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NEW 1,10-PHENANTHROLINE DERIVATIVES WITH POTENTIAL ANTITUMORAL ACTIVITY**

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The 1,3-dipolar cycloaddition reaction of 1-(4-cyanophenacyl)-1,10-phenanthrolinium ylide **4**, with symmetrical and non-symmetrical alkynes gave new pyrrolo[1,2-a][1,10]phenanthrolines **7a-e**. The *N*-(4-cyanophenacyl)-1,10-phenanthrolinium bromide **3**, the intermediate for *N*-ylide **4**, was found to possess antitumoral activity.

INTRODUCTION

1,10-Phenanthroline and its derivatives possess a variety of uses, especially as biologically active compounds and chelating agents.[1-6] Among these compounds the quaternary salts of 1,10-phenanthroline have been evaluated as herbicides, carcinostatics and bacteriostatics, as enzyme inhibitors or activators, or as precursors in the field of organic chemistry.[1-16] Recently, *N*-phenacyl-1,10-phenanthrolinium bromides were prepared and their chemical, physicochemical and biological properties were investigated.[6-16] Thus, these 1,10-phenanthroline bromides were used for the synthesis of pyrrolo[1,2-a][1,10]phenanthroline derivatives[10-13] which were found to possess biological activity.[6] The stereostructure and crystal structure of thin organic films of the pyrrolo[1,2-a][1,10]phenanthroline derivatives were determined by X-ray analysis.[14-16]

Herein we report the synthesis of new pyrrolo[1,2,a][1,10]phenanthroline derivatives **7** obtained by reactions of 1-(4-cyanophenacyl)-1,10-phenanthrolinium *N*-ylide **4** with symmetrical and non-symmetrical acetylenic dipolarophiles. The structural assignment of a dihydro-pyrrolophenanthroline derivative **6a** as an intermediate in 1,3-dipolar cycloaddition between *N*-ylide **4** and dimethyl acetylenedicarboxylate (DMAD) is also presented.

RESULTS AND DISCUSSION

The synthesis of pyrrolo[1,2-a] [1,10]phenanthrolines **7** used, as key intermediate, the cycloimmonium bromide **3** which was prepared by *N*-alkylation of 1,10-phenanthroline **1** with 2-bromo-4'-cyanoacetophenone **2** in acetone under reflux. The structure of bromide **3** was assigned by elemental analysis and NMR spectroscopy. In the ^{1}H-NMR recorded in DMSO-d_6 the signal for the methylenic protons appear as a sharp singlet with δ = 7.25-7.35 ppm. The broad singlet in **3** resembles the AB system near coalescence. The magnetic non-equivalence of the methylenic protons was explained on the basis of the non-coplanarity of the pyridine and pyridinium rings. This hypothesis was confirmed by X-ray analysis.[8,9] Preliminary investigations indicated that the 1,10-phenanthrolinium bromide **3** presents significant antimicrobial and antitumoral activity. The pyrrolo[1,2-a][1,10]phenanthroline derivatives **7a-e** were obtained by 1,3-dipolar cycloaddition reactions between 1-(4-cyanophenacyl)-1,10-phenanthrolinium *N*-ylide **4** with electron-deficient esters of acetylenedicarboxylic acid and propiolic

