QUINOXALINES, BENZODIAZEPINES AND BENZODIAZOCINES FUSED TO PYRROLE AND ISOINDOLE *VIA* *N*-ACYLIMINIUM ION AROMATIC CYCLIZATION

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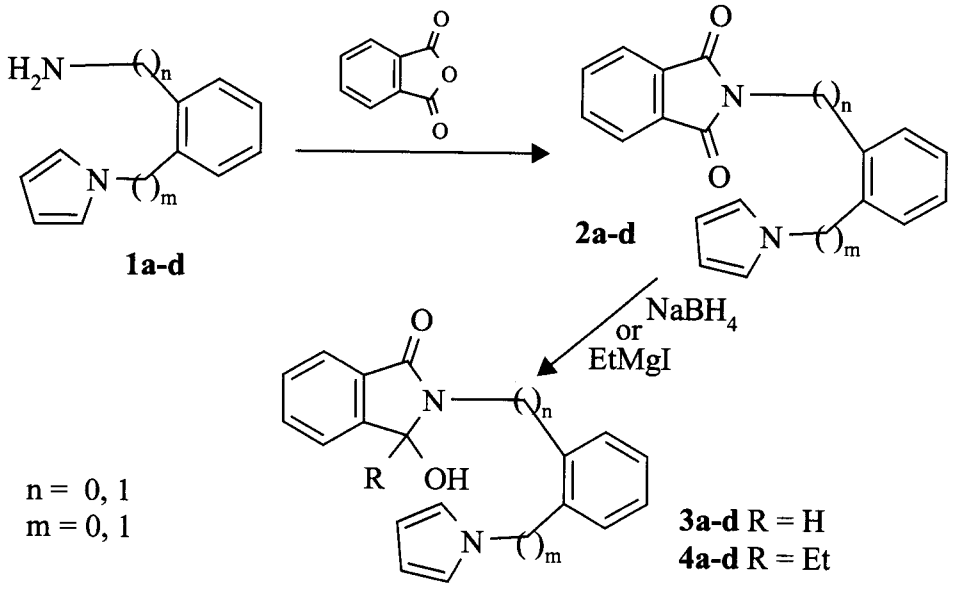
Abstract - Quinoxaline (**6a**), [1,4]benzodiazepines (**6b,c**) and [2,5]-benzodiazocine (**6d**) were synthesized from hydroxylactams (**3a-d**) or (**4a-d**) *via* an *N*-acyliminium ion-pyrrole cyclization reaction. **3** and **4** were prepared in two steps from ready available substituted anilines (**1a,b**) or benzylamines (**1c,d**).

Heterocycles containing a [1,4]diaza system, as in quinoxalines, [1,4]benzodiazepines, [1,4 or 2,5] benzodiazocines are compounds with potent biological activities. For example, isoindoloquinoxalines showed an antihypertensive effect[1] and pyrrolo[1,4]benzodiazepines widely described in the literature exhibited antitumor antibiotic activities.[2,3] As a further development of our search on the synthesis and reactivity of polycyclic systems containing a pyrrole or/and an isoindole moieties fused to diazaheterocycles[4-7] we wish to report herein the syntheses of isoindolopyrroloquinoxaline (**6a**), isoindolopyrrolo[1,4]benzodiazepines (**6b,c**) and isoindolopyrrolo[2,5]benzodiazocine (**6d**). The key step of each synthesis was an *N*-acyliminium ion aromatic cyclization. Examples of this reaction are reported in the literature[8] and recently we described the synthesis of an isoindolodibenz[*c,e*]azepine[9] according to this way. It is with this aim in view that we prepared hydroxylactams (**3a-d**) and (**4a-d**), precursors of *N*-acyliminium ions. Compounds (**3**) and (**4**) were obtained in two steps from ready available amines (**1a**) (commercial), (**1b**),[10] (**1c**)[11] and (**1d**).[12]

As shown in Scheme 1, condensation of amines (**1a-d**) with phthalic anhydride gave the corresponding phthalimides (**2a-d**) in good yields (88 to 95%). The phthalimide (**2d**) had been previously prepared[12] in a 63% yield. Reduction of **2a-d** with sodium borohydride in methanol with a regular addition of ethanolic hydrochloric acid solution led to the hydroxylactams (**3a-d**) in good yields (92 to 98%).

