New N-bridgehead heterocyclic compounds. I. Carbamoyl-substituted indolizines and benzoindolizines

Emilian Georgescu,[a] Florentina Georgescu,*[a] Mariana G. Danila,[b] Petru I. Filip,[b] Constantin Drăghici, [b] and Miron T. Căproiu [b]

[a] S.C. OLTCHIM - Research Center, 1 Uzinei St., Ramnicu Valcea 1000, Romania
[b] Romanian Academy - Centre of Organic Chemistry, 202B Independentei Spl., Bucharest 71141, Romania
E-mail: florentina_fg@yahoo.com;sinteze@oltchim.onix.ro

In commemoration of the 100th birthday of Prof. C. D. Nenitzescu
(received 23 Aug 2001; accepted 25 Nov 2001; published on the web 03 Dec 2001)

Abstract
Quaternary salts obtained by the reaction of several pyridines and benzopyridines with chloro- or bromoacetanilides were reacted with corresponding activated alkynes in the presence of an oxirane, yielding new carbamoyl-substituted indolizines and benzoindolizines derivatives. Other new 3-carbamoyl substituted indolizine and pyrrolo[2,1-a]isoquinoline derivatives were obtained by heating the intermediate N-metylcarbamoyl quaternary salts, in the presence of an acid acceptor, with alkenes and tetrapyridinecobalt(II)dichromate as a reaction promoter and dehydrogenating catalyst. The new compounds are fully characterised by elemental microanalysis and IR, ^{1}H and ^{13}C NMR spectra.

Keywords: Haloacetanilides as quaternizing agents, 1,3-dipolar cycloaddition reaction, carbamoylmethylide, 3-carbamoyl-indolizines, 1-carbamoylpyrrolo[1,2-a]quinoline, 3-carbamoylpyrrolo[2,1-a]isoquinoline

Introduction

The indolizines have been subject of considerable interest from physical, chemical and biological points of view.[1,2] The presence of a carbamoyl group on the pyrrole ring of the indolizines should have interesting effects on their chemical and biological properties. One of the most important methods for the synthesis of indolizines and benzoindolizines derivatives is based on 1,3-dipolar cycloaddition reactions of N-heterocyclic ylides with electron-deficient alkynes or alkenes.[3-5] The N-heterocyclic ylides could be obtained by the dehydrohalogenation of the corresponding quaternary salts of N-heterocyclic compounds.[4,5]

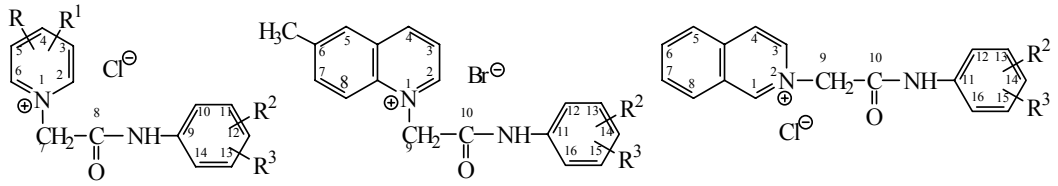
Herein we report new carbamoyl-substituted N-bridgehead heterocyclic compounds obtained by the reactions of N-heterocyclic compounds with chloroacetanilides or bromoacetanilides

followed by the direct reactions of the intermediate N-methylcarbamoyl quaternary salts with activated alkynes or alkenes.

Results and Discussion

N-Methylcarbamoyl quaternary salts

By the quaternisation reactions of several pyridine, quinoline and isoquinoline derivatives with chloro- or bromoacetanilides the intermediate N-methylcarbamoyl quaternary salts **1-3** appeared easily accessible (Scheme 1, Table 1). The structures of the quaternary salts **1-3** were confirmed by chemical and spectral analyses. Some of the quaternary salts couldn't be separated and purified. They were used as crude products in the next step.



1a-e **2** **3a-d**

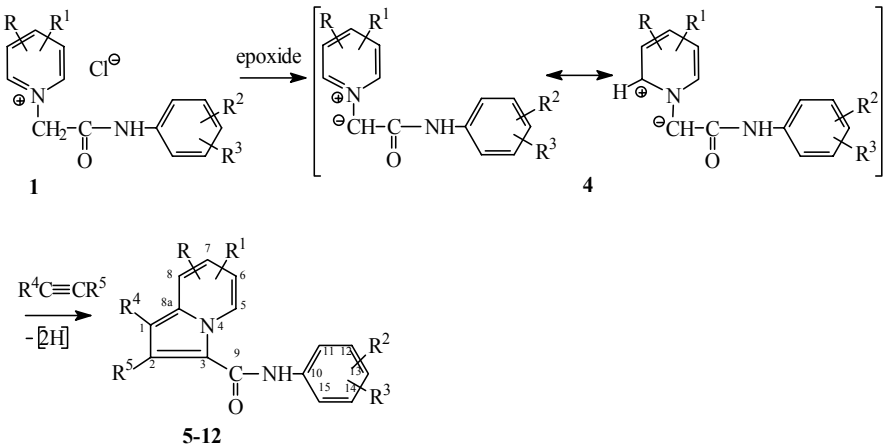
Scheme 1

Table 1. N-Methylcarbamoyl quaternary salts **1-3**

Compound	R	R^1	R^2	R^3	m.p. (^oC)	yield (%)
1a	H	H	2-F	H	238-240	83
1b	H	H	3-CF_3	H	211-213	81
1c	4-CH_3	H	3-CF_3	H	222-225	76
1d	4-CH_3	H	2-F	H	246-249	84
1e	2-CH_3	5-C_2H_5	2-C_2H_5	6-C_2H_5	208-210	94
2	6-CH_3	H	3-CF_3	H	228-230	96
3a	-	H	4-CH_3	H	136-139	82
3b	-	H	2-F	H	186-187	76
3c	-	H	2-OCH_3	H	247-250	80
3d	-	H	3-CF_3	H	252-255	76

Carbamoyl-substituted indolizines and benzoindolizines

By the direct reaction of the intermediate N-methylcarbamoyl pyridinium salts **1** with activated alkynes in an epoxide, as acid acceptor and reaction solvent, new indolizines bearing a carbamoyl group on the pyrrolo ring **5-12** were obtained (Scheme 2, Table 2).



Scheme 2

Table 2. New prepared 3-carbamoylindolizines

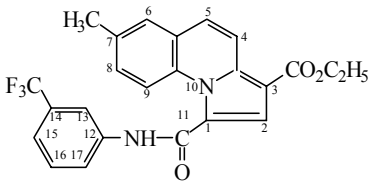
Compound	R	R^1	R^2	R^3	R^4	m.p. (°C)	yield (%)
5	H	H	2-F	H	$CO_2C_2H_5$	160-162	44
6	H	H	2-C_2H_5	H	$CO_2C_2H_5$	172.5-174	51
7	H	H	3-CF_3	H	$CO_2C_2H_5$	171-172	41
8	7-CH_3	H	2-F	H	$CO_2C_2H_5$	153-154	42
9	7-CH_3	H	3-CF_3	H	$CO_2C_2H_5$	183-185	39
10	7-CH_3	H	2-CH_3	6-C_2H_5	COC_6H_5	220-222	28
11	5-CH_3	8-C_2H_5	2-C_2H_5	6-C_2H_5	$COCH_3$	207-210	26
12	5-CH_3	8-C_2H_5	2-C_2H_5	6-C_2H_5	CO_2CH_3	190-192	50

The structures of 3-carbamoylindolizines **5-12** were confirmed by microanalysis, IR, ^{1}H- and ^{13}C-NMR spectral data.

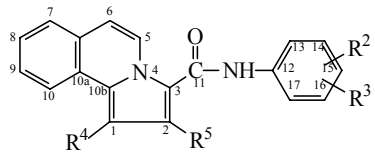
The ^{1}H-NMR spectra of **5-12** in $CDCl_3$ reveal characteristic signals in the range δ 7.47-8.16 (NH) and δ 7.78-8.16 (H-2). The ^{1}H-NMR spectra of **5-9** show the signals for the ethyl protons of the carbethoxy group at δ 4.37-4.40 (q) and δ 1.41-1.44 (t). The ^{1}H-NMR spectra of **10** and **12** exhibit the signals for the methyl protons of the acetyl and carbomethoxy group at δ 2.57, respectively δ 3.90.

The ^{13}C-NMR spectra of **5-12** in $CDCl_3$ show characteristic signals for the carbonyl carbon at δ 159-161 (carbamoyl group), δ~164 (carboethoxy or carbomethoxy group) and δ 192.6 (acetyl group), respectively.

Based on this one-pot procedure new 1-[(3-trifluoromethylphenyl)carbamoyl]-7-methylpyrrolo[1,2-a]quinoline **13** and 3-carbamoyl substituted pyrrolo[2,1-a]-isoquinolines **14-29** were obtained (Scheme 3, Table 3).



13



14-29

Scheme 3

The structures of new carbamoyl-substituted benzoindolizines **13** and **14-29** were confirmed by microanalysis, IR, ^{1}H- and ^{13}C-NMR analysis.

For example, the IR spectra of **13-29** exhibit the characteristic absorption bands at about 3300 cm^{-1} and 3100 cm^{-1} (NH) and characteristic C=O absorption bands at about 1700 cm^{-1} (COOMe/COOEt) and 1660 cm^{-1} (C=O from carbamoyl group). The ^{1}H-NMR spectra of **13-29**, in $CDCl_3$, present signals at δ 7.86-8.39 (NH) in $CDCl_3$, respectively at δ 10.21-11.12 (NH) in a mixture of $CDCl_3$ and trifluoroacetic acid, and two doublets at δ 7.02-7.20 and δ 9.29-9.47 (*J* 7.5-7.8 Hz). These latter signals were attributed to the protons H-4 and H-5 (in **13**), respectively H-6 and H-5 (in **14-29**). In the ^{1}H-NMR spectra of **14-18** and **22** the signal at δ 7.73-7.83 was attributed to the H-2 proton. The methyl, respectively ethyl, signals from ester groups appears at δ 3.97-4.03, respectively δ 4.40 (q) and δ 1.46 (t).