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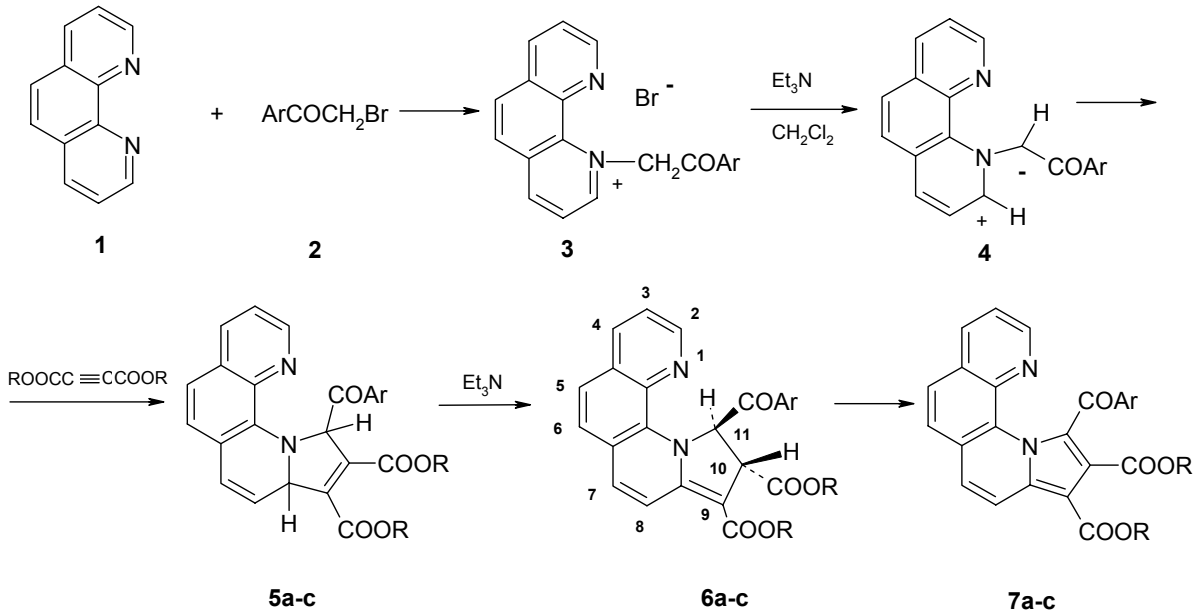
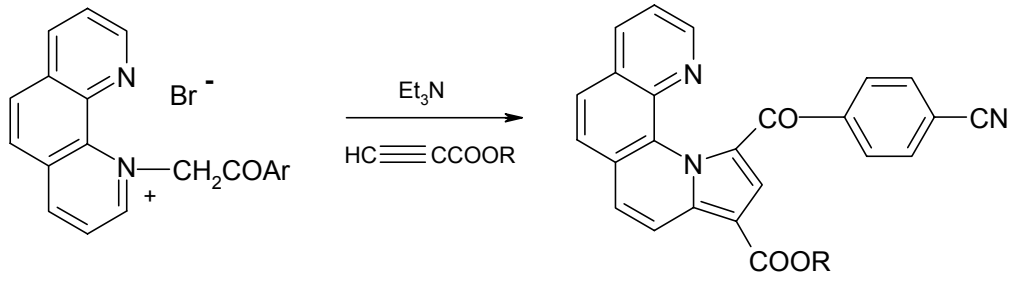
acid as dipolarophiles (Scheme 1). The heteroaromatic *N*-ylide **4**, being unstable, was generated *in situ* by reaction between bromide **3** and triethylamine. 1,3-Dipolar cycloaddition reactions of *N*-ylide **4** with dimethyl, diethyl or diisopropyl acetylenedicarboxylate gave pyrrolophenanthroline derivatives **7a-c** in good yields (79-87 %). The formation of compounds **7** implies in the first step the 1,3-dipolar cycloaddition between 1,3-dipole **4** and acetylenic dipolarophiles giving the primary cycloadducts **5**. Subsequently, the cycloadducts **5** undergo an isomerization reaction followed by dehydrogenation to the aromatic compounds **7a-c**.



a: R = Me; **b**: R = Et; **c**: R = *i*Pr; Ar = 4-NCC_6H_4

Scheme 1

Under similar reaction conditions, the cycloaddition between *N*-ylide **4** and esters of propiolic acid gave 9,10-disubstituted pyrrolophenanthrolines **7d,e** (Scheme 2). On the basis of H-NMR data it was established that the cycloaddition reaction is completely regioselective.



d: R = Me; **e**: R = Et; Ar = 4-NCC_6H_4

Scheme 2

The structures of compounds **7a-e** were assigned by elemental analysis and NMR spectroscopy. In the H-NMR spectra, recorded in $CDCl_3$ or $CDCl_3$+TFA, the three protons of the terminal pyridine ring appear as a doublet of doublets (ABC system). It is interesting to note that in $CDCl_3$ the value of the coupling constant between H-2 and H-3 is 4.3 Hz, whereas in $CDCl_3$+TFA the same coupling constant has a value of 6.2 Hz. Also, a strong deshielding in the case of the three protons from the terminal pyridine ring was observed. The difference between the magnitudes in $CDCl_3$ and $CDCl_3$+TFA for chemical shifts and coupling constants could be

explained as being due to protonation of N-2 by trifluoroacetic acid.