Scheme 1

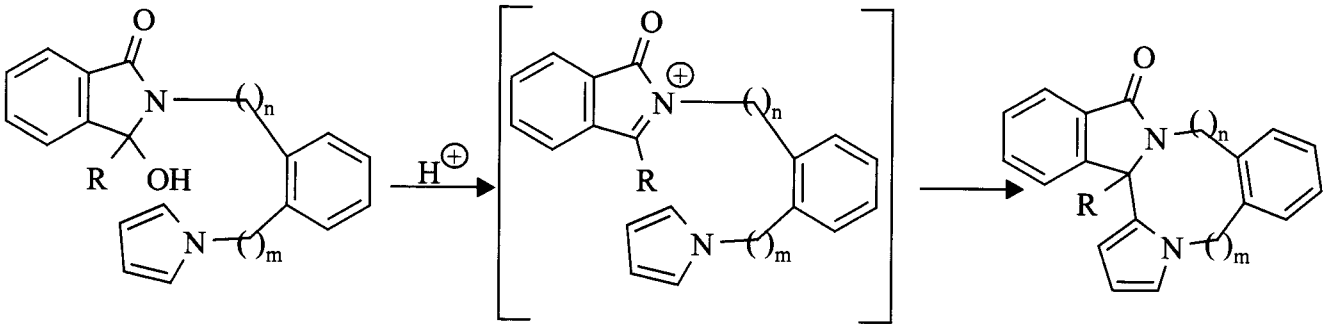


	n = 0 m = 0	n = 0 m = 1	n = 1 m = 0	n = 1 m = 1
starting amine	**1a**	**1b**	**1c**	**1d**
phthalimide	**2a**	**2b**	**2c**	**2d**
hydroxylactam R = H	**3a**	**3b**	**3c**	**3d**
hydroxylactam R = Et	**4a**	**4b**	**4c**	**4d**

When these hydroxylactams (**3a-d**) were treated overnight with trifluoroacetic acid in dichloromethane at room temperature, they led to the expected diazapentacyclic derivatives **6a-d** (R = H) (28 to 94%). The cyclization occurred *via* the reaction of the *N*-acyliminium ions (**5a-d**) upon the π nucleophile pyrrole ring. To improve these results we tried the reaction in the presence of thionyl chloride since it has been demonstrated that α-chloroalkylamide served as an *N*-acyliminium ion source.[8,13] Actually when the hydroxylactams (**3a-d**) were treated with thionyl chloride during 5 min at room temperature they provided the cyclic products **(6a-d)** (R = H) in better yields (35 to 100%). A longer time of reaction led to more and more degradation products.

An alternative route to **6a** (R = H) has been reported utilizing the Mannich reaction from the amine (**1a**) under the action of *o*-formylbenzoic acid.[14] Nevertheless, this procedure was limited since substituted product at the junction carbon (R different of H) could not be prepared.

Scheme 2



3a-d R = H
4a-d R = Et

5a-d

6a-d

So, to demonstrate that our approach was general, we investigated (Schemes 1 and 2) the reactivity of substituted hydroxylactams (**4a-d**). These latter was provided by the action of ethylmagnesium iodide upon the imides (**2a-d**). In a similar manner as above, treatment of **4a-d** with thionyl chloride during one hour gave quinoxaline (**6a**) (R = Et) (35%), [1,4]benzodiazepines (**6b**) (R = Et) (100%) and (**6c**) (R = Et) (100%) and benzodiazocine (**6d**) (R = Et) (100%). Furthermore the competitive dehydrohalogenation of the intermediate α-ethyl-α-chloro lactam was not observed according to our previous work concerning the synthesise of substituted indolizinones.[13] On the other hand it is interesting to note that from **3c** or **3d** the cyclization did not occur with the benzene ring since the possible isoindoloisoindole was not observed. This selectivity is probably due to the great reactivity of the pyrrole ring compared to this of the benzene ring and to the difficulty accounted in the formation of a 5-membered ring. We have already observed a similar result in the thiophene series.[13]

In conclusion we have presented a general approach (by intramolecular amido-alkylation cyclization) to quinoxaline, benzodiazepines and benzodiazocine annelated to both pyrrole and isoindole rings. The ready available starting amines gave in two steps hydroxy lactams precursors of *N*-acyliminium. The reaction of cyclization furnished a 7- or 8-membered ring rather than a 5-membered one.