Table 3. New 3-carbamoyl pyrrolo[2,1-a]isoquinolines 14-29

Compound	R^2	R^3	R^4	R^5	m.p. (°C)	yield (%)
14	2-F	H	$CO_2C_2H_5$	H	152-154	53
15	3-CH_3	H	CO_2CH_3	H	166-168	51
16	2-OCH_3	H	$CO_2C_2H_5$	H	164-166	50
17	3-OCH_3	H	$CO_2C_2H_5$	H	171-172	54
18	3-CF_3	H	$CO_2C_2H_5$	H	201-203	61
19	2-CH_3	H	CO_2CH_3	CO_2CH_3	152-154	46
20	4-CH_3	H	CO_2CH_3	CO_2CH_3	166-167.5	44
21	3-CF_3	H	CO_2CH_3	CO_2CH_3	143-145	44
22	3-Cl	4-F	$CO_2C_2H_5$	H	202-204	43
23	4-Cl	H	CO_2CH_3	CO_2CH_3	177-179	29
24	2-CH_3	6-CH_3	CO_2CH_3	CO_2CH_3	180-182	34
25	2-C_2H_5	6-C_2H_5	CO_2CH_3	CO_2CH_3	160-162	38
26	2-CH_3	3-Cl	CO_2CH_3	CO_2CH_3	167-169	39
27	2-CH_3	4-Cl	CO_2CH_3	CO_2CH_3	171-172	41
28	2-CH_3	5-Cl	CO_2CH_3	CO_2CH_3	198-200	36
29	3,4-methylenedioxy		CO_2CH_3	CO_2CH_3	185-186	57

All the ^{13}C-NMR spectra of **13-29** reveal characteristic signals for the carbonyl carbon at δ~160 (carbamoyl group) and δ~164 (carboethoxy or carbomethoxy group).

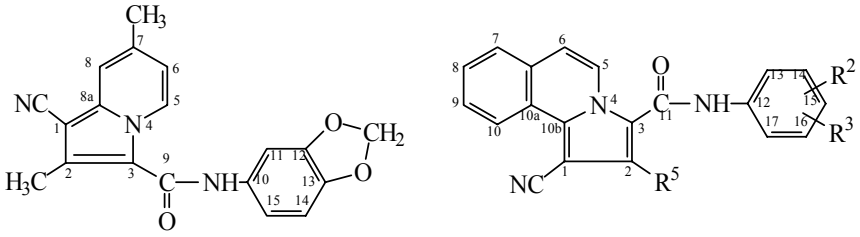
Propenoxide was used as acid acceptor in all these reactions, and the activated alkynes were methyl or ethyl propiolate, 1-butyne-3-one, phenylethynyl ketone or dimethylacetylene dicarboxylate.

In the regular conditions of a 1,3-dipolar cycloaddition reaction, N-heterocyclic ylides react slowly even with strong activated alkenes.[4,5] In some cases aromatic indolizines were prepared by two-steps procedures, in which the initially formed tetrahydroindolizines or dihydroindolizines are dehydrogenated by treatment with suitable reagents.[6-10]

By 1,3-dipolar cycloaddition reactions of the 4-methylpyridinium-, respectively isoquinolinium-carbamoylmethylides, generated *in situ* from the corresponding quaternary salts, with acrylonitrile and respectively with crotononitrile, in the presence of tetrapyridinecobalt(II)-dichromate,[11,12] as a reaction promoter and dehydrogenating catalyst, other new 3-carbamoyl substituted indolizine **30**, respectively pyrrolo[2,1-a]-isoquinolines **31-32** (Scheme 4, Table 4) were obtained.

These cycloadition reactions could be accomplished by treating the corresponding quaternary salts with alkenes and tetrapyridinecobalt(II)dichromate, in DMF at 90°C, using pyridine as hydrobromic acid acceptor,[11,12] or by heating the N-methylcarbamoyl quaternary salts with alkenes and tetrapyridinecobalt(II)dichromate in 1,2-epoxybutane used as acid acceptor and solvent.[13]

The structures of new carbamoyl-substituted indolizine **30** and pyrrolo[2,1-a]-isoquinolines **31-32** were confirmed by IR, ^{1}H- and ^{13}C-NMR analysis.



30 **31-32**

Scheme 4

Table 4. New 3-carbamoyl indolizine and benzoindolizine derivatives **30-32**

Compound	R^1	R^2	R^3	R^5	m.p. (°C)	yield (%)
30	7-CH_3	3,4-methylenedioxy		CH_3	246-246.5	12.0
31	H	3-CF_3	H	CH_3	225-228	34
32	H	3-OCH_3	H	H	286-289	38

The IR spectra of **30-32** exhibit the single CN absorbtion bands at 2204 cm^{-1} (**30**, **31**) or 2213 cm^{-1} (**32**), two NH absorption bands at about 3300 cm^{-1} and 3100 cm^{-1}, characteristic C=O absorption bands at 1636-1669 cm^{-1} and 1536-1547 cm^{-1}. The ^{1}H-NMR spectrum of **30** in a mixture of $CDCl_3$ and trifluoroacetic acid reveals the signals at δ 7.82 (NH) and δ 7.40 (H-8), as a broad singlet, a doublet at δ 9.09 (*J* 7.2 Hz) attributed to H-5 and a double doublet at δ 6.82 (*J*

7.2 and 1.8 Hz) attributed to H-6. The characteristic two methyl signals appear at δ 2.45 (2-CH_3) and 2.69 (7-CH_3) and the methylene protons appear at δ 6.00. The ^{1}H-NMR spectra of **31** (in $CDCl_3$), respectively of **32** (in a mixture of $CDCl_3$ and trifluoroacetic acid), show the characteristic NH signals at δ 8.11, respectively δ 9.30. The two doublets at δ 8.71 and δ 6.82 (for **31**), and respectively at δ 9,16 and δ 7.23 (for **32**), were attributed to H-5 and H-6. The characteristic signals for methyl protons appeared at δ 2.75, respectively δ 3.88. The ^{13}C-NMR spectra of **30-32** exhibit the characteristic signals for the C=O carbon at δ~160 (carbamoyl group) and for the C≡N carbon at δ~116.

In conclusion, the otherwise not easily accessible indolizines and benzoindolizines bearing carbamoyl groups on the pyrrolo ring are readily prepared by the simple one-pot synthesis described herein.

Experimental Section

General Procedures. Melting points were determined on a Boetius apparatus and are uncorrected. The IR spectra were recorded on a Nicolet Impact 410 spectrometer, in KBr pellets. The ^{1}H- and ^{13}C-NMR spectra were registered with a Varian Gemini 300BB instrument at ambient temperature using TMS as internal standard; for unambiguous assignment ^{1}H-decoupling COSY (^{1}H-^{1}H) and COSY (^{1}H-^{13}C) were used. The solvent used was $CDCl_3$ for the compounds **5-12**, **14-17**, **19-25** and **31,** or a mixture of 10:1 molar ratio $CDCl_3$:TFA only for the compounds **1a-1e**, **2**, **3a-3d**, **13**, **18**, **26-30** and **32**. Elemental analyses were carried out on a Carlo Erba 1106 Elemental Analyzer. Pyridine, quinoline and isoquinoline derivatives were commercially available products (Aldrich). Chloro- and bromoacetanilides were obtained from the corresponding aromatic amines and chloroacetyl chloride, respectively bromoacetyl bromide. Tetrapyridinecobalt(II)dichromate (TPCD) was prepared according to a previously described method.[11]

N-Methylcarbamoyl quaternary salts. General procedure

A mixture of a N-heterocyclic compound (20 mmol) and the corresponding chloroacetanilide or bromoacetanilide (20 mmol) in chloroform (50 mL) was heated at reflux for 20 hours. The mixture was cooled and left overnight at the room temperature. The solid product was filtered, washed with a mixture of methylene dichloride-diethyl ether (30 mL) and recrystallised from methanol or methanol/diethyl ether.

The yields and m. p. are shown in Table 1. The spectral data are given below.

1-[*N*-(2-Fluorophenyl)carbamoylmethyl]pyridinium chloride (1a). IR ν 3144, 3093, 1685, 1554. ^{1}H-NMR (δ ppm, *J* Hz): 9.43 (1H, s, NH); 8.89 (2H, d, 6.6, 2-H, 6-H); 8.56 (1H, t, 7.6, 4-H); 8.10 (2H, dd, 6.6, 7.6, 3-H, 5-H,); 7.68 (1H, td, 8.8, 1.80, 14-H); 7.08-7.23 (3H, m, 11-H, 12-H, 13-H); 5.91 (2H, s, CH_2). ^{13}C-NMR δ 163.02 (8-C); 154.60 (10-C, d, 248.1), 146.44 (4-C); 146.01 (2-C, 6-C); 128.17 (3-C, 5-C, 14-C); 124.66 (12-C, d, 3.9); 124.32 (13-C); 122.95 (9-C, d, 11.1); 115.92 (11-C, d, 19.3); 62.83 (CH_2). Anal. calcd. for $C_{13}H_{12}ClFN_2O$ (266.70): C, 58.54; H, 4.53; N, 10.50%. Found: C, 58.65; H, 4.59; N, 10.62%.