Interestingly, in the H-NMR spectra of compounds **7b,e** the methylenic protons in the ester group appear as two ABX_3 systems. Also, the methyl groups in each isopropyl radical (compound **7c**) were found to be non-equivalent in the H-NMR spectrum, as well as in the C-NMR spectrum. As previously reported[10,13,14] the magnetic non-equivalence of methylenic protons and methyl groups represents good evidence for helical distortion of the pyrrolophenanthroline tetracyclic system.

The C-NMR spectra for compounds **7** showed all the expected signals. The chemical shifts for the carbon atoms were assigned from H/C correlation experiments.

When the cycloaddition reactions between *N*-ylide **4** and esters of acetylenenedicarboxylic acid were performed in the presence of an excess of triethylamine, the dihydro derivatives **6** were isolated as sole product, or along with small quantities of the corresponding aromatized compounds **7**.

The structures of dihydro derivatives **6b,c** were deduced on the basis of NMR spectroscopy for representative compound **6a**. The positions for the two protons of the pyrrolinic ring were assigned on the basis of their multiplicity, *viz.* two doublets with J = 4.5 Hz, as well as the high chemical shifts of 7.58 ppm, attributed to H-11. The low value of the vicinal coupling constant between H-10 and H-11 indicates a *trans* configuration. In the aromatic region of compound **6a**, the protons of the terminal pyridine ring show an ABC system due to H-2, H-3 and H-4, whereas the other protons from the pyrrolophenanthroline moiety appeared as two AB systems ($J_{5,6}$= 8.5 Hz; $J_{7,8}$= 9.6 Hz).

Also, the position of the double bond in the pyrroline moiety was evident from the chemical shifts of the three carbonyl groups. Thus, the large difference between the two carbonyl ester groups (δ = 165.8 ppm and 173.5 ppm) show that they are a attached to Csp^2 (δ = 165.8 ppm) and Csp^3 (δ = 173.5 ppm) centres, respectively. The deshielding of the carbonyl group of the 4-cyanobenzoyl moiety (δ = 188.6 ppm) by 6 ppm relative to those of the corresponding aromatic compounds **7a** (δ = 182.5 ppm) is good evidence that the radical is attached to a Csp^3 centre.

The formation of dihydroderivatives **6** was explained by the regio- and stereoselective prototropic rearrangement of the primary cycloadducts **5** in the presence of an excess of triethylamine. The dihydro derivative **6a** could be easily aromatized to the corresponding pyrrolophenanthroline with the oxidant tetrakis-pyridinoCo(II) dichromate (TPCD). This reagent was used for aromatization of cycloadducts obtained by reaction between heteroaromatic *N*-ylides and activated olefines.[17-19]

EXPERIMENTAL

Melting points were determined on a Boetius hot plate and are uncorrected. The NMR spectra were recorded on a Varian Gemini 300 BB instrument, operating at 300 MHz for H and 75 MHz for C. Supplementary evidence was given by HETCOR and COSY experiments.

***1-[2-(4-cyanophenyl)-2-oxoethyl]-1,10-phenanthrolinium bromide* (3)**. 4 g (20 mmol) 1,10-Phenanthroline hydrate and 5.5 g (22 mmol) 2-bromo-4'-cyanoacetophenone in 80 mL acetone were refluxed for 12 h. The precipitate was filtered by suction and washed with water and acetone. Yield 76 %, m.p. 245-7 °C (from ethanol). Anal. Calcd. for $C_{21}H_{14}BrN_3O$: C 62.39, H 3.49, Br 19.77, N 10.39. Found: C 62.77, H 3.74, Br 20.11, N 10.60.

^{1}H-NMR (300 MHz, DMSO-d_6) δ: 7.25-7.35 (bs, 2H, CH_2); 8.23 (d, 2H, J = 8.5 Hz, H-3', H-5'); 7.90 (dd, 1H, J = 8.2, 4.3 Hz, H-8); 8.36 (d, 2H, J = 8.5 Hz, H-2', H-6'); 8.41 (dd, 1H, J = 4.3, 1.7 Hz, H-9); 8.48, 8.57 (2d, 1H, J = 8.9 Hz, H-5, H-6); 8.64 (dd, 1H, J = 8.2, 5.9 Hz, H-3); 8.78 (dd, 1H, J = 8.2, 1.7 Hz, H-7); 9.62 (dd, 1H, J = 8.2, 1.4 Hz, H-4); 9.69 (dd, 1H, J = 5.9, 1.4 Hz, H-2).