EXPERIMENTAL

Melting points are uncorrected. The IR spectra of solids (potassium bromide) were recorded on a Perkin Elmer FTIR paragon 1000 spectrometer. The ^{1}H and ^{13}C NMR spectra were recorded on a Bruker AC-200 (200 MHz) instrument in deuteriochloroform and chemical shifts (δ) are expressed in ppm relative to internal TMS. Ascending thin layer chromatography was performed on precoated plates of silica gel 60 F 254 (Merck) and the spots visualized using an ultraviolet lamp or iodine vapor. E. Merck silica gel 60 F

(70-300 mesh) was used for column chromatography. The elemental analyses were carried out by the microanalysis laboratory of INSA at Rouen, F 76130 M^{t}. S^{t}. Aignan, France.

General procedure for phthalimides (2).

A mixture of **1** (10 mmol), phthalic anhydride (1.48 g, 10 mmol) and triethylamine (0.5 mL, 3.6 mmol) in toluene (50 mL) was refluxed with a Dean-stark apparatus for 2 days. The reaction mixture was cooled, then was concentrated under reduced pressure. The residue was dissolved into dichloromethane, washed with 10% hydrochloric acid solution then with a sodium hydrogen carbonate solution. The organic layer was dried over magnesium sulfate, concentrated under reduced pressure then recrystallization of the residue from ethanol gave **2**.

2-[2-(Pyrrol-1-yl)phenyl]phthalimide (2a).

This compound was obtained in 88% yield, mp 180 °C; IR: 1709 (C=O) cm^{-1}; ^{1}H NMR : δ 6.13 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.70 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.33-7.69 (m, 4H, H_{arom}), 7.69-7.78 (m, 2H, $H_{phthalimide}$), 7.80-7.88 (m, 2H, $H_{phthalimide}$). Anal. Calcd for $C_{18}H_{12}N_2O_2$: C, 74.99; H, 4.19; N, 11.13. Found: C, 74.68; H, 4.23; N, 11.06.

2-[2-(Pyrrol-1-ylmethyl)phenyl]phthalimide (2b).

This compound was obtained in 90% yield, mp 152 °C; IR: 1711 (C=O) cm^{-1}; ^{1}H NMR : δ 5.01 (s, 2H, CH_2), 6.04 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.53 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.98-7.03 (m, 1H, H_{arom}), 7.21-7.26 (m, 1H, H_{arom}), 7.44-7.39 (m, 2H, H_{arom}), 7.76-7.93 (m, 2H, $H_{phthalimide}$), 7.91-7.95 (m, 2H, $H_{phthalimide}$). Anal. Calcd for $C_{19}H_{14}N_2O_2$: C, 75.48; H, 4.67; N, 9.27. Found: C, 75.35; H, 4.66; N, 9.33.

2-[2-(Pyrrol-1-yl)benzyl]phthalimide (2c).

This compound was obtained in 95% yield, mp 143 °C; IR: 1706 (C=O) cm^{-1}; ^{1}H NMR : δ 4.74 (s, 2H, CH_2), 6.33 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.92 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.15-7.34 (m, 4H, H_{arom}), 7.67-7.77 (m, 2H, $H_{phthalimide}$), 7.78-7.88 (m, 2H, $H_{phthalimide}$). Anal. Calcd for $C_{19}H_{14}N_2O_2$: C, 75.48; H, 4.67; N, 9.27. Found: C, 75.40; H, 4.59; N, 9.22.

2-[2-(Pyrrol-1-ylmethyl)benzyl]phthalimide (2d).

This product was obtained in 82% yield, mp 143 °C (lit.,[12] 142-143 °C); IR: 1708 (C=O) cm^{-1}; ^{1}H NMR : δ 4.78 (s, 2H, CH_2), 5.39 (s, 2H, CH_2), 6.16 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.67 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.88-6.91 (m, 1H, H_{arom}), 7.20-7.25 (m, 2H, H_{arom}), 7.38-7.43 (m, 1H, H_{arom}), 7.67-7.71 (m, 2H, $H_{phthalimide}$), 7.80-7.85 (m, 2H, $H_{phthalimide}$). Anal. Calcd for $C_{20}H_{16}N_2O_2$: C, 75.93; H, 5.10; N, 8.85. Found: C, 75.94; H, 5.13; N, 8.70.

Synthesis of hydroxy lactams (3).