1-[*N*-(3-Trifluoromethylphenyl)carbamoylmethyl]pyridinium chloride (1b). IR ν 3246, 3085, 1707, 1566. ^{1}H-NMR (δ ppm, *J* Hz): 10.28 (1H, bs, NH), 8.90 (2H, dd, 6.6, 0.9, 2-H, 6-H); 8.49 (1H, tt, 7.8, 0.9, 4-H); 8.03 (2H, dd, 7.8, 6.6, 3-H, 5-H); 7.90 (1H, s, 11-H); 7.65 (1H, m, 15-H); 7.35-7.42 (2H, m, 13-H, 14-H); 5.88 (2H, s, CH_2). ^{13}C-NMR δ 162.41 (8-C); 146.08 (4-C); 145.95 (2-C, 6-C); 137.16 (10-C); 131.40 (12-C, d, 33.1); 129.67 (14-C); 127.95 (3-C, 5-C); 123.53 (15-C); 122.00 (13-C); 121.95 (CF_3, q, 272.2); 117.13 (11-C); 63.07 (CH_2). Anal. calcd. for $C_{14}H_{12}ClF_3N_2O$ (316.71): C, 53.09; H, 3.82; N, 8.85%. Found: C, 53.19; H, 3.89; N, 8.93%.

1-[*N*-(3-Trifluoromethylphenyl)carbamoylmethyl]-4-methylpyridinium chloride (1c). IR ν 3252, 3031, 1693, 1574. ^{1}H-NMR (δ ppm, *J* Hz): 9.95 (1H, bs, NH); 8.64 (2H, d, 6.7, 2-H, 6-H); 7.90 (1H, bs, 10-H); 7.83 (2H, d, 6.7, 3-H, 5-H); 7.48-7.62 (3H, m, 12-H, 13-H, 14-H); 5.75 (2H, s, CH_2); 2.71 (3H, s, CH_3). ^{13}C-NMR δ 163.40 (8-C); 161.56 (4-C); 144.72 (2-C, 6-C); 136.32 (9-C); 131.69 (11-C, q, 33.1); 129.89 (14-C); 128.64 (3-C, 5-C); 124.06 (13-C); 123.53 (CF_3, q, 272.3); 122.86 (12-C, q, 3.8); 117.76 (10-C, q, 4.1); 62.08 (CH_2); 22.19 (CH_3). Anal. calcd. for $C_{15}H_{14}ClF_3N_2O$ (330.73): C, 54.47; H, 4.26; N, 8.47%. Found: C, 54.43; H, 4.21; N, 8.42%.

1-[*N*-(2-Fluorophenyl)carbamoylmethyl]-4-methylpyridinium chloride (1d). IR ν 3162, 3035, 1689, 1545. ^{1}H-NMR (δ ppm, *J* Hz): 9.49 (1H, s, NH); 8.68 (2H, d, 6.4, 2-H, 6-H); 7.78 (2H, 6.4, 3-H, 5-H); 7.74 (1H, td, 8.0, 1.8, 14-H); 7.01-7.19 (3H, m, 11-H, 12-H, 13-H); 5.83 (2H, s, CH_2); 2.66 (3H, s, CH_3). ^{13}C-NMR δ 163.63 (8-C); 161.14 (4-C); 154.30 (10-C, d, 247.8); 144.79 (2-C, 6-C); 128.47 (3-C, 5-C); 127.43 (14-C, d, 7.6); 124.49 (12-C, d, 3.7); 124.13 (13-C); 123.57 (9-C, d, 11.6); 115.67 (11-C, d, 19.1); 61.93 (CH_2); 22.04 (CH_3). Anal. calcd. for $C_{14}H_{14}ClFN_2O$ (280.72): C, 59.90; H, 5.03; N, 9.98%. Found: C, 59.86; H, 5.12; N, 9.94%.

1-[*N*-(2,6-Diethylphenyl)carbamoylmethyl]-2-ethyl-5-methylpyridinium chloride (1e). IR ν 3392, 3049, 1673, 1540. ^{1}H-NMR (δ ppm, *J* Hz): 10.93 (1H, s, NH); 9.29 (1H, d, 1.90, 6-H); 8.09 (1H, dd, 1.9, 8.1, 4-H); 7.70 (1H, d, 8.1, 3-H); 7.09-7.19 (3H, m, 11-H, 12-H, 13-H); 6.31 (2H, s, 7-CH_2); 2.92 (3H, s, 2-CH_3); 2.89 (2H, q, 6.9, 5-CH_2); 1.31 (3H, t, 6.9, 5-C_2H_5); 2.66 (4H, q, 2,6-diEt, 7.1); 1.14 (6H, t, 7.1, 2,6-diEt). ^{13}C-NMR δ 163.23 (8-C); 153.20 (2-C); 146.19 (6-C); 144.61 (4-C); 141.12 (10-C); 142.12 (9-C); 141.12 (10-C, 14-C); 132.26 (5-C); 128.88 (3-C); 127.69 (12-C); 125.88 (11-C, 13-C); 60.03 (7-CH_2); 25.34 (CH_2 from 5-Et) 24.78 (2CH_2 from 2,6-diEt); 20.37 (2-CH_3); 14.37 (2CH_3 from 2,6-diEt); 14.08 (CH_3 from 5-Et). Anal. calcd. for $C_{20}H_{27}ClN_2O$ (346.89): C, 69.25; H, 7.84; N, 8.07%. Found: C, 69.53; H, 7.75; N, 8.05%.

1-[*N*-(3-Trifluoromethylphenyl)carbamoylmethyl]-6-methylquinolinium bromide (2). IR ν 3205, 3069, 1692, 1573. ^{1}H-NMR (δ ppm, *J* Hz): 10.27 (1H, s, NH); 9.15 (1H, dd, 6.0, 1.5, 2-H); 8.96 (1H, bd, 8.4, 4-H); 8.30 (1H, d, 9.1, 8-H); 8.10 (1H, dd, 9.1, 20, 7-H); 8.06 (1H, bs, 5-H); 8.02 (1H, dd, 8.4, 6.0, 3-H); 7.89 (1H, bs, 12-H); 7.71 (1H, m, 15-H); 7.47-7.51 (2H, m, 14-H, 16-H); 6.33 (2H, s, CH_2); 2.69 (3H, s, 6-CH_3). ^{13}C-NMR δ 163.80 (CO); 148.94 (2-C); 147.90 (4-C); 142.77 (8a-C); 139.88 (7-C); 137.66 (6-C); 136.23 (11-C); 131.91 (13-C, q, 33.1); 130.45 (4a-C); 129.98 (16-C); 129.40 (5-C); 124.24 (15-C); 123.56 (CF_3, q, 272.2); 123.16 (14-C, q, 3.5); 121.52 (3C); 117.98 (12-C, q, 3.6); 117.95 (8-C); 60.13 (CH_2); 21.23 (CH_3). Anal. calcd. for $C_{19}H_{16}BrF_3N_2O$ (425.24): C, 53.66; H, 3.79; N, 6.59%. Found: C, 53.60; H, 3.85; N, 6.61%.

2-[*N*-(4-Methylphenyl)carbamoylmethyl]isoquinolinium chloride (3a). IR ν 3235, 3049, 1636, 1544. ^{1}H-NMR (δ ppm, *J* Hz): 9.79 (1H, bs, 1-H); 9.67 (1H, s, NH); 8.50 (1H, d, 6.7, 3-

H); 8.40 (1H, d, 8.4, 8-H); 8.31 (1H, d, 6.7, 4-H); 8.26 (1H, ddd, 1.1, 6.7, 8.4, 6-H); 8.20 (1H, dd, 1.1, 8.3, 5-H); 8.07 (1H, ddd, 1.2, 6.7, 8.3, 7-H); 7.33 (2H, d, 8.2, 10-H, 14-H); 7.14 (2H, d, 8.2, 11-H, 13-H); 5.90 (2H, s, CH_2); 2.30 (3H, s, CH_3). ^{13}C-NMR δ 162.96 (CO); 150.62 (1-C); 137.96 (6-C); 137.84 (4a-C); 135.78 (12-C or C-9); 135.37 (3-C); 133.72 (9-C or 12-C); 131.79 (7-C); 130.72 (8-C); 127.49 (8a-C); 129.60 (11-C, 13-C); 127.22 (5-C); 126.02 (4-C); 120.97 (10-C, 14-C); 62.73 (CH_2); 20.66 (CH_3). Anal. calcd. for $C_{18}H_{17}ClN_2O$ (312.79): C, 69.12; H, 5.48; N, 8.95%. Found: C, 69.20; H, 5.52; N, 8.59%.

2-[*N*-(2-Fluorophenyl)carbamoylmethyl]isoquinolinium chloride (3b). IR ν 3184, 3047, 1702, 1548. ^{1}H-NMR (δ ppm, *J* Hz): 9.76 (1H, bs, 1-H); 9.66 (1H, s, NH); 8.44 (1H, dd, 1.4, 6.9, 3-H); 8.43 (1H, dd, 8.4, 0.8, 8-H); 8.31 (1H, d, 6.9, 4-H); 8.24 (1H, ddd, 1.2, 6.6, 8.2, 6-H); 8.19 (1H, bd, 8.2, 5-H); 8.05 (1H, ddd, 1.4, 6.6, 8.4, 7-H); 7.80 (1H, td, 7.7, 1.9, 14-H); 7.07-7.22 (3H, m, 11-H, 12-H, 13-H); 6.06 (2H, s, CH_2). ^{13}C-NMR δ 163.52 (CO); 154.38 (10-C, d, 248.5); 150.81 (1-C); 138.21 (6-C); 137.96 (4a-C); 135.49 (3-C); 132.01 (7-C); 130.90 (8-C); 127.62 (8a-C); 127.45 (12-C, d, 7.7); 127.29 (5-C); 126.05 (4-C); 124.52 (14-C, d, 3.9); 124.02 (13-C); 123.74 (9-C, d, 11.5); 115.83 (11-C, d, 19.0); 62.71 (CH_2). Anal. calcd. for $C_{17}H_{14}ClFN_2O$ (316.76): C, 64.46; H, 4.45; N, 8.84%. Found: C, 64.52; H, 4.51; N, 8.88%.