^{13}C-NMR (75 MHz, DMSO-d_6) δ: 69.4 (CH_2); 115.9, 118.1 (CN, C-4'); 124.8 (C-3); 125.5 (C-8);; 127.0 (C-6); 128.8 (C-2', C-6'); 130.7 (C-5); 131.5, 132.0(C-4a, C-6a); 136.0, 137.6, 138.2 (C-10a, C-10b, C-1'); 133.3 (C-3', C-5'); 138.1 (C-7); 148.2 (C-4); 148.6 (C-9); 152.0 (C-2); 189.7 (CO).

***Trans* dimethyl 11-(4-cyanobenzoyl)-10,11-dihydro-pyrrolo[1,2-a][1,10] phenanthroline -9,10-dicarboxylate (6a)**. 2.0 g (5 mmol) cycloimmonium bromide **3** and 5.5 mmol DMAD were suspended in 25 mL of methylene chloride. The mixture was cooled at 0 °C (ice bath), and 6 mmol of triethylamine dissolved in 5 mL of methylene chloride were then added under stirring, over 5 min. Stirring was continued for 20 min after which the reaction mixture was washed with water and the solvent removed at room temperature. The residue was triturated with ethanol, filtered and air dried. The product was recrystallized from acetonitrile and red crystals with mp 230-3 °C were obtained; yield 91 %. Anal. Calcd. $C_{27}H_{19}N_3O_5$: C 69.76, H 4.11, N 9.03. Found: C 70.01, H 4.23, N 9.18.

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 3.70, 3.85 (2s, 6H, 2Me); 4.09 (d, 1H, J = 4.5 Hz, H-10); 7.22 (dd, 1H, J = 8.2, 4.2 Hz, H-3); 7.37, 7.47 (2d, 2H, J = 8.5 Hz, H-5, H-6); 7.44 (d, 1H, J = 9.6 Hz, H-7); 7.58 (d, 1H, J = 4.5 Hz, H-11); 7.88 (d, 1H, J = 9.6 Hz, H-8); 7.90 (d, 2H, J = 8.6 Hz, H-3', H-5'); 7.91 (dd, 1H, J = 4.2, 1.8 Hz, H-2); 8.02 (1H, dd, J = 8.2, 1.8 Hz, H-4); 8.27 (d, 2H, J = 8.6 Hz, H-2', H-6').

^{13}C-NMR (75 MHz, $CDCl_3$) δ: 49.6 (C-10); 50.4, 52.4 (2MeO); 71.0 (C-11); 88.2 (C-9); 116.5, 117.9 (C-4', CN); 119.7 (C-8); 121.0, 126.8 (C-5, C-6); 121.9 (C-3); 122.0, 130.3, 135.2, 137.1, 137.3 (C-4a, C-6a, C-12a, C-12b, C-1');

129.6 (C-2', C-6'); 132.6 (C-3', C-5'); 136.6 (C-4); 146.1 (C-2); 155.0 (C-8a); 165.8 (9-COOMe); 173.5 (10-COOMe); 188.6 (COAr).

General procedure for synthesis of esters 7a-c. 2.0 g (5 mmol) phenanthrolinium salt **3** were suspended in 25 mL of dichloromethane and 5.5 mmol of dimethyl (or diethyl, diisopropyl) acetylenedicarboxylate were then added. Under vigorous stirring 0.75 mL (5 mmol) of triethylamine (dissolved in 5 mL methylene chloride) were added dropwise. After 1 h the reaction mixture was washed twice with water and the solvent evaporated. The residue was refluxed with stirring in ethanol for 1 h and the precipitate was isolated by filtration.

***Dimethyl 11-(4-cyanobenzoyl)-pyrrolo[1,2-a][1,10]phenanthroline-9, 10-dicarboxylate* (7a)**.

The product was recrystallized from DMF and yellow crystals with mp 329-331 °C were obtained; yield 87 %. Anal. Calcd. $C_{27}H_{17}N_3O_5$: C 69.97, H 3.70, N 9.07. Found: C 70.08, H 3.93, N 9.31.

