

12-(5-Bromo-2-methoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVp, VIIp). Yield 49%, mp 316–317°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.56 m ($2H^8$), 2.90 m ($2H^{10}$), 3.31 m, 3.48 m (H^9), 3.98 s, 4.02 s (OMe), 6.05 s, 6.10 s (H^{12}), 6.79 m, 7.06–7.34 m (H^2, Ph, $3H_{arom}$), 7.48 d, 7.80 d ($H^{5,6}$, ^3J 9.0), 8.52 d (H^1, ^3J 8.1), 8.60 d (H^3, ^3J 5.2), 9.50 s, 9.60 s (NH). Found, %: C 67.94; H 4.41; Br 15.23; N 5.26. $C_{29}H_{23}BrN_2O_2$. Calculated %: C 68.11; H 4.50; Br 15.64; N 5.48.

12-(3,4-Methylenedioxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVc, VIIc). Yield 68%, mp 185–186°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.55 m ($2H^8$), 2.85 m ($2H^{10}$), 3.28 m, 3.44 m (H^9), 5.80 m (OCH_2O), 5.86 s, 5.94 s (H^{12}), 6.63 s, 6.80 s, 7.16–7.30 m (H^2, Ph, $3H_{arom}$), 7.49 d, 7.82 d ($H^{5,6}$, ^3J 8.7), 8.32 d (H^1, ^3J 7.6), 8.61 d (H^3, ^3J 4.9), 9.52 s, 9.61 s (NH). Found, %: C 77.38; H 5.39; N 6.04. $C_{29}H_{24}N_2O_3$. Calculated, %: C 77.68; H 5.36; N 6.25.

9-Phenyl-12-(4-ethoxyphenyl)-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVr, VIIr). Yield 65%, mp 302–303°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 1.20 t, 4.11 q (OEt), 2.55 m ($2H^8$), 2.84 m ($2H^{10}$), 3.24 m, 3.44 m (H^9), 5.75 s, 5.83 s (H^{12}), 6.68 d, 7.10 d, 7.16–7.30 m (H^2, Ph, $4H_{arom}$, ^3J 7.2), 7.50 d, 7.82 d ($H^{5,6}$, ^3J 9.0), 8.30 d (H^1, ^3J 7.7),

8.58 d (H^3, ^3J 4.8), 9.51 s, 9.60 s (NH). Found, %: C 80.54; H 5.69; N 6.11. $C_{30}H_{26}N_2O_2$. Calculated, %: C 80.72; H 5.83; N 6.28.

12-(4-Propoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVs, VIIs). Yield 61%, mp 302–303°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 0.94 t, 1.65 q, 3.78 t (OPr), 2.50 m ($2H^8$), 2.81 m ($2H^{10}$), 3.26 m, 3.43 m (H^9), 5.81 s, 5.87 s (H^{12}), 6.62 d, 7.04 d, 7.15–7.35 m (H^2, Ph, $4H_{arom}$, ^3J 7.3), 7.51 d, 7.82 d ($H^{5,6}$, ^3J 9.2), 8.28 d (H^1, ^3J 7.4), 8.59 d (H^3, ^3J 4.6), 9.50 s, 9.60 s (NH). Found, %: C 80.54; H 5.69; N 6.11. $C_{30}H_{26}N_2O_2$. Calculated, %: C 80.72; H 5.83; N 6.28.

12-(4-Propoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVs, VIIs). Yield 61%, mp 302–303°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 0.94 t, 1.65 q, 3.78 t (OPr), 2.50 m ($2H^8$), 2.81 m ($2H^{10}$), 3.26 m, 3.43 m (H^9), 5.81 s, 5.87 s (H^{12}), 6.62 d, 7.04 d, 7.15–7.35 m (H^2, Ph, $4H_{arom}$, ^3J 7.3), 7.51 d, 7.82 d ($H^{5,6}$, ^3J 9.2), 8.28 d (H^1, ^3J 7.4), 8.59 d (H^3, ^3J 4.6), 9.50 s, 9.60 s (NH). Found, %: C 80.51; H 5.94; N 6.05. $C_{31}H_{28}N_2O_2$. Calculated, %: C 80.86; H 6.09; N 6.09.