2-[*N*-(2-Methoxyphenyl)carbamoylmethyl]isoquinolinium chloride (3c). IR ν 3325, 3046, 1689, 1544. ^{1}H-NMR (δ ppm, *J* Hz): 9.72 (1H, bs, H-1); 9.31 (1H, s, NH); 8.51 (1H, dd, 6.8, 1.2, 3-H); 8.39 (1H, bd, 8.4, 5-H); 8.28 (1H, d, 6.8, 4-H); 8.20 (1H, ddd, 1.1, 7.2, 8.4, 6-H); 8.15 (1H, bd, 7.2, 8-H); 8.00 (1H, ddd, 1.4, 7.2, 8.4, 7-H); 7.82 (1H, ddd, 7.9, 7.6, 1.5, 14-H); 7.15 (1H, ddd, 1.6, 7.6, 7.9, 12-H); 6.89 (2H, m, 13-H, 11-H); 6.00 (2H, s, CH_2); 3.84 (3H, s, OMe). ^{13}C-NMR δ 163.38 (CO); 150.73 (1-C); 150.13 (10-C); 138.23 (6-C); 137.95 (4a-C); 135.30 (3-C); 132.00 (7-C); 130.75 (8-C); 127.56 (8a-C); 127.30 (5-C); 126.97 (12-C); 126.18 (4-C); 124.78 (9-C); 122.14 (14-C); 120.79 (13-C); 111.00 (11-C); 62.84 (CH_2); 55.65 (OMe). Anal. calcd. for $C_{18}H_{17}ClN_2O_2$ (328.79): C, 65.75; H, 5.21; N, 8.52%. Found: C, 65.78; H, 5.26; N, 8.48%.

2-[*N*-(3-Trifluorophenyl)carbamoylmethyl]isoquinolinium chloride (3d). IR ν 3198, 3056, 1693, 1577. ^{1}H-NMR (δ ppm, *J* Hz): 10.16 (1H, s, NH), 9.69 (1H, bs, H-1); 8.52 (1H, dd, 1.3, 6.9, 3-H); 8.42 (1H, bd, 8.4, 8-H); 8.33 (1H d, 6.9, 4-H); 8.28 (1H, ddd, 1.2, 6.7, 7.3, 6-H); 8.21 (1H, bd, 7.3, 5-H); 8.08 (1H, ddd, 1.4, 6.7, 8.4, 7-H); 7.91 (1H, bs, 10-H); 7.66 (1H, m, 12-H); 7.47 (1H, t, 7.7, 13-H); 7.45 (1H, m, 14-H); 5.97 (2H, s, CH_2). ^{13}C-NMR δ 163.39 (CO); 150.61 (1-C); 138.45 (6-C); 138.00 (4a-C); 136.52 (9-C); 135.28 (3-C); 132.21 (7-C); 131.68 (11-C, q, 32.8); 130.80 (8-C); 129.86 (C13-H); 127.62 (8a-C); 127.35 (5-C); 126.24 (4-C); 123.91 (14-C); 123.69 (CF_3, q, 271.8); 122.77 (12-C, q, 3.4); 117.65 (10-C, q, 3.7); 62.73 (CH_2). Anal. calcd. for $C_{18}H_{14}ClF_3N_2O$ (366.76): C, 58.95; H, 3.85; N, 7.64%. Found: C, 59.02; H, 3.75; N, 7.61%.

Carbamoyl-substituted indolizines and benzoindolizines. General procedure

A mixture of N-methylcarbamoyl quaternary salt (10 mmol) and acetylenic compound (15 mmol) in propenoxid (50 mL) was stirred at room temperature for 10-12 days and then was concentrated under reduced pressure. The residue was treated with methanol (10 mL) and kept refrigerated overnight. The solid was filtered and washed with cold methanol and then with diethyl ether. All crude products were recrystallised from chloroform/methanol.

The yields and m. p. for 3-carbamoylindolizines **5-12** are shown in Table 2. The spectral data are given below.

1-Carbethoxy-3-[(2-fluorophenyl)carbamoyl]indolizine (5). IR ν 3323, 3112, 1669, 1656, 1529. ^{1}H-NMR (δ ppm, *J* Hz): 9.71 (1H, dt, 7.1, 1.1, 5-H); 8.40 (1H, m, 14-H); 8.34 (1H, dt, 9.1, 1.3, 8-H); 7.93 (1H, d, 3.1, NH); 7.85 (1H, s, 2-H); 7.33 (1H, ddd, 1.1, 6.8, 9.1, 7-H); 7.04-7.22 (3H, m, 12-H, 13-H, 15-H); 4.40 (2H, q, 7.1, CH_2 from CO_2Et); 1.43 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.07 (COO); 159.14 (9-C); 152.70 (11-C, d, 243.1); 138.73 (8a-C); 128.25 (5-C); 125.95 (10-C, d, 10.3); 124.55 (15-C or 13-C, d, 3.4); 124.22 (13-C or 15-C, d, 7.5); 121.78 (14-C); 119.47 (8-C); 119.47 (2-C); 116.80 (3-C); 114.92 (12-C, d, 19.1); 114.32 (6-C); 104.85 (1-C); 60.06 (CH_2 from CO_2Et); 14.54 (CH_3 from CO_2Et). Anal. calcd. for $C_{19}H_{16}BrF_3N_2O$ (425.24): C, 53.66; H, 3.79; N, 6.59%. Found: C, 53.60; H, 3.85; N, 6.61%. Anal. calcd. for $C_{18}H_{15}FN_2O_3$ (326.32): C, 66.25; H, 4.63; N, 8.58%. Found: C, 66.30; H, 4.65; N, 8.63%.

1-Carbethoxy-3-[(2-ethylphenyl)carbamoyl]indolizine (6). IR ν 3336, 3110, 1671, 1653, 1528. ^{1}H-NMR (δ ppm, *J* Hz): 9.72 (1H, dt, 7.2, 1.1, 5-H); 8.29 (1H, dt, 1.3, 8.9, 8-H); 7.86 (1H, s, 2-H); 7.80 (1H, dd, 7.8, 1.8, 15-H); 7.72 (1H, s, NH); 7.23-7.32 (3H, m, 7-H, 12-H, 14-H); 7.20 (1H, dt, 7.0, 1.5, 13-H); 6.94 (1H, td, 6.9, 1.4, 6-H); 4.37 (2H, CH_2, q, 7.1, from CO_2Et); 2.70 (2H, q, 7.4, CH_2 from 2-Et); 1.41 (3H, t, 7.1, CH_3 from CO_2Et); 1.28 (3H, t, 7.4, CH_3 from 2-Et). ^{13}C-NMR δ 164.32 (COO); 159.84 (9-C); 138.51 (8a-C); 136.09 (10-C); 134.69 (11-C); 128.65 (12-C); 128.46 (5-C); 126.67 (7-C); 125.82 (13-C); 125.43 (14-C); 124.42 (15-C); 119.45 (8-C); 119.02 (2-C); 117.36 (3-C), 114.14 (6-C); 104.65 (1-C); 60.06 (CH_2 from CO_2Et); 24.43 (CH_2 from 2-Et); 14.55 (CH_3 from CO_2Et); 13.98 (CH_3 from 2-Et). Anal. calcd. for $C_{20}H_{20}N_2O_3$ (336.38): C, 71.41; H, 5.99; N, 8.33%. Found: C, 71.38; H, 6.04; N, 8.28%.

1-Carbethoxy-3-[(3-trifluoromethylphenyl)carbamoyl]indolizine (7). IR ν 3326, 3123, 1669, 1657, 1554. ^{1}H-NMR (δ ppm, *J* Hz): 9.69 (1H, dt, 7.2, 1.1, 5-H); 8.29 (1H, dt, 9.1, 1.1, 8-H); 8.16 (1H, s, NH); 8.01 (1H, bs, 11-H); 7.93 (1H, s, 2-H); 7.83 (1H, bd, 7.8, 13-H); 7.42 (1H, t, 7.8, 14-H); 7.37 (1H, bd, 7.8, 15-H); 7.31 (1H, dd, 9.1, 7.2, 7-H); 6.97 (1H, td, 7.2, 0.9, 6-H); 4.37 (2H, q, 7.2, CH_2 from CO_2Et); 1.42 (3H, t, 7.2, CH_3 from CO_2Et). ^{13}C-NMR δ 164.28 (COO); 159.51 (9-C); 138.74 (8a-C); 138.52 (10-C); 131.58 (12-C, q, 31.9); 129.57 (14-C); 128.34 (5-C); 125.84 (7-C); 123.81 (CF_3, q, 272.3); 123.07 (15-C); 120.69 (13-C, q, 3.4); 119.77 (2-C); 119.51 (8-C); 116.79 (11-C, q, 3.7); 116.42 (3-C); 114.43 (6-C); 104.83 (1-C); 60.22 (CH_2 from CO_2Et); 14.56 (CH_3 from CO_2Et). Anal. calcd. for $C_{19}H_{15}F_3N_2O_3$ (376.33): C, 60.64; H, 4.02; N, 7.44%. Found: C, 60.58; H, 4.05; N, 7.38%.