^{1}H-NMR (300 MHz, $CDCl_3$+TFA) δ: 3.74, 3.95 (2s, 6H, 2 MeO); 7.55 (d, 2H, *J* = 8.6 Hz, H-2', H-6'); 7.66 (d, 2H, *J* = 8.6 Hz, H-3', H-5'); 7.93 (d, 1H, d, 1H, *J* = 9.6 Hz, H-7); 8.21 (dd, 1H, *J* = 8.1, 6.3 Hz, H-3); 8.28, 8.35 (2d, 2H, *J* = 8.8 Hz, H-5, H-6); 8.57 (d, 1H, *J* = 9.6 Hz, H-8); 9.13 (dd, 1H, *J* = 8.1, 1.3 Hz, H-4); 9.36 (dd, 1H, *J* = 6.3, 1.3 Hz, H-2).

^{13}C-NMR (75 MHz, $CDCl_3$+TFA) δ: 52.4, 53.2 (2 MeO); 95.1 (C-9); 109.6, 114.6, 116.9, 117.6, 122.4, 126.5, 127.0, 128.5, 130.6 (C-4a, C-6a, C-8a, C-10, C-11, C-12a, C-12b, C-1', CN); 123.9 (C-7); 124.6 (C-3); 125.8 (C-8); 125.7, 130.3 (C-5, C-6); 126.0 (C-2', C-6'); 133.0 (C-3', C-5'); 144.1 (C-2); 145.6 (C-4'); 147.2 (C-4); 163.3, 165.0 (2COO); 182.5 (COAr).

***Diethyl 11-(4-cyanobenzoyl)-pyrrolo[1,2-a][1,10]phenanthroline-9, 10-dicarboxylate* (7b)**. The product was recrystallized from chloroform and yellow crystals with mp 292-4 °C were obtained; yield 79 %. Anal. Calcd. $C_{29}H_{21}N_3O_5$: C 70.87, H 4.31, N 8.55 Found: C 71.08, H 3.93, N 9.31.

^{1}H-NMR (300 MHz, $CDCl_3$+TFA) δ: 1.20 (t, 3H, *J* = 7.1 Hz, 10-Me); 1.40 (t, 3H, *J* = 7.1 Hz; 9-Me); 4.12-4.33 (m, 2H, *J* = 10.8, 7.1 Hz, 10-OCH_2); 4.42 (q, 2H, *J* = 7.1 Hz, 9-OCH_2); 7.56 (d, 2H, *J* = 8.6 Hz, H-2', H-6'); 7.67 (d, 2H, *J* = 8.6 Hz, H-3', H-5'); 7.95 (d, 1H, d, 1H, *J* = 9.6 Hz, H-7); 8.22 (dd, 1H, *J* = 8.1, 6.3 Hz, H-3); 8.30, 8.37 (2d, 2H, *J* = 8.8 Hz, H-5, H-6); 8.59 (d, 1H, *J* = 9.6 Hz, H-8); 9.15 (dd, 1H, *J* = 8.1, 1.3 Hz, H-4); 9.38 (dd, 1H, *J* = 6.3, 1.3 Hz, H-2).

^{13}C-NMR (75 MHz, $CDCl_3$+TFA) δ: 13.4, 13.9 (2Me); 62.4, 63.8 (2CH_2O); 94.2 (C-9); 108.9, 114.3, 116.4, 117.5, 122.8, 126.3, 127.1, 128.5, 130.7 (C-4a, C-6a, C-8a, C-10, C-11, C-12a, C-12b, C-1', CN); 124.3 (C-7); 124.8 (C-3); 125.0 (C-8); 125.9, 130.4 (C-5, C-6); 126.0 (C-2', C-6'); 133.2 (C-3', C-5'); 144.2 (C-2); 145.6 (C-4'); 147.6 (C-4); 163.4, 165.8 (2COO); 182.6 (COAr).

***Diisopropyl 11-(4-cyanobenzoyl)-pyrrolo[1,2-a][1,10]phenanthroline-9, 10-dicarboxylate* (7c)**. The product was recrystallized from acetonitrile and yellow crystals with mp 263-4 °C were obtained; yield 81 %. Anal. Calcd. $C_{31}H_{25}N_3O_5$: C 71.67, H 4.85, N 8.09 Found: C 71.88, H 5.15, N 8.22.