12-[4-(Methoxycarbonyl)phenyl]-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVt, VIIt). Yield 76%, mp 310–311°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.52 m ($2H^8$), 2.82 m ($2H^{10}$), 3.25 m, 3.46 m (H^9), 3.82 s (CO_2Me), 5.80 s, 5.89 s (H^{12}), 7.11–7.32 m, 7.36 d, 7.70 d (H^2, Ph, $4H_{arom}$, ^3J 8.0), 7.50 d, 7.78 d ($H^{5,6}$, ^3J 9.1), 8.26 d (H^1, ^3J 8.0), 8.61 d (H^3, ^3J 4.9), 9.53 s, 9.63 s (NH). Found, %: C 78.04: H 5.12; N 5.88. $C_{30}H_{24}N_2O_3$. Calculated, %: C 78.26; H 5.22; N 6.09.

12-(4-Biphenylyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVu, VIIu). Yield 48%, mp 330–331°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.54 m ($2H^8$), 2.83 m ($2H^{10}$), 3.28 m, 3.46 m (H^9), 5.90 s, 5.96 s (H^{12}), 7.10–7.46 m (H^2, 2Ph, $4H_{arom}$), 7.52 d, 7.85 d ($H^{5,6}$, ^3J 9.0), 8.31 d (H^1, ^3J 7.3), 8.61 d (H^3, ^3J 4.9), 9.59 s, 9.68 s (NH). Found, %: C 85.12; H 5.27; N 5.69. $C_{34}H_{26}N_2O$. Calculated, %: C 85,36; H 5.44; N 5.86.

12-(4-Benzoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVv, VIIv. Yield 65%, mp 282–283°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.51 m ($2H^8$), 2.82 m ($2H^{10}$), 3.24 m, 3.44 m (H^9), 4.90 m (OCH_2Ph), 5.88 s, 5.97 s (H^{12}), 7.08–7.43 m (H^2, 2Ph, $4H_{arom}$), 7.48 d, 7.79 d ($H^{5,6}$, ^3J 8.8), 8.28 d (H^1, ^3J 7.1), 8.59 d (H^3, ^3J 4.8), 9.52 s, 9.60 s (NH). Found, %: C 82.24; H 5.38; N 5.46. $C_{35}H_{28}N_2O_2$. Calculated, %: C 82.68; H 5.51; N 5.51.

12-(2-Pyridyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVw, VIIw). Yield 71%, mp 288–289°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.49 m ($2H^8$), 2.79 m ($2H^{10}$), 3.29 m, 3.45 m (H^9), 6.04 s, 6.11 s (H^{12}), 6.96–7.11 m, 7.15–7.32 m, 8.48 d (H^2, Ph, $4H_{heteroarom}$, ^3J 4.8), 7.50 d, 7.80 d ($H^{5,6}$, ^3J 8.9), 8.55 d (H^1, ^3J 7.3), 8.61 d (H^3, ^3J 4.5), 9.50 s, 9.60 s (NH). Found, %: C 80.32; H 5.13; N 10.29. $C_{27}H_{21}N_3O$. Calculated, %: C 80.40; H 5.21; N 10.42.

12-(3-Pyridyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVx, VIIx). Yield 65%, mp 297–298°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.50 m ($2H^8$), 2.81 m ($2H^{10}$), 3.25 m, 3.44 m (H^9), 5.91 s, 5.98 s (H^{12}), 6.91–7.06 m, 7.13–7.30 m, 8.37 s (H^2, Ph, $4H_{heteroarom}$) 7.53 d, 7.84 d ($H^{5,6}$, ^3J 9.0), 8.32 d (H^1, ^3J 7.8), 8.60 d (H^3, ^3J 4.9), 9.53 s, 9.61 s (NH). Found, %: C 80.27; H 5.03; N 10.31. $C_{27}H_{21}N_3O$. Calculated, %: C 80.40; H 5.21; N 10.42.

12-(4-Thiomethylphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVy, VIIy). Yield 49%, mp 281–282°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.34 s (SMe), 2.50 m ($2H^8$), 2.78 m ($2H^{10}$), 3.26 m, 3.42 m (H^9), 5.81 s, 5.87 s (H^{12}), 6.98 d, 7.02–7.31 m (H^2, Ph, $4H_{arom}$, ^3J 7.2), 7.50 d, 7.82 d ($H^{5,6}$, ^3J 9.1), 8.24 d (H^1, ^3J 7.7), 8.60 d (H^3, ^3J 4.8), 9.54 s, 9.62 s (NH). Found, %: C 77.42; H 5.22; N 6.07; S 6.79. $C_{29}H_{24}N_2OS$. Calculated, %: C 77.68; H 5.36; N 6.25; S 7.14.