1-Carbethoxy-3-[(2-fluorophenyl)carbamoyl]-7-methylindolizine (8). IR ν 3319, 3122, 1691, 1631, 1534. ^{1}H-NMR (δ ppm, *J* Hz): 9.59 (1H, dd, 7.2, 1.0, 5-H); 8.37 (1H, td, 8.1, 1.7, 14-H); 8.11 (1H, dqui, 2.0, 1.0, 8-H); 7.87 (1H, d, 3.2, NH); 7.78 (1H, s, 2-H); 7.04-7.20 (3H, m, 12-H, 13-H, 15-H); 4.39 (2H, q, 7.1, CH_2 from CO_2 Et); 2.45 (3H, s, 7-CH_3); 1.44 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.22 (COO); 159.19 (9-C); 152.63 (11-C, d, 241.6); 139.32 (8a-C); 137.17 (7-C); 127.65 (5-C); 126.45 (10-C, d, 10.0); 124.56 (13-C or 15-C, d, 3.6); 124.10 (15-C or 13-C, d, 7.8); 121.65 (14-C); 119.53 (2-C); 118.11 (8-C); 116.93 (6-C); 116.25 (3-C); 114.91 (12-C, d, 19.5); 103.53 (1-C); 59.96 (CH_2 from CO_2Et); 21.42 (7-CH_3); 14.52 (CH_3 from CO_2Et).

Anal. calcd. for $C_{19}H_{17}FN_2O_3$ (340.35): C, 67.05; H, 5.03; N, 8.23%. Found: C, 67.10; H, 5.15; N, 8.26%.

1-Carbethoxy-3-[(3-trifluoromethylphenyl)carbamoyl]indolizine (9). IR ν 3361, 3117, 1673, 1657, 1553. ^{1}H-NMR (δ ppm, *J* Hz): 9.58 (1H, dt, 7.2, 0.8, 5-H); 8.10 (1H, dq, 2.0, 1.0, 8-H); 8.03 (1H, s, NH); 7.98 (1H, bs, 11-H); 7.83 (1H, s, 2-H); 7.78 (1H, dq, 7.8, 1.5, 13-H); 7.47 (1H, t, 7.8, 14-H); 7.39 (1H, bd, 7.8, 15-H); 6.82 (1H, dd, 7.2, 2.0, 6-H); 4.37 (2H, q, 7.1, CH_2 from CO_2Et); 2.43 (3H, d, 1.0, 7-CH_3); 1.43 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.37 (COO); 159.53 (9-C); 139.33 (8a-C); 138.61 (10-C); 137.32 (7-C); 131.50 (12-C, q, 32.1); 129.55 (14-C); 127.70 (5-C); 123.81 (CF_3, q, 271.8); 122.99 (15-C); 120.56 (13-C, q, 3.4); 119.78 (2-C); 118.13 (8-C); 116.98 (6-C); 116.74 (11-C, q, 3.8); 116.18 (3-C); 103.53 (1-C); 60.05 (CH_2 from CO_2Et); 21.44 (7-CH_3); 14.56 (CH_3 from CO_2Et). Anal. calcd. for $C_{20}H_{17}F_3N_2O_3$ (390.36): C, 61.54; H, 4.39; N, 7.18%. Found: C, 61.48; H, 4.45; N, 7.12%.

1-Benzoyl-3-[(2-methyl-6-ethylphenyl)carbamoyl]-7-methylindolizine (10). IR ν 3295, 3134, 1656, 1637, 1511. ^{1}H-NMR (δ ppm, *J* Hz): 9.63 (1H, d, 7.2, 5-H); 8.36 (1H, dqui, 1.8, 0.9, 8-H-8); 7.97 (1H, bs, NH); 7.80 (2H, m, H-*orto* from Ph); 7.79 (1H, s, 2-H); 7.45 (3H, m, H-*meta*, H-*para* from Ph); 7.08-7.20 (3H, m, 12-H, 13-H, 14-H); 6.83 (1H, dd, 7.2, 1.8, 6-H); 2.61 (2H, q, 7.6, CH_2 from Et); 2.44 (3H, s, 7-CH_3); 2.24 (3H, s, 2-CH_3); 1.15 (3H, t, 7.6, CH_3 from Et). ^{13}C-NMR δ 190.20 (1-COPh); 160.32 (9-C); 141.51 (7-C); 140.59 (8a-C); 140.01 (10-C); 138.56 (15-C); 136.22 (11-C); 132.83 (C_q-Ph); 130.94 (C-*para* from Ph); 128.65 (2C-*ortho* from Ph); 128.18 (2C-*meta* from Ph); 127.91 (14-C or 12-C); 127.68 (12-C or 14-C); 126.32 (13-C); 121.06 (2-C); 118.99 (8-C); 117.71 (6-C); 116.73 (3-C); 111.18 (1-C); 24.86 (CH_2 from Et); 21.39 (2-Me); 18.46 (7-Me); 14.36 (CH_3 from Et). Anal. calcd. for $C_{26}H_{24}N_2O_2$ (396.49): C, 78.76; H, 6.10; N, 7.06%. Found: C, 78.83; H, 6.18; N, 7.98%.

1-Acetyl-3-[(2,6-diethylphenyl)carbamoyl]-5-methyl-8-ethylindolizine (11). IR ν 3168, 1663, 1631, 1512. ^{1}H-NMR (δ ppm, *J* Hz): 7.85 (1H, s, 2-H); 7.65 (1H, s, NH); 7.27 (1H, m, 13-H); 7.16 (2H, m, 12-H, 14-H); 7.02 (1H, d, 7.2, 7- H); 6.66 (1H, d, 7.2, 6-H); 3.20 (2H, q, 7.4, CH_2 from 8-Et); 2.70 (4H, q, 7.7, 2CH_2 from 2,6-diEt); 2.62 (3H, s, 5-Me); 2.57 (3H, s, CH_3 from 1-Ac); 1.27 (6H, t, 7.7, 2CH_3 from 2,6-diEt); 1.10 (3H, t, 7.4, CH_3 from 8-Et). ^{13}C-NMR δ 192.58 (CO-Ac); 161.12 (9-C); 141.67 (5-C); 137.54 (8a-C); 135.30 (10-C); 134.18 (11-C, 15-C); 132.13 (8-C); 128.23 (7-C); 126.56 (12-C, 14-C); 125.73 (13-C); 123.59 (2-C); 120.24 (3-C); 116.22 (6-C); 103.30 (1-C); 29.45 (CH_3 from Ac); 27.25 (CH_2 from 8-Et); 24.91 (2CH_2 from 2,6-diEt); 21.91 (5-Me); 14.61 (3CH_3 from 8-Et, 2-Et, 6-Et). Anal. calcd. for $C_{24}H_{28}N_2O_2$ (376.50): C, 76.56; H, 7.50; N, 7.44%. Found: C, 76.61; H, 7.56; N, 7.46%.

1-Carbomethoxy-3-[(2,6-diethylphenyl)carbamoyl]-5-methyl-8-ethylindolizine (12). IR ν 3359, 3273, 1698, 1648, 1504. ^{1}H-NMR ($CDCl_3$, δ ppm, *J* Hz): 7.83 (1H, s, 2-H); 7.47 (1H, s, NH); 7.27 (1H, m, 13-H); 7.16 (2H, m, 12-H, 14-H); 7.03 (1H, d, 7.3, 7-H); 6.66 (1H, d, 7.3, 6-H); 3.90 (3H, s, Me from CO_2Me); 3.24 (2H, q, 7.4, CH_2 from 8-Et); 2.69 (4H, q, 7.6, 2CH_2 from 2,6-diEt); 2.64 (3H, s, 5-Me); 1.26 (6H, t, 7.6, 2CH_3 from 2,6-diEt); 1.22 (3H, t, 7.4, CH_3 from 8-Et). ^{13}C-NMR δ 164.61 (COO); 160.98 (9-C); 141.76 (5-C); 138.47 (8a-C); 135.63 (10-C); 133.48 (11-C, 15-C); 132.05 (8-C); 128.26 (7-C); 126.51 (12-C, 14-C); 125.12 (13-C); 123.78 (2-C); 120.19 (3-C); 115.74 (6-C); 105.21 (1-C); 51.54 (CH_3 from CO_2Me) 27.00 (CH_2 from 8-Et); 24.87 (CH_2 from 2,6-diEt); 22.09 (5-Me); 14.96 (CH_3 from 8-Et); 14.57 (2CH_3 from 2,6-

diEt). Anal. calcd. for $C_{24}H_{28}N_2O_3$ (392.50): C, 73.44; H, 7.19; N, 7.14%. Found: C, 73.49; H, 7.16; N, 7.08%.

1-[(3-Trifluoromethylphenyl)carbamoyl]-3-carbethoxy-7-methylpyrrolo[1,2-a]quinoline (13). m. p.: 182-184°C; yield: 23%; IR ν 3254, 1702, 1649, 1544. ^{1}H-NMR (δ ppm, *J* Hz): 8.02 (1H, bs, 13-H); 7.96 (1H, bd, 8.0, 17-H); 7.93 (1H, d, 9.4, 5-H); 7.86 (1H, d, 9.3, 9-H); 7.56 (1H, s, 2-H); 7.53 (1H, t, 8.0, 16-H); 7.47 (1H, bd, 8.0, 15-H); 7.37 (1H, s, NH); 7.30-7.40 (2H, m, 6-H, 8-H); 7.20 (1H, d, 9.4, 4-H); 4.39 (2H, q, 7.1, CH_2 from CO_2Et); 2.44 (3H, s, 7-CH_3); 1.43 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 165.75 (COO); 162.18 (11-C); 137.93 (3a-C, 9a-C); 137.84 (12-C); 135.27 (7-C); 131.54 (14-C, q, 33.1); 130.24 (5-C); 130.07 (8-C); 129.72 (16-C); 128.35 (6-C); 127.59 (4-C); 124.39 (1-C); 123.75 (15-C, q, 3.4); 123.56 (CF_3, q, 279.1); 121.86 (2-C); 121.85 (17-C); 118.26 (9-C); 117.43 (13-C, q, 3.5); 116.50 (5-C); 105.67 (3-C); 61.13 (CH_2 from CO_2Et); 20.69 (7-CH_3); 14.11 (CH_3 from CO_2Et). Anal. calcd. for $C_{24}H_{19}F_3N_2O_3$ (440.42): C, 65.45; H, 4.35; N, 6.36%. Found: C, 65.51; H, 4.42; N, 6.44%.