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 0.94, 1.12 (2d, 6H, *J* = 6.3 Hz, 10-CH**Me$_2$**); 1.37, 1.40 (2d, 6H, *J* = 6.2 Hz, 9-CH**Me$_2$**); 4.80 (sep, 1H, *J* = 6.2 Hz, 10-C**H**Me$_2$); 5.31 (sep, 1H, *J* = 6.2 Hz, 9-C**H**Me$_2$); 7.35 (dd, 1H, *J* = 8.2, 4.3 Hz, H-3); 7.69 (d, 1H, d, 1H, *J* = 9.5 Hz, H-7); 7.79 (d, 2H, *J* = 8.6 Hz, H-3', H-5'); 7.80, 7.87 (2d, 2H, *J* = 8.8 Hz, H-5, H-6); 7.91 (dd, 1H, *J* = 4.3, 1.7 Hz, H-2); 8.18 (dd, 1H, *J* = 8.2, 1.7 Hz, H-4); 8.23 (d, 2H, *J* = 8.6 Hz, H-2', H-6'); 8.57 (d, 1H, *J* = 9.5 Hz, H-8).

^{1}H-^{NMR} (300 MHz, $CDCl_3$+TFA) δ: 1.15, 1.29 (2d, 6H, *J* = 6.2 Hz, 10-CH**Me$_2$**); 1.40, 1.41 (2d, 6H, *J* = 6.2 Hz, 9-CH**Me$_2$**); 5.11 (sep, 1H, *J* = 6.2 Hz, 10-C**H**Me$_2$); 5.29 (sep, 1H, *J* = 6.2 Hz, 9-C**H**Me$_2$); 7.53 (d, 2H, *J* = 8.6 Hz, H-2', H-6'); 7.65 (d, 2H, *J* = 8.6 Hz, H-3', H-5'); 7.94 (d, 1H, d, 1H, *J* = 9.6 Hz, H-7); 8.22 (dd, 1H, *J* = 8.1, 6.3 Hz, H-3); 8.29, 8.36 (2d, 2H, *J* = 8.8 Hz, H-5, H-6); 8.57 (d, 1H, *J* = 9.6 Hz, H-8); 9.14 (dd, 1H, *J* = 8.1, 1.3 Hz, H-4); 9.43 (dd, 1H, *J* = 6.3, 1.3 Hz, H-2).

^{13}C-NMR (75 MHz, $CDCl_3$) δ: 21.1, 21.5, 21.9, 22.1 (4Me); 68.1, 69.7 (**C**HMe_2); 104.8 (C-9); 115.3, 118.2 (C-1', CN); 120.4 (C-8); 122.3 (C-3); 125.4, 126.8 (C-5, C-6); 125.7 (C-7); 125.8, 126.0, 127.7, 128.6 (C-4a, C-6a, C-8a, C-10, C-11); 130.3 (C-2', C-6'); 132.0 (C-3', C-5'); 136.3 (C-4); 136.9, 137.1 (C-12a, C-12b); 145.1 (C-1'); 145.2 (C-2); 162.8, 164.8 (2COO); 181.7 (COAr).

^{13}C-NMR (75 MHz, $CDCl_3$+TFA) δ: 21.1, 21.7 (4Me); 70.6, 72.7 (**C**HMe_2); 94.5 (C-9); 109.4, 114.3, 116.6, 117.1, 123.2, 126.4, 127.0, 128.5, 130.5 (C-4a, C-6a, C-8a, C-10, C-11, C-12a, C-12b, C-1', CN); 124.2 (C-7); 124.8 (C-3); 125.0 (C-8); 125.9 (C-2', C-6'); 126.2, 130.4 (C-5, C-6); 133.3 (C-3', C-5'); 143.9 (C-2); 145.7 (C-4'); 147.6 (C-4); 162.9, 165.7 (2COO); 182.6 (COAr).

The procedure for synthesis of esters 7d,e. 2.0 g (5 mmol) Phenanthrolinium salt **3** were suspended in 25 mL of dichloromethane and then 6 mmol of ethyl or isopropyl propiolate were added. Under vigorous stirring 0.7 mL (5 mmol) of triethylamine (dissolved in 10 mL of methylene chloride) were added dropwise. After 20 min the reaction mixture was washed with water and the solvent evaporated. The residue was purified by column chromatography on neutral Al_2O_3 using CH_2Cl_2 as eluent.