To a mixture of imide (**2**) (16 mmol) in dry methanol (100 mL) at 0 °C was added sodium borohydride (4 g, 96 mmol) by portions. To this mixture were added 20 drops of ethanolic hydrochloric acid solution (prepared from 9 drops of concentrated hydrochloric acid in 15 mL of ethanol) at regular intervals (10 min). The reaction was monitored by TLC (dichloromethane - acetone 9/1). When starting product had

disappeared (30 min), the excess of sodium borohydride was decomposed by careful addition of cold water and 10% hydrochloric acid. Sodium hydrogen carbonate was added and the solvent was evaporated. The residue was triturated with water and the hydroxy lactam (**3**) was separated by filtration, washed with water, dried and recrystallized from ethanol.

2,3-Dihydro-3-hydroxy-2-[2-(pyrrol-1-yl)phenyl]-1*H*-isoindol-1-one (3a).

This compound was obtained in 92% yield, mp 217 °C; IR: 3367 (OH), 1695 (C=O) cm^{-1}; ^1H NMR : δ 2.22 (d, 1H, OH, J = 9 Hz), 5.19 (d, 1H, CH, J = 9 Hz), 5.96-6.24 (m, 2H, $H_{pyrrole}$), 6.55-6.87 (m, 2H, $H_{pyrrole}$), 7.03-7.95 (m, 8H, H_{arom}). Anal. Calcd for $C_{18}H_{14}N_2O_2$: C, 74.47; H, 4.86; N, 9.65. Found: C, 74.24; H, 4.81; N, 9.60.

2,3-Dihydro-3-hydroxy-2-[2-(pyrrol-1-ylmethyl)phenyl]-1*H*-isoindol-1-one (3b).

This compound was obtained in 96% yield, mp 222 °C; IR: 3302 (OH), 1671 (C=O) cm^{-1}; ^1H NMR : δ 4.94 (d, 1H, CH_2, J = 15 Hz), 5.44 (d, 1H, CH_2, J = 15 Hz), 5.86 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.39 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.24-7.63 (m, 8H, $7H_{arom}$+CH), 7.89 (d, 1H, H_{arom}, J = 8 Hz). Anal. Calcd for $C_{19}H_{16}N_2O_2$: C, 74.98; H, 5.30; N, 9.20. Found: C, 74.73; H, 5.32; N, 9.27.

2,3-Dihydro-3-hydroxy-2-[2-(pyrrol-1-yl)benzyl]-1*H*-isoindol-1-one (3c).

This compound was obtained in 98% yield, mp 180 °C; IR: 3324 (OH), 1682 (C=O) cm^{-1}; ^1H NMR : δ 2.93 (d, 1H, OH, J = 10 Hz), 4.28 (d, 1H, CH_2, J = 16 Hz), 4.67 (d, 1H, CH_2, J = 16 Hz), 5.39 (d, 1H, CH, J = 10 Hz), 6.41 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.88 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.25-7.56 (m, 7H, H_{arom}), 7.68 (d, 1H, H_{arom}, J = 7 Hz). Anal. Calcd for $C_{19}H_{16}N_2O_2$: C, 74.98; H, 5.30; N, 9.20. Found: C, 74.85; H, 5.35; N, 9.11.

2,3-Dihydro-3-hydroxy-2-[2-(pyrrol-1-ylmethyl)benzyl]-1*H*-isoindol-1-one (3d).

This compound was obtained in 93% yield, mp 185 °C; IR: 3362 (OH), 1688 (C=O) cm^{-1}; ^1H NMR : δ 2.91 (d, 1H, OH, J = 10 Hz), 4.29 (d, 1H, CH_2-pyrrole, J = 15 Hz), 4.90 (d, 1H, CH_2-pyrrole, J = 15 Hz), 5.07 (d, 1H, CH_2-N, J = 15 Hz), 5.30 (d, 1H, CH_2-N, J = 15 Hz), 5.41 (d, 1H, CH, J = 10 Hz), 6.15 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.64 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.01-7.05 (m, 1H, H_{arom}), 7.22-7.37 (m, 3H, H_{arom}), 7.43-7.54 (m, 3H, H_{arom}), 7.70 (d, 1H, H_{arom}, J = 8 Hz). Anal. Calcd for $C_{19}H_{16}N_2O_2$: C, 75.45; H, 5.70; N, 8.80. Found: C, 75.46; H, 5.72; N, 8.66.