The yields and m. p. for 3-carbamoylpyrrolo[2,1-a]isoquinolines **14-29** are shown in Table 3. The spectral data are given below.

1-Carbethoxy-3-[(2-fluorophenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (14). IR ν 3306, 3055, 1700, 1669, 1534. ^{1}H-NMR (δ ppm, *J* Hz): 9.77 (1H, dd, 7.3, 2.2, 10-H); 9.37 (1H, d, 7.5, 5-H); 8.36 (1H, td, 8.0, 1.6, 17-H); 7.99 (1H, s, NH); 7.80 (1H, s, 2-H); 7.67 (1H, dd, 7.0, 2.4, 7-H); 7.53-7.64 (2H, m, 8-H, H-9); 7.05-7.20 (3H, m, 14-H, 15-H, 16-H); 7.11 (1H, d, 7.5, 6-H); 4.43 (2H, q, 7.1, CH_2 from CO_2Et); 1.46 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.42 (COO); 159.02 (11-C); 152.70 (13-C, d, 243.3); 135.66 (10b-C); 129.55 (6a-C); 128.78 (8-C or 9-C); 127.67 (10-C); 127.59 (9-C or 8-C); 126.60 (7-C); 126.27 (12-C, d, 10.2); 124.76 (10a-C); 124.60 (16-C, d, 3.6); 124.43 (5-C); 124.38 (15-C, d, 7.5); 121.83 (17-C); 120.20 (2-C); 118.25 (3-C); 114.94 (14-C, d, 18.3); 114.81 (6-C); 109.11 (1-C); 60.60 (CH_2 from CO_2Et); 14.49 (CH_3 from CO_2Et). Anal. calcd. for $C_{22}H_{17}FN_2O_3$ (376.39): C, 70.20; H, 4.55; N, 7.44%. Found: C, 70.26; H, 4.66; N, 7.54%.

1-Carbomethoxy-3-[(3-methylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (15). IR ν 3311, 3134, 1710, 1632, 1533. ^{1}H-NMR (δ ppm, *J* Hz): 9.73 (1H, m, 10-H); 9.29 (1H, d, 7.5, 5-H); 7.91 (1H, s, NH); 7.73 (1H, s, 2-H); 7.64 (1H, m, 7-H); 7.52-7.59 (2H, m, 8-H, 9-H); 7.50 (1H, bs, 13-H); 7.40 (1H, bd, 7.6, 17-H); 7.25 (1H, t, 7.6, 16-H); 7.04 (1H, d, 7.5, 6-H); 6.97 (1H, bd, 7.6, 15-H); 3.92 (3H, s, CH_3 from CO_2Me); 2.37 (3H, s, 3-CH_3). ^{13}C-NMR δ 164.94 (COO); 159.30 (11-C); 139.04 (12-C); 137.70 (14-C); 135.51 (10b-C); 129.55 (6a-C); 128.91 (16-C); 128.74 (8-C or 9-C); 127.56 (10-C); 127.55 (9-C or 8-C); 126.61 (7-C); 125.26 (15-C); 124.77 (10a-C); 124.45 (5-C); 120.86 (17-C); 119.74 (2-C); 118.98 (3-C); 117.29 (13-C); 114.67 (6-C); 108.37 (1-C); 51.65 (CH_3 from CO_2Me); 21.51 (3-Me). Anal. calcd. for $C_{22}H_{18}N_2O_3$ (358.40): C, 73.73; H, 5.06; N, 7.82%. Found: C, 73.80; H, 5.98; N, 7.86%.

1-Carbethoxy-3-[(2-methoxyphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (16). IR ν 3331, 3126, 1703, 1669, 1532. ^{1}H-NMR (δ ppm, *J* Hz): 9.80 (1H, dd, 7.5, 2.0, 10-H); 9.50 (1H, d, 7.6, 5-H); 8.45 (1H, s, NH); 8.42 (1H, dd, 7.9, 1.7, 17-H); 7.83 (1H, s, 2-H); 7.73 (1H, dd, 7.3, 2.2, 7-H); 7.58-7.65 (2H, m, 8-H, 9-H); 7.17 (1H, d, 7.6, 6-H); 7.11 (1H, td, 7.9, 1.7, 15-H); 7.03 (1H, td, 7.9, 1.6, 16-H); 6.96 (1H, dd, 7.9, 1.6, 14-H); 4.45 (2H, q, 7.1, CH_2 from CO_2Et); 3.98 (3H, s, OMe); 1.49 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.65 (COO); 159.09 (11-C); 148.14

(13-C); 135.38 (10b-C); 129.59 (6a-C, 12-C); 128.64 (9-C or 8-C); 127.62 (10-C); 127.51 (8-C or 9-C); 126.63 (7-C); 124.93 (10a-C); 124.69 (5-C); 123.81 (15-C); 121.14 (16-C); 119.93 (17-C); 119.74 (2-C); 119.24 (3-C); 114.62 (6-C); 110.06 (14-C); 108.97 (1-C); 60.53 (CH_2 from CO_2Et); 55.56 (OMe); 14.52 (CH_3 from CO_2Et). Anal. calcd. for $C_{23}H_{20}N_2O_4$ (388.42): C, 71.12; H, 5.19; N, 7.21%. Found: C, 71.06; H, 5.25; N, 7.16%.

1-Carbethoxy-3-[(3-methoxyphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (17). IR ν 3298, 3124, 1708, 1635, 1532. ^{1}H-NMR (δ ppm, *J* Hz): 9.78 (1H, m, 10-H); 9.38 (1H, d, 7.6, 5-H); 8.01 (1H, s, NH); 7.73 (1H, s, 2-H); 7.70 (1H, m, 7-H); 7.55-7.64 (2H, m, 8-H, 9-H); 7.28 (1H, t, 8.1, 16-H); 7.13 (1H, ddd, 8.1, 2.2, 0.9, 17-H); 7.02 (1H, d, 7.6, 6-H); 6.72 (1H, ddd, 8.1, 2.2, 0.9, 15-H); 4.39 (2H, q, 7.1, CH_2 from CO_2Et); 3.83 (3H, s, OMe); 1.44 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.61 (COO); 160.20 (14-C); 159.34 (11-C); 139.04 (12-C); 135.37 (10b-C); 129.73 (16-C); 129.48 (6a-C); 128.68 (9-C or C-8); 127.53 (8-C or 9-C); 127.49 (10-C); 126.58 (7-C); 124.68 (10a-C); 124.32 (5-C); 119.84 (2-C); 118.81 (3-C); 114.62 (6-C); 112.34 (17-C); 110.23 (15-C); 108.76 (1-C); 105 86 (13-C); 60.55 (CH_2 from CO_2Et); 55.32 (OMe); 14.49 (CH_3 from CO_2Et). Anal. calcd. for $C_{23}H_{20}N_2O_4$ (388.42): C, 71.12; H, 5.19; N, 7.21%. Found: C, 71.19; H, 5.28; N, 7.16%.

1-Carbethoxy-3-[(3-trifluoromethylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (18). IR ν 3320, 3126, 1703, 1669, 1532. ^{1}H-NMR (δ ppm, *J* Hz): 9.42 (1H, dd, 7.8, 2.2, 10-H); 9.11 (1H, d, 7.5, 5-H); 8.39 (1H, s, NH); 7.89 (1H, s, 2-H); 7.88 (1H, bs, 13-H); 7.78 (1H, dq, 7.6, 1.6, 15-H); 7.55-7.64 (3H, m, 7-H, 8-H, 9-H); 7.52 (1H, dd, 8.0, 7.6, 16-H); 7.46 (1H, bd, 8.0, 17-H); 7.08 (1H, d, 7.5, 6-H); 4.47 (2H, q, 7.2, CH_2 from CO_2Et); 1.47 (3H, t, 7.2, CH_3 from CO_2Et). ^{13}C-NMR δ 166.10 (COO); 160.27 (11-C); 137.46 (12-C); 135.98 (10b-C); 131.70 (14-C, q, 33.0); 129.81 (8-C or 9-C); 129.80 (6a-C); 129.28 (C-9 or 8-C); 127.75 (7-C); 127.26 (10-C); 126.93 (16-C); 124.82 (CF_3, q, 272.7); 124.24 (10a-C); 124.12 (15-C, q, 1.2); 124.06 (5-C); 121.82 (17-C); 121.74 (2-C); 117.90 (3-C); 117.86 (13-C, q, 3.7); 115.43 (6-C); 108.63 (1-C); 61.76 (CH_2 from CO_2Et); 14.22 (CH_3 from CO_2Et). Anal. calcd. for $C_{23}H_{17}F_3N_2O_3$ (426.39): C, 64.79; H, 4.02; N, 6.57%. Found: C, 64.76; H, 4.14; N, 6.63%.

1,2-Dicarbomethoxy-3-[(2-methylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (19). IR ν 3319, 3070, 1714, 1654, 1523. ^{1}H-NMR (δ ppm, *J* Hz): 10.21 (1H, s, NH); 9.39 (1H, d, 7.7, 5-H); 8.62 (1H, m, 10-H); 7.98 (1H, d, 8.0, 17-H); 7.69 (1H, m, 7-H); 7.54-7.60 (2H, m, 8-H, 9-H); 7.24-7.31 (2H, m, 14-H, 16-H); 7.12 (1H, m, 15-H); 7.10 (1H, d, 7.7, 6-H); 4.01 (3H, s, 1-CO_2Me); 3.97 (3H, s, 2-CO_2Me); 2.41 (3H, s, 2-Me). ^{13}C-NMR δ 167.42 and 166.80 (COO); 158.77 (11-C); 135.69 (10b-C); 130.95 (6a-C); 130.71 (14-C); 130.31 (13-C); 128.98 (12-C); 128.73 (9-C or 8-C); 128.14 (8-C or 9-C); 127.13 (7-C); 126.49 (16-C); 125.41 (15-C); 124.96 (5-C); 124.76 (10-C); 124.22 (10a-C); 123.58 (17-C); 120.27 (2-C); 119.83 (3-C); 115.13 (6-C); 110.33 (1-C); 53.33 and 52.68 ($2CH_3$ from 1,2-CO_2Me); 18.20 (2-Me). Anal. calcd. for $C_{24}H_{20}N_2O_5$ (416.43): C, 69.22; H, 4.84; N, 6.73%. Found: C, 69.09; H, 4.90; N, 6.64%.