***Methyl 11-(4-cyanobenzoyl)-pyrrolo[1,2-a][1,10]phenanthroline-9- carboxylate* (7d)**. The product was recrystallized from nitromethane and yellow crystals with mp 246-7 °C were obtained; yield 41 %. Anal. Calcd. for $C_{25}H_{15}N_3O_3$: C 74.07, H 3.73, N 10.36. Found: C 74.23, H 4.11, N 10.52.

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 3.94 (s, 3H, MeO); 7.38 (dd, 1H, *J* = 8.2, 4.3 Hz, H-3); 7.55 (s,1H, H-10); 7.74 (d, 1H, *J* = 9.2 Hz, H-7); 7.82, 7.95 (2d, 1H, *J* = 8.6 Hz, H-5, H-6); 7.85 (d, 2H, *J* = 8.6 Hz, H-3', H-5'); 8.19-8.23 (m, 2H, H-2, H-4); 8.31 (d, 2H, *J* = 8.6 Hz, H-2', H-6'); 8.59 (d, 1H, *J* = 9.2 Hz, H-8).

^{13}C-NMR (75 MHz, $CDCl_3$) δ: 51.3 (OMe); 106.0 (C-9); 115.4, 118.2 (C-1', CN); 119.8 (C-8); 121.7 (C-10); 122.5 (C-3); 125.4, 126.6 (C-5, C-6); 125.5, 127.8, 129.2, 131.6 (C-4a, C-6a, C-8a, C-10); 126.2 (C-7); 130.5 (C-2', C-6'); 132.2 (C-3', C-5') 136.0 (C-4); 137.8, 138.9 (C-12a, C-12b); 141.4 (C-4'); 146.0 (C-2); 164.8 (COO); 183.0 (COAr).

***Ethyl 11-(4-cyanobenzoyl)-pyrrolo[1,2-a][1,10]phenanthroline-9-carboxylate* (7e)**. The product was recrystallized from nitromethane and yellow crystals with mp 242-4 °C were obtained; yield 37 %. Anal. Calcd. for $C_{26}H_{17}N_3O_3$: C 74.45, H 4.09, N 10.02. Found: C 74.58, H 4.18, N 10.21.

^{1}H-NMR (300 MHz, $CDCl_3$) δ: 1.41 (t, 3H, *J* = 7.1 Hz; Me); 4.35-4.67 (m, 2H, *J* = 10.4, 7.1 Hz, CH_2); 7.37 (dd, 1H, *J* = 8.2, 4.3 Hz, H-3); 7.53 (s,1H, H-10); 7.73 (d, 1H, *J* = 9.2 Hz, H-7); 7.82, 7.90 (2d, 1H, *J* = 8.6 Hz, H-5, H-6); 7.85 (d, 2H, *J* = 8.6 Hz, H-3', H-5'); 8.19-8.23 (m, 2H, H-2, H-4); 8.26 (d, 2H, *J* = 8.6 Hz, H-2', H-6'); 8.59 (d, 1H, *J* = 9.2 Hz, H-8).

^{13}C-NMR (75 MHz, $CDCl_3$) δ: 14.6 (Me); 60.2 (CH_2); 106.5 (C-9); 114.9, 118.4 (C-1', CN); 120.1 (C-8); 121.8 (C-10); 122.7 (C-3); 125.3, 126.7 (C-5, C-6); 125.6, 127.8,

129.3, 131.6 (C-4a, C-6a, C-8a, C-10); 126.2 (C-7); 130.5 (C-2', C-6'); 132.3 (C-3', C-5') 136.2 (C-4); 137.7, 138.9 (C-12a, C-12b); 141.3 (C-4'); 146.0 (C-2); 164.4 (COO); 182.8 (COAr).

CONCLUSIONS

Six new pyrrolophenanthroline derivatives **6a** and **7a-e** were synthesized by 1,3-dipolar cycloaddition reactions between 1,10-phenanthrolinium *N*-ylide **4** and acetylenic dipolarophiles. The regioselectivity of the cycloaddition reaction was evidenced by use of non-symmetrical acetylenic dipolarophiles.

The 1-[2-(4-cyanophenyl)-2-oxoethyl]-1,10-phenanthrolinium bromide **3** presents significant antimicrobial and antitumoral activity.

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