Synthesis of hydroxy lactams (4).

To a solution of imide (**2**) (2 mmol) in dry dichloromethane (15 mL) was added a solution of ethylmagnesium iodide (0.5 M in ether, 10 mL, 5 mmol). The resulting mixture was stirred at rt for 3 h, then was poured into 30 mL of 1M ammonium chloride solution then was extracted with dichloromethane. The organic layer was dried over magnesium sulfate, concentrated under reduced pressure. These compounds were pure enough for the next reaction and were not recrystallized to avoid dehydration. Consequently the mp are not given.

2,3-Dihydro-3-ethyl-3-hydroxy-2-[2-(pyrrol-1-yl)phenyl]-1*H*-isoindol-1-one (4a).

This compound was obtained in 90% yield, IR: 3332 (OH), 1675 (C=O) cm^{-1}; ^1H NMR : δ 0.66 (t, 3H,

CH_3, J = 7 Hz), 1.64-2.05 (m, 2H, CH_2), 6.13 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.85 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.29-7.61 (m, 7H, H_{arom}), 7.88 (d, 1H, H_{arom}, J = 8 Hz).

2,3-Dihydro-3-ethyl-3-hydroxy-2-[2-(pyrrol-1-ylmethyl)phenyl]-1*H*-isoindol-1-one (4b).

This compound was obtained in 92% yield, IR: 3319 (OH), 1678 (C=O) cm^{-1}; ^1H NMR : δ 0.72 (t, 3H, CH_3, J = 7 Hz), 2.16 (q, 2H, CH_2, J = 7 Hz), 4.87 (d, 1H, CH_2, J = 15 Hz), 5.26 (d, 1H, CH_2, J = 15 Hz), 5.91 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 6.37 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.22-7.62 (m, 7H, H_{arom}), 7.90 (d, 1H, H_{arom}, J = 7 Hz).

2,3-Dihydro-3-ethyl-3-hydroxy-2-[2-(pyrrol-1-yl)benzyl]-1*H*-isoindol-1-one (4c).

This compound was obtained in 88% yield, IR: 3346 (OH), 1673 (C=O) cm^{-1}; ^1H NMR : δ 0.33 (t, 3H, CH_3, J = 8 Hz), 1.57-2.06 (m, 2H, CH_2), 4.16 (d, 1H, CH_2-N, J = 16 Hz), 4.63 (d, 1H, CH_2-N, J = 16 Hz), 6.34 (t 2H, $H_{pyrrole}$, J = 2 Hz), 6.85 (t, 2H, $H_{pyrrole}$, J = 2 Hz), 7.20-7.33 (m, 3H, H_{arom}), 7.36-7.60 (m, 4H, H_{arom}), 7.73 (d, 1H, H_{arom}, J = 7 Hz).

2,3-Dihydro-3-ethyl-3-hydroxy-2-[2-(pyrrol-1-ylmethyl)benzyl]-1*H*-isoindol-1-one (4d).

This compound was obtained in 89% yield, IR: 3365 (OH), 1672 (C=O) cm^{-1}; ^1H NMR : δ 0.33 (t, 3H, CH_3, J = 7 Hz), 1.61-2.19 (m, 2H, CH_2), 3.10 (s, 1H, OH), 4.20 (d, 1H, CH_2, J = 16 Hz), 4.74 (d, 1H, CH_2, J = 16 Hz), 5.18-5.36 (m, 2H, CH_2), 6.05-6.09 (m, 2H, $H_{pyrrole}$), 6.59-6.63 (m, 2H, $H_{pyrrole}$), 6.92-7.71 (m, 8H, H_{arom}).

Cyclization of hydroxy lactams (3) and (4).

Procedure A: To a well stirred solution of hydroxy lactam (**3**) or (**4**) (0.36 mmol) in dry dichloromethane (5 mL) was added dropwise thionyl chloride (0.04 mL, 0.54 mmol). After stirring at rt for 30 min, the solvent was evaporated. Recrystallization of the residue from ethanol afforded pure compound **6**.

Procedure B: To a well stirred solution of hydroxylactam (**3**) or (**4**) (0.36 mmol) in dry dichloromethane (5 mL) was added trifluoroacetic acid (2 drops). After stirring at rt for 1 h, the solvent was evaporated. Recrystallization of the residue from ethanol afforded pure compound **(6)**.