1,2-Dicarbomethoxy-3-[(4-methylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (20). IR ν 3310, 3025, 1726, 1699, 1663, 1544. ^{1}H-NMR (δ ppm, *J* Hz): 10.72 (1H, s, NH); 9.42 (1H, d, 7.8, 5-H); 8.56 (1H, m, 10-H); 7.64 (1H, m, 7-H); 7.63 (2H, d, 8.4, 14-H, 16-H); 7.48-7.62 (2H, m, 8-H, 9-H); 7.19 (2H, d, 8.4, 13-H, 17-H); 7.17 (1H, d, 7.8, 6-H); 4.00 (3H, s, 1-CO_2Me); 3.97 (3H, s, 2-CO_2Me); 2.35 (3H, s, 4-Me). ^{13}C-NMR δ 167.55 and 166.92 (COO); 158.15 (11-C);

135.56 (10b-C); 134.04 (12-C); 130.54 (15-C); 129.52 (10-C); 129.49 (13-C); 128.85 (6a-C); 128.59 (8-C or 9-C); 128.07 (9-C or 8-C); 127.09 (7-C); 124.82 (5-C); 124.12 (10a-C); 120.60 (2-C); 120.18 (14-C, 16-C); 119.12 (3-C); 115.04 (6-C); 110.54 (1-C); 53.30, 52.64 ($2CH_3$ from 1,2-CO_2Me); 20.91 (4-Me). Anal. calcd. for $C_{24}H_{20}N_2O_5$ (416.43): C, 69.22; H, 4.84; N, 6.73%. Found: C, 69.26; H, 4.78; N, 6.79%.

1,2-Dicarbomethoxy-3-[(3-trifluoromethylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (21). IR ν 3154, 3022, 1718, 1691, 1664, 1576. ^{1}H-NMR (δ ppm, *J* Hz): 11.28 (1H, s, NH); 9.47 (1H, d, 7.8, 5-H); 8.43 (1H, m, 10-H); 8.16 (1H, bt, 1.8, 13-H); 7.88 (1H, bd, 7.9, 15-H); 7.68 (1H, m, 7-H); 7.53-7.62 (2H, m, 8-H, 9-H); 7.49 (1H, t, 7.9, 16-H); 7.40 (1H, bd, 7.9, 17-H); 7.10 (1H, d, 7.8, 6-H); 4.03 (3H, s, 1-CO_2Me); 4.00 (3H, s, 2-CO_2Me). ^{13}C-NMR δ 167.65 and 167.07 (COO); 158.57 (11-C); 138.14 (12-C); 131.44 (14-C, q, 32.2); 130.67 (10b-C); 129.47 (7-C); 128.87 (6a-C); 128.81 (8-C or 9-C); 128.30 (9-C or 8-C); 127.22 (10-C); 124.80 (16-C); 124.36 (5-C); 124.05 (10a-C); 123.94 (CF_3, q, 272.6); 123.21 (17-C); 120.83 (15-C, q, 3.8); 120.00 (2-C); 119.00 (3-C); 115.46 (6-C); 111.27 (1-C); 53.81, 53.56 ($2CH_3$ from 1,2-CO_2Me). Anal. calcd. for $C_{24}H_{17}F_3N_2O_5$ (470.40): C, 61.28; H, 3.64; N, 5.95%. Found: C, 61.34; H, 3.70; N, 6.05%.

1-Carbethoxy-3-[(3-chloro-4-fluorophenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (22). IR ν 3339, 3125, 1700, 1684, 1660, 1536. ^{1}H-NMR (δ ppm, *J* Hz): 9.74 (1H, m, 10-H); 9.30 (1H, d, 7.6, 5-H); 7.86 (1H, s, NH); 7.83 (1H, dd, 6.6, 2.2, 13-H); 7.77 (1H, s, 2-H); 7.68 (1H, m, 7-H); 7.55-7.61 (2H, m, 8-H, 9-H); 7.44 (1H, ddd, 8.7, 4.0, 2.2, 17-H); 7.14 (1H, t, 8.7, 16-H); 7.11 (1H, d, 7.6, 6-H); 4.43 (2H, q, 7.1, CH_2 from CO_2Et); 1.46 (3H, t, 7.1, CH_3 from CO_2Et). ^{13}C-NMR δ 164.61 (COO); 159.25 (11-C); 154.91 (15-C, d, 246.2); 135.68 (10b-C); 134.49 (12-C, d, 3.3); 129.63 (6a-C); 128.91 (8-C or 9-C); 127.65 (9-C or 8-C); 127.64 (10-C); 126.70 (7-C); 124.73 (10a-C); 124.33 (5-C); 122.52 (13-C); 121.32 (14-C, d, 18.2); 120.05 (2-C); 119.92 (17-C, d, 6.8); 118.26 (3-C); 116.70 (16-C, d, 22.1); 114.92 (6-C); 109.08 (1-C); 60.67 (CH_2 from CO_2Et); 14.54 (CH_3 from CO_2Et). Anal. calcd. for $C_{22}H_{16}ClFN_2O_3$ (410.83): C, 64.32; H, 3.92; N, 6.82%. Found: C, 64.26; H, 4.11; N, 6.86%.

1,2-Dicarbomethoxy-3-[(4-chlorophenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (23). IR ν 3277, 3166, 1731, 1703, 1651, 1557. ^{1}H-NMR (δ ppm, *J* Hz): 11.05 (1H, s, NH); 9.42 (1H, d, 7.8, 5-H); 8.46 (1H, m, 10-H); 7.71 (2H, d, 8.8, 13-H, 17-H); 7.68 (1H, m, 7-H); 7.52-7.62 (2H, m, 8-H, 9-H); 7.32 (2H, d, 8.8, 14-H, 16-H); 7.09 (1H, d, 7.8, 6-H); 4.02 (s, CH_3 from 1-CO_2Me); 3.98 (s, CH_3 from 2-CO_2Me). ^{13}C-NMR δ 167.65 and 167.01 (COO); 158.32 (11-C); 136.84 (10b-C); 130.61 (12-C); 129.30 (6a-C); 129.02 (14-C, 16-C); 128.87 (15-C); 128.74 (9-C or 8-C); 128.24 (8-C or 9-C); 127.18 (7-C); 124.80 (10-C); 124.43 (5-C); 124.11 (10a-C); 121.41 (13-C, 17-C); 120.43 (2-C); 119.00 (3-C); 115.32 (6-C); 111.01 (1-C); 53.44, 52.74 ($2CH_3$ from 1,2-CO_2Me). Anal. calcd. for $C_{23}H_{17}ClN_2O_5$ (436.85): C, 63.24; H, 3.92; N, 6.41%. Found: C, 63.32; H, 4.02; N, 6.53%.

1,2-Dicarbomethoxy-3-[(2,6-dimethylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (24). IR ν 3367, 3142, 1740, 1698, 1653, 1540. ^{1}H-NMR (δ ppm, *J* Hz): 10.02 (1H, s, NH); 9.47 (1H, d, 7.7, 5-H); 8.46 (1H, m, 10-H); 7.68 (1H, m, 7-H); 7.52-7.62 (2H, m, 8-H, 9-H); 7.15 (3H, bs, 14-H, 15-H, 16-H); 7.09 (1H, d, 7.8, 6-H); 4.02 (3H, s, CH_3 from 1-CO_2Me); 3.98 (3H, s, CH_3 from 2-CO_2Me); 2.31 (6H, s, $2CH_3$ 2,6-diMe). ^{13}C-NMR δ 167.62 and 166.83 (COO); 158.84 (11-C);

135.42 (13-C, 17-C); 133.73 (10b-C); 130.84 (12-C); 128.95 (6a-C); 128.68 (8-C or 9-C); 128.21 (14-C, 16-C); 128.12 (9-C or 8-C); 127.31 (15-C); 127.10 (7-C); 125.00 (5-C); 124.70 (10-C); 124.19 (10a-C); 119.85 (2-C); 119.83 (3-C); 115.23 (6-C); 110.38 (1-C); 53.30, 52.66 ($2CH_3$ from 1,2-CO_2Me); 18.59 ($2CH_3$ from 2,6-diMe). Anal. calcd. for $C_{25}H_{22}N_2O_5$ (430.46): C, 69.76; H, 5.15; N, 6.51%. Found: C, 69.86; H, 5.25; N, 6.56%.