12-(2-Thienyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVz, VIIz). Yield 56%, mp 306–307°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.52 m ($2H^8$), 2.81 m ($2H^{10}$), 3.32 m, 3.46 m (H^9), 6.10 s, 6.16 s (H^{12}), 6.55 s, 6.70 s, 6.98 d, 7.15–7.38 m (H^2, Ph, $3H_{heteroarom}$, ^3J 4.6), 7.49 d, 7.85 d ($H^{5,6}$, ^3J 8.8), 8.38 d (H^1, ^3J 7.6), 8.65 d (H^3, ^3J 4.9), 9.70 s, 9.76 s (NH). Found, %: C 76.28; H 4.76; N 6.65; S 7.71. $C_{26}H_{20}N_2OS$. Calculated, %: C 76.47; H 4.90; N 6.86; S 7.84.

12-[2-(3-Methyl)thienyl]-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVα, VIIα). Yield 53%, mp 257–258°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.48 s (Me), 2.58 m ($2H^8$), 2.72 m ($2H^{10}$), 3.30 m, 3.44 m (H^9), 6.03 s, 6.09 s (H^{12}), 6.52 m, 6.72 m, 7.17–7.36 m (H^2, Ph, $2H_{heteroarom}$), 7.46 d, 7.80 d ($H^{5,6}$, ^3J 8.9), 8.20 d (H^1, ^3J 7.3), 8.61 d (H^3, ^3J 4.7), 9.70 s, 9.78 s (NH). Found, %: C 76.49; H 5.04; N 6.31; S 7.29. $C_{27}H_{22}N_2OS$. Calculated, %: C 76.78; H 5.21; N 6.64; S 7.58.

9-Phenyl-12-(3-cyclohexenyl)-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVβ, VIIβ). Yield 56%, mp 195–196°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 0.92–2.03 m ($7H_{cyclo}$), 2.48 s (Me), 2.61 m ($2H^{8}$), 2.78 m ($2H^{10}$), 3.39 m, 3.50 m (H^{9}), 4.80 d, 5.40 d (CH=CH), 5.44 s, 5.51 s (H^{12}), 7.15–7.36 m (H^{2}, Ph), 7.42 d, 7.79 d ($H^{5,6}$, ^3J 8.8), 8.42 d (H^{1}, ^3J 7.9), 8.66 d (H^3, ^3J 4.9), 9.38 s, 9.50 s (NH). Found, %: C 82.57; H 6.01; N 6.73. $C_{28}H_{25}N_2O$. Calculated, %: C 82.96; H 6.17; N 6.91.

12-(4-Methylphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVγ, VIIγ). Yield 41%, mp 215–216°C. ^{1}H NMR spectrum, δ, ppm (*J,* Hz): 2.17 s (Me), 2.57 m ($2H^{8}$), 2.84 m ($2H^{10}$), 3.22 m, 3.44 m (H^{9}), 5.78 s, 5.87 s (H^{12}), 6.88 d, 7.10 d, 7.13–7.31 m (H^{2}, Ph, $4H_{arom}$, ^3J 7.8), 7.51 d, 7.81 d ($H^{5,6}$, ^3J 9.0), 8.28 d (H^{1}, ^3J 8.2), 8.60 d (H^{3}, ^3J 4.7), 9.51 s, 9.62 s (NH). Found, %: C 83.94; H 5.42; N 6.51. $C_{29}H_{24}N_2O$. Calculated, %: C 84.06; H 5.77; N 6.73.

12-[4-(Methoxycarbonyl)phenyl]-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVt, VIIt). Yield 76%, mp 310–311°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.52 m ($2H^{8}$), 2.82 m ($2H^{10}$), 3.25 m, 3.46 m (H^{9}), 3.82 s (CO_2Me), 5.80 s, 5.89 s (H^{12}), 7.11–7.32 m, 7.36 d, 7.70 d (H^{2}, Ph, $4H_{arom}$, ^3J 8.0), 7.50 d, 7.78 d ($H^{5,6}$, ^3J 9.1), 8.26 d (H^{1}, ^3J 8.0), 8.61 d (H^{3}, ^3J 4.9), 9.53 s, 9.63 s (NH). Found, %: C 78.04: H 5.12; N 5.88. $C_{30}H_{24}N_2O_3$. Calculated, %: C 78.26; H 5.22; N 6.09.