Isoindolo[2,1-*a*]pyrrolo[2,1-*c*]quinoxalin-10(14b*H*)-one (6a, R = H).

This known compound was obtained in 35% (A) or 28% (B) yield, mp 224 °C (decomp) (lit.,[14] = 200 °C); IR: 1704 (C=O) cm^{-1}; ^1H NMR : δ 3.81 (s, 1H, H_{14b}), 6.25-6.31 (m, 1H, $H_{pyrrole}$), 6.33 (dd, 1H, $H_{pyrrole}$, J = 3 and 3.5 Hz), 7.21-7.33 (m, 3H, $2H_{arom}$+$H_{pyrrole}$), 7.47-7.56 (m, 1H, H_{arom}), 7.60 (d, 1H, H_{arom}, J = 7 Hz), 7.71 (dd, 1H, H_{arom}, J = 7 and 1 Hz), 7.85 (d, 1H, H_{arom}, J = 8 Hz), 7.95 (d, 1H, H_{arom}, J = 8 Hz), 8.13-8.21 (m, 1H, H_{arom}); ^{13}C NMR : δ 55.9 (CH), 104.9 (CH), 110.8 (CH), 115.1 (CH), 116.4 (CH), 122.9 (CH), 123.2 (CH), 124.5 (CH), 124.8 (CH), 125.2 (C), 125.6 (CH), 126.3 (C), 129.0 (CH), 129.1 (C) 131.9 (C), 132.6 (CH), 141.2 (C), 166.0 (CO). Anal. Calcd for $C_{18}H_{12}N_2O$: C, 79.40; H, 4.44; N, 10.29. Found: C, 79.33; H, 4.57; N, 10.22.

5*H*-Isoindolo[2,1-*a*]pyrrolo[2,1-*c*][1,4]benzodiazepin-11(15b*H*)-one (6b, R = H).

This compound was obtained in 100% (A) or 93% (B) yield, mp 200 °C; IR: 1707 (C=O) cm^{-1}; ^1H NMR : δ 4.89 (d, 1H, H_5, J = 15 Hz), 5.12 (d, 1H, H_5, J = 15 Hz), 6.05-6.10 (m, 1H, $H_{pyrrole}$), 6.14 (s, 1H, H_{15b}),

6.19-6.24 (m, 1H, $H_{pyrrole}$), 6.62-6.67 (m, 1H, $H_{pyrrole}$), 7.21-7.68 (m, 6H, H_{arom}), 7.90 (d, 1H, H_{12}, J = 8 Hz), 7.94 (d, 1H, H_{arom}, J = 8 Hz); ^{13}C NMR : δ 51.3 (CH_2), 60.4 (CH), 107.4 (CH), 108.1 (CH), 121.9 (CH), 123.3 (CH), 124.2 (CH), 126.3 (C), 127.2 (CH), 127.4 (CH), 128.6 (CH), 128.8 (CH), 129.5 (CH), 131.1 (C), 132.4 (CH), 132.8 (C), 137.7 (C), 144.0 (C), 167.7 (CO). Anal. Calcd for $C_{19}H_{14}N_2O$: C, 79.70; H, 4.93; N, 9.78. Found: C, 79.63; H, 4.87; N, 9.82.

9*H*-Isoindolo[1,2-*c*]pyrrolo[1,2-*a*][1,4]benzodiazepin-11(15b*H*)-one (6c, R = H).

This compound was obtained in 98% (A) or 94% (B) yield, mp >190 °C (decomp); IR: 1678 (C=O) cm^{-1}; ^{1}H NMR : δ 4.16 (d, 1H, H_9, J = 14 Hz), 5.05 (d, 1H, H_9, J = 14 Hz), 5.41 (s, 1H, H_{15b}), 5.90-5.96 (m, 1H, $H_{pyrrole}$), 6.25 (t, 1H, $H_{pyrrole}$, J = 3 Hz), 7.09 (m, 1H, $H_{pyrrole}$), 7.27-7.40 (m, 1H, H_{arom}), 7.43-7.64 (m, 6H, H_{arom}), 7.90 (d, 1H, H_{12}, J = 7 Hz); ^{13}C NMR : δ 44.5 (CH_2), 56.4 (CH), 107.1 (CH), 109.4 (CH), 121.8 (CH), 123.5 (2 CH), 124.0 (CH), 127.2 (CH), 128.5 (C), 128.9 (C + CH), 129.9 (CH), 131.1 (CH), 131.4 (CH), 133.6 (C), 140.2 (C), 141.6 (C), 166.9 (CO). Anal. Calcd for $C_{19}H_{14}N_2O$: C, 79.70; H, 4.93; N, 9.78. Found: C, 79.48; H, 4.85; N, 9.67.

5,10-Dihydro-isoindolo[2,1-*b*]pyrrolo[2,1-*d*][2,5]benzodiazocin-12(16b*H*)-one (6d, R = H).

This compound was obtained in 100% (A) or 92% (B) yield, mp 227 °C; IR: 1688 (C=O) cm^{-1}; ^{1}H NMR : δ 4.59 (d, 1H, CH_2, J = 16 Hz), 4.79 (s, 2H, CH_2), 5.22 (d, 1H, CH_2, J = 16 Hz), 5.85 (s, 1H, H_{16b}), 6.04 (t, 1H, $H_{pyrrole}$, J = 3 Hz), 6.10-6.21 (m, 1H, $H_{pyrrole}$), 6.63 (m, 1H, $H_{pyrrole}$), 7.12-7.65 (m, 7H, H_{arom}), 7.86 (d, 1H, H_{13}, J = 7 Hz); ^{13}C NMR : δ 46.0 (CH_2), 50.8 (CH_2), 60.6 (CH), 108.0 (CH), 110.3 (CH), 122.9 (CH), 123.6(CH), 123.8 (CH), 127.7 (CH), 128.7 (CH), 128.7 (CH), 129.8 (CH), 130.2 (CH), 131.3 (C), 131.9 (CH), 135.3 (2 C), 144.1 (2 C), 168.34 (CO). Anal. Calcd for $C_{20}H_{16}N_2O$: C, 79.98; H, 5.37; N, 9.33. Found: C, 79.70; H, 5.32; N, 9.49.

14b-Ethylisoindolo[2,1-*a*]pyrrolo[2,1-*c*]quinoxalin-10(14b*H*)-one (6a, R = Et).

This compound was obtained in 35% (A) or 28% (B) yield, mp 160 °C; IR: 1709 (C=O) cm^{-1}; ^{1}H NMR : δ 0.48 (t, 3H, CH_3, J = 7 Hz), 1.83-2.08 (m, 2H, CH_2), 6.21 (dd, 1H, $H_{pyrrole}$, J = 3 and 1 Hz), 6.28 (t, 1H, $H_{pyrrole}$, J = 3 Hz), 7.18 (dd, 1H, $H_{pyrrole}$, J = 3 and 1 Hz), 7.21-7.33 (m, 2H, H_{arom}), 7.43-7.59 (m, 2H, H_{arom}), 7.70 (t, 1H, H_{arom}, J = 7 Hz), 7.78 (d, 1H, H_{arom}, J = 7 Hz), 7.95 (d, 1H, H_{arom}, J = 7 Hz), 8.05-8.18 (m, 1H, H_{arom}); ^{13}C NMR : δ 7.3 (CH_3), 32.6 (CH_2), 64.6 (C), 104.4 (CH), 110.3 (CH), 114.7 (CH), 115.6 (CH), 122.1 (CH), 123.6 (CH), 124.0 (CH), 124.5 (C), 124.6 (CH), 125.6 (CH), 128.5 (CH), 128.8 (C), 129.6 (C), 131.5 (C), 132.4 (CH), 144.8 (C), 165.9 (CO). Anal. Calcd for $C_{20}H_{16}N_2O$: C, 79.98; H, 5.37; N, 9.33. Found: C, 79.77; H, 5.40; N, 9.31.

5*H*-15b-Ethylisoindolo[2,1-*a*]pyrrolo[2,1-*c*][1,4]benzodiazepin-11(15b*H*)-one (6b, R = Et).