12-(4-Biphenylyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVu, VIIu). Yield 48%, mp 330–331°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.54 m ($2H^{8}$), 2.83 m ($2H^{10}$), 3.28 m, 3.46 m (H^{9}), 5.90 s, 5.96 s (H^{12}), 7.10–7.46 m (H^{2}, 2Ph, $4H_{arom}$), 7.52 d, 7.85 d ($H^{5,6}$, ^3J 9.0), 8.31 d (H^{1}, ^3J 7.3), 8.61 d (H^{3}, ^3J 4.9), 9.59 s, 9.68 s (NH). Found, %: C 85.12; H 5.27; N 5.69. $C_{34}H_{26}N_2O$. Calculated, %: C 85,36; H 5.44; N 5.86.

12-(4-Benzoxyphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVv, VIIv. Yield 65%, mp 282–283°C. ^{1}H NMR spectrum, δ, ppm (*J,* Hz): 2.51 m ($2H^{8}$), 2.82 m ($2H^{10}$), 3.24 m, 3.44 m (H^{9}), 4.90 m (OCH_2Ph), 5.88 s, 5.97 s (H^{12}), 7.08–7.43 m (H^{2}, 2Ph, $4H_{arom}$), 7.48 d, 7.79 d ($H^{5,6}$, ^3J 8.8), 8.28 d (H^{1}, ^3J 7.1), 8.59 d (H^{3}, ^3J 4.8), 9.52 s, 9.60 s (NH). Found, %: C 82.24; H 5.38; N 5.46. $C_{35}H_{28}N_2O_2$. Calculated, %: C 82.68; H 5.51; N 5.51.

12-(2-Pyridyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVw, VIIw). Yield 71%, mp 288–289°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.49 m ($2H^{8}$), 2.79 m ($2H^{10}$), 3.29 m, 3.45 m (H^{9}), 6.04 s, 6.11 s (H^{12}), 6.96–7.11 m, 7.15–7.32 m, 8.48 d (H^{2}, Ph, $4H_{heteroarom}$, ^3J 4.8), 7.50 d, 7.80 d ($H^{5,6}$, ^3J 8.9), 8.55 d (H^{1}, ^3J 7.3), 8.61 d (H^{3}, ^3J 4.5), 9.50 s, 9.60 s (NH). Found, %: C 80.32; H 5.13; N 10.29. $C_{27}H_{21}N_3O$. Calculated, %: C 80.40; H 5.21; N 10.42.

12-(3-Pyridyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVx, VIIx). Yield 65%, mp 297–298°C. ^{1}H NMR spectrum, δ, ppm (*J,* Hz): 2.50 m ($2H^{8}$), 2.81 m ($2H^{10}$), 3.25 m, 3.44 m (H^{9}), 5.91 s, 5.98 s (H^{12}), 6.91–7.06 m, 7.13–7.30 m, 8.37 s (H^{2}, Ph, $4H_{heteroarom}$) 7.53 d, 7.84 d ($H^{5,6}$, ^3J 9.0), 8.32 d (H^{1}, ^3J 7.8), 8.60 d (H^{3}, ^3J 4.9), 9.53 s, 9.61 s (NH). Found, %: C 80.27; H 5.03; N 10.31. $C_{27}H_{21}N_3O$. Calculated, %: C 80.40; H 5.21; N 10.42.

12-(4-Thiomethylphenyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVy, VIIy). Yield 49%, mp 281–282°C. ^{1}H NMR spectrum, δ, ppm (*J*, Hz): 2.34 s (SMe), 2.50 m ($2H^{8}$), 2.78 m ($2H^{10}$), 3.26 m, 3.42 m (H^{9}), 5.81 s, 5.87 s (H^{12}), 6.98 d, 7.02–7.31 m (H^{2}, Ph, $4H_{apOm.}$, ^3J 7.2), 7.50 d, 7.82 d ($H^{5,6}$, ^3J 9.1), 8.24 d (H^{1}, ^3J 7.7), 8.60 d (H^{3}, ^3J 4.8), 9.54 s, 9.62 s (NH). Found, %: C 77.42; H 5.22; N 6.07; S 6.79. $C_{29}H_{24}N_2OS$. Calculated, %: C 77.68; H 5.36; N 6.25; S 7.14.

12-(2-Thienyl)-9-phenyl-8,9,10,12-tetrahydro-7*H*-benzo[*b*][4,7]phenanthrolin-11-one (IVz, VIIz). Yield 56%, mp 306–307°C. ^{1}H NMR spectrum, δ, ppm (*J,* Hz): 2.52 m ($2H^{8}$), 2.81 m ($2H^{10}$), 3.32 m, 3.46 m (H^{9}), 6.10 s, 6.16 s (H^{12}), 6.55 s, 6.70 s, 6.98 d, 7.15–7.38 m (H^{2}, Ph, $3H_{heteroarom}$, ^3J 4.6), 7.49 d, 7.85 d ($H^{5,6}$, ^3J 8.8), 8.38 d (H^{1}, ^3J 7.6), 8.65 d (H^{3}, ^3J 4.9), 9.70 s, 9.76 s (NH). Found, %: C 76.28; H 4.76; N 6.65; S 7.71. $C_{26}H_{20}N_2OS$. Calculated, %: C 76.47; H 4.90; N 6.86; S 7.84.

5-Phenyl-3-(6-quinolylamino)-2-cyclohexenone (V). A solution of 5 mmol of phendione (**I**) and 5 mmol of 6-quinolylamine (**II**) in 20 ml of 1-butanol was boiled for 3 h. On completion of the reaction the solution was evaporated by half, 10 ml of acetone was added the separated precipitate was filtered off and recrystallized from a mixture ethanol–benzene, 1:1. Yield 69%, mp 219–220°C. ^{1}H NMR spectrum, δ, ppm: 2.54 m (CH_2), 2.78 m (CH_3), 5.65 s (CH=), 7.21–7.30 m (Ph), 7.40 d.d (H^{3}, ^3J 8.5, ^4J 4.1 Hz), 7.52 d (H^{4}, ^3J 8.4 Hz), 7.65 s (H^{5}), 7.94 d, 8.21 d ($H^{7,8}$, ^3J 8.9 Hz), 8.23 d (H^{1}, ^3J 4.6 Hz), 9.80 s (NH). Found, %: C 80.02; H 5.67; N 8.63. $C_{21}H_{18}N_2O$. Calculated, %: C 80.23; H 5.77; N 8.91.

Compound **V** was also obtained by reacting phendione (**I**) with 6-quinolylamine (**II**) and *p*-tolualdehyde (**III**γ) along the procedure described for preparation of compounds **IVa–IVz, IV**α–**IV**γ and **VIIa–VIIz, VII**α–**VII**γ **(**procedure *a)* by evaporation of solvent after removal of the precipitate of 4,7-phenanthroline **IV**γ and **VII**γ and recrystallization of the solid residue. Yield 26%. C 80.51; H 5.94; N 6.05. $C_{31}H_{28}N_2O_2$. Calculated, %: C 80.86; H 6.09; N 6.09.

REFERENCES

1. Kozlov, N.S. and Gusak, K.N., *Dokl. Akad. Nauk SSSR,* 1990, vol. 314, p. 1419.
2. Martinez, R., Cortes, E., and Toscano, R.A., *J. Heterocyclic, Chem.* 1990, 27, p. 363.
3. Kozlov, N.G., Petrusevich, I.I., Gusak, K.N., and Koroleva, E.V., *Zh. Org. Khim.,* 2000, vol. 36, p. 890.
4. Kozlov, N.G., Gusak, K.N., and Bezborodov, B.C., *Zh. Org. Khim.,* 2000, vol. 36, p. 98.
5. Haas, G., Jaeggi, K.A., Possi, A., and Sele, A., Europe Patent 13666, 1980, *Chem. Abstr.,* 1988, vol. 94, 15704kh.
6. Hall, C.M., Wright, J.B., Johnson, H.G., and Taylor, A.J., *J. Med. Chem.,* 1977, vol. 20, p. 1337.
7. Gusak, K.N., Tereshko, A.B., and Kozlov, N.G., *Zh. Org. Khim.,* 2000, vol. 70, p. 320.
8. Gusak, K.N., Tereshko, A.B., and Kozlov, N.G., *Zh. Org. Khim.,* 2001, vol. 37, p. 1564.
9. Gauptman, 3., Grefe, Yu., and Remane, X., *Organicheskaya khimiya* (Organic Chemistry), Moscow: Khimiya, 1979, p. 487.
10. Reutov, O.A., *Teoreticheskie osnovy organicheskoi khimii* (Theoretical Bases of Organic Chemistry), Moscow: Moskovskii Gos. Univ., 1964, p. 585.
11. Kozlov, N.S., Gusak, K.N., Serzhanina, V.A., and Krot, N.A., *Khim. Geterotsikl. Soed.,* 1985, p. 1398.
12. Gudrinietse, E.Yu., Kurgan, D.K., and Vanag, G.N., *Zh. Org. Khim.,* 1957, vol. 27, p. 3087.