This compound was obtained in 100% (A) or 93% (B) yield, mp 215 °C; IR: 1686 (C=O) cm^{-1}; ^{1}H NMR : δ 0.58 (t, 3H, CH_3, J = 7 Hz), 1.90-2.40 (m, 2H, CH_2), 6.08-6.11 (m, 1H, $H_{pyrrole}$), 6.39-6.45 (m, 1H, $H_{pyrrole}$), 6.54-6.56 (m, 1H, $H_{pyrrole}$), 7.30-7.62 (m, 7H, H_{arom}), 7.91 (d, 1H, H_{arom}, J = 7 Hz); ^{13}C NMR : δ 7.40 (CH_3), 33.6 (CH_2), 51.1 (CH_2), 69.7 (C), 107.2 (CH), 108.4 (CH), 121.6 (CH), 122.4 (CH), 123.8 (CH), 128.0 (CH), 128.5 (CH), 128.7 (CH), 129.4 (CH), 129.6 (CH), 130.6 (C), 130.7 (C), 132.7 (CH), 136.1 (C), 136.8 (C), 148.7 (C), 168.1 (CO). Anal. Calcd for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91.

Found: C, 79.98; H, 5.78, N, 8.76.

9*H*-15b-Ethylisoindolo[1,2-*c*]pyrrolo[1,2-*a*][1,4]benzodiazepin-11(15b*H*)-one (6c, R = Et).

This compound was obtained in 100% (A) or 94% (B) yield, mp 146 °C; IR: 1686 (C=O) cm^{-1}; ^1H NMR : δ 0.24 (t, 3H, CH_3, J = 7 Hz), 1.43-1.82 (m, 2H, CH_2, J = 7 Hz), 4.26 (d, 1H, H_9, J = 14 Hz), 5.02 (d, 1H, H_9, J = 14 Hz), 5.91 (dd, 1H, $H_{pyrrole}$, J = 3 and 2 Hz), 6.16 (t, 1H, $H_{pyrrole}$, J = 3 Hz), 7.03 (dd, 1H, $H_{pyrrole}$, J = 3 and 2 Hz), 7.22-7.67 (m, 7H, H_{arom}), 7.85 (d, 1H, H_{arom}, J = 7 Hz); ^{13}C NMR : δ 7.5 (CH_3), 32.2 (CH_2), 45.4 (CH_2), 67.7 (C), 108.6 (CH), 108.8 (CH), 122.5 (2 CH), 122.8 (CH), 123.7 (CH), 126.9 (CH), 127.8 (C), 128.5 (CH), 129.9 (CH), 130.7 (CH), 131.7 (CH), 132.1 (C), 132.2 (C), 141.5 (C), 147.4 (C), 169.2 (CO). Anal. Calcd for $C_{21}H_{18}N_2O$: C, 80.23; H, 5.77; N, 8.91. Found: C, 79.94; H, 5.65; N, 8.72.

5,10-Dihydro-16b-ethylisoindolo[2,1-*b*]pyrrolo[2,1-*d*][2,5]benzodiazocin-12(16b*H*)-one (6d, R = Et).

This compound was obtained in 100% (A) or 92% (B) yield, mp 176 °C; IR: 1693 (C=O) cm^{-1}; ^1H NMR : δ 0.46 (t, 3H, CH_3, J = 7 Hz), 2.27-2.60 (m, 2H, CH_2), 4.31 (d, 1H, CH_2, J = 16 Hz), 4.42 (d, 1H, CH_2, J = 16 Hz), 4.81 (d, 1H, CH_2, J = 16 Hz), 4.98 (d, 1H, CH_2, J = 16 Hz), 6.06-6.11 (m, 1H, $H_{pyrrole}$), 6.38-6.43 (m, 1H, $H_{pyrrole}$), 6.50-6.53 (m, 1H, $H_{pyrrole}$), 6.99-7.59 (m, 7H, H_{arom}), 7.82 (d, 1H, H_{arom}, J = 7 Hz); ^{13}C NMR : δ 6.5 (CH_3), 30.3 (CH_2), 43.5 (CH_2), 51.6 (CH_2), 67.8 (C), 107.7 (CH), 108.7 (CH), 122.2 (CH), 123.0 (CH), 123.6 (CH), 127.2 (CH), 128.4 (CH), 128.7 (CH), 128.8 (CH), 128.9 (C), 130.5 (CH), 130.9 (C), 132.5 (CH), 134.3 (C), 134.8 (C), 147.8 (C), 168.8 (CO). Anal. Calcd for $C_{22}H_{20}N_2O$: C, 80.46; H, 6.14; N, 8.53. Found: C, 80.01; H, 6.15; N, 8.42.

ACKNOWLEDGMENTS

The authors wish to thank Marie-José Tranchant for technical assistance.

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Found: C, 79.98; H, 5.78, N, 8.76.

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Received, 23rd March, 1999