1,2-Dicarbomethoxy-3-[(2,6-diethylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (25). IR ν 3269, 3143, 1725, 1696, 1650, 1538. ^{1}H-NMR (δ ppm, *J* Hz): 10.04 (1H, s, NH); 9.50 (1H, d, 7.7, 5-H); 8.61 (1H, m, 10-H); 7.68 (1H, m, 7-H); 7.54-7.62 (2H, m, 8-H, 9-H); 7.28 (1H, t, 7.8, 15-H); 7.19 (2H, d, 7.8, 14-H, 16-H); 7.10 (1H, d, 7.7, 6-H); 4.03 (3H, s, CH_3 from 1-CO_2Me); 3.98 (3H, s, CH_3 from 2-CO_2Me); 2.66 (4H, q, 7.6, $2CH_2$ from 2,6-diEt); 1.21 (6H, t, 7.6, $2CH_3$ from 2,6-diEt). ^{13}C-NMR δ 167.72 and 166.86 (COO); 159.59 (11-C); 141.54 (13-C, 17-C); 132.38 (10b-C); 130.86 (6a-C); 128.99 (12-C); 128.71 (8-C or 9-C); 128.13 (9-C or 8-C); 127.95 (15-C); 127.12 (7-C); 126.46 (14-C, 16-C); 125.09 (5-C); 124.70 (10-C); 124.20 (10a-C); 119.88 (3-C); 119.76 (2-C); 115.26 (6-C); 110.43 (1-C); 53.30, 52.69 ($2CH_3$ from 1,2-CO_2Me); 25.06 ($2CH_2$ 2,6-diEt); 14.59 ($2CH_3$ from 2,6-diEt). Anal. calcd. for $C_{27}H_{26}N_2O_5$ (458.51): C, 70.73; H, 5.71; N, 6.11%. Found: C, 70.75; H, 5.66; N, 6.14%.

1,2-Dicarbomethoxy-3-[(2-methyl-3-chlorophenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (26). IR ν 3154, 3022, 1718, 1691, 1664, 1576. ^{1}H-NMR (δ ppm, *J* Hz): 11.12 (1H, s, NH); 9.32 (1H, d, 7.5, 5-H); 8.28 (1H, m, 10-H); 7.74 (1H, m, 7-H); 7.57-7.68 (2H, m, 8-H, 9-H); 7.38 (1H, dd, 8.0, 1.8, 15-H); 7.37 (1H, dd, 8.0, 1.8, 17-H); 7.20 (1H, t, 8.0, 16-H); 7.19 (1H, d, 7.5, 6-H); 4.12 (3H, s, CH_3 from 1-CO_2Me); 4.02 (3H, s, CH_3 from 2-CO_2Me); 2.40 (3H, s, 2-Me). ^{13}C-NMR δ 169.25 and 167.19 (COO); 160.44 (11-C); 135.72 (10b-C); 135.11 (12-C); 132.25 (13-C); 131.67 (14-C); 129.41 (8-C or 9-C); 129.11 (6a-C); 128.72 (15-C); 128.58 (9-C or 8-C); 127.59 (7-C); 127.07 (16-C); 124.79 (17-C); 124.66 (5-C); 124.12 (10-C); 123.73 (10a-C); 120.05 (3-C); 118.84 (2-C); 116.32 (6-C); 110.93 (1-C); 53.76, 53.69 ($2CH_3$ from 1,2-CO_2Me); 15.04 (2-CH_3). Anal. calcd. for $C_{24}H_{19}ClN_2O_5$ (450.88): C, 63.93; H, 4.25; N, 6.21%. Found: C, 64.05; H, 4.15; N, 6.14%.

1,2-Dicarbomethoxy-3-[(2-methyl-4-chlorophenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (27). IR ν 3252, 3037, 1700, 1696, 1663, 1543. ^{1}H-NMR (δ ppm, *J* Hz): 10.87 (1H, s, NH); 9.31 (1H, d, 7.7, 5-H); 8.37 (1H, m, 10-H); 7.72 (1H, m, 7-H); 7.52-7.63 (2H, m, 8-H, 9-H); 7.46 (1H, d, 8.5, 17-H); 7.27 (1H, d, 2.5, 14-H); 7.25 (1H, dd, 8.5, 2.5, 16-H); 4.08 (3H, s, CH_3 from 1-CO_2Me); 3.99 (3H, s, CH_3 from 2-CO_2Me); 2.35 (3H, s, 2-Me). ^{13}C-NMR δ 167.91 and 167.25 (COO), 159.32 (11-C); 134.12 (10b-C); 133.19 (12-C); 131.13 (13-C); 130.76 (14-C); 129.15 (8-C or 9-C); 129.07 (6a-C); 128.51 (9-C or 8-C); 127.40 (7-C, 16-C); 126.32 (17-C); 124.78 (5-C); 124.40 (10-C); 123.98 (10a-C); 120.16 (3-C); 119.99 (2-C); 115.91 (6-C); 111.07 (1-C); 53.55, 53.17 ($2CH_3$ from 1,2-CO_2Me); 17.92 (2-CH_3). Anal. calcd. for $C_{24}H_{19}ClN_2O_5$ (450.88): C, 63.93; H, 4.25; N, 6.21%. Found: C, 63.89; H, 4.20; N, 6.29%.

1,2-Dicarbomethoxy-3-[(2-methyl-5-chlorophenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (28). IR ν 3289, 3001, 1712, 1696, 1653, 1579. ^{1}H-NMR (δ ppm, *J* Hz): 10.37 (1H, s, NH); 9.41 (1H, d, 7.7, 5-H); 8.58 (1H, m, 10-H); 8.15 (1H, d, 2.1, 17-H); 7.70 (1H, m, 7-H); 7.52-7.62 (2H, m, 8-H, 9-H); 7.13 (1H, d, 8.1, 14-H); 7.10 (1H, d, 7.7, 6-H); 7.09 (1H, dd, 8.1, 2.1, 15-H); 4.02 (3H, s, CH_3 from 1-CO_2Me); 3.97 (3H, s, CH_3 from 2-CO_2Me); 2.39 (3H, s, 2-Me). ^{13}C-NMR δ

167.40 and 166.75 (COO); 158.77 (11-C); 136.94 (10b-C); 131.86 (12-C); 131.07 (13-C); 129.06 (6a-C); 129.05 (16-C); 128.80 (8-C or 9-C); 128.22 (9-C or 8-C); 127.17 (7-C); 125.09 (15-C); 124.97 (5-C, 14-C); 124.73 (10-C); 124.26 (10a-C); 123.26 (17-C); 120.08 (2-C); 119.74 (3-C); 115.29 (6-C); 110.73 (1-C); 53.30, 52.61 ($2CH_3$ from 1,2-CO_2Me); 17.76 (CH_3 from 2-Me). Anal. calcd. for $C_{24}H_{19}ClN_2O_5$ (450.88): C, 63.93; H, 4.25; N, 6.21%. Found: C, 63.88; H, 4.32; N, 6.18%.

1,2-Dicarbomethoxy-3-[(3,4-methylenedioxyphenyl)carbamoyl]pyrrolo-[2,1-a]isoquinoline (29). IR ν 3248, 3027, 1732, 1701, 1650, 1536. ^{1}H-NMR (δ ppm, *J* Hz): 10.81 (1H, s, NH); 9.42 (1H, d, 7.8, 5-H); 8.51 (1H, m, 10-H); 7.68 (1H, m, 7-H); 7.52-7.62 (2H, m, 8-H, 9-H); 7.48 (1H, d, 2.1, 13-H); 7.10 (1H, d, 7.8, 6-H); 7.09 (1H, dd, 8.4, 2.1, 17-H); 6.80 (1H, d, 8.4, 16-H); 5.98 (2H, s, CH_2); 4.01 (3H, s, CH_3 from 1-CO_2Me); 3.98 (3H, s, CH_3 from 2-CO_2Me). ^{13}C-NMR δ 167.65 and 166.95 (COO); 158.16 (11-C); 147.89 (14-C); 144.41 (15-C); 132.56 (10b-C); 130.63 (12-C); 128.98 (6a-C); 128.66 (8-C or 9-C); 128.16 (9-C or 8-C); 127.16 (7-C); 124.96 (5-C); 124.60 (10-C); 124.30 (10a-C); 120.69 (2-C); 119.08 (3-C); 115.14 (6-C); 113.44 (17-C); 110.84 (1-C); 108.19 (16-C); 102.86 (13-C); 101.25 (CH_2); 53.29, 52.60 ($2CH_3$ from 1,2-CO_2Me). Anal. calcd. for $C_{24}H_{18}N_2O_7$ (446.42): C, 64.57; H, 4.06; N, 6.27%. Found: C, 64.64; H, 4.15; N, 6.32%.

General procedure for carbamoyl substituted indolizine 30 and pyrrolo[2,1-a]isoquinolines 31-32

(a) A solution of N-methylcarbamoyl quaternary salt (10 mmol), olefine (acrylonitrile or crotononitrile, 40 mmol), TPCD (4.0 g, 6.5 mmol) and pyridine (2.0 mL) in DMF (40 mL) was stirred at 90 ^{o}C for 2 h. The mixture was then cooled to room temperature and poured into 5% aq. HCl (100 mL). The solution was extracted with chloroform (4 x 50 mL) and the combined extracts were washed with water (2 x 50 mL), dried (Na_2SO_4) and evaporated to give a solid compound. This was purified by recrystallisation.

(b) The olefinic compound (40 mmol) was added at room temperature to a stirred mixture of N-methylcarbamoyl quaternary salt (10 mmol) and TPCD (4.0 g, 6.5 mmol) in 1,2-epoxybutane (50 mL). The reaction mixture was heated to reflux for 5-8 h, then it was concentrated under reduced pressure. The residue was cooled to room temperature and then was treated with 5% aq. HCl (100 mL) and was worked up as described above.

The yields and m. p. for compounds **30-32** are shown in Table 4; the spectral data are given below.

1-Cyano-2,7-dimethyl-3-[(3,4-methylenedioxyphenyl)carbamoyl]indolizine (30). IR ν 3356, 3053, 2205, 1636, 1536. ^{1}H-NMR (δ ppm, *J* Hz): 9.09 (1H, d, 7.2, 5-H); 7.82 (1H, s, NH); 7.40 (1H, bs, H-8); 6.98 (1H, bs, 11-H); 6.82 (2H, s, 14-H, 15-H); 6.84 (1H, dd, 7.2, 1.8, 6-H); 6.00 (2H, s, CH_2); 2.69 (3H, s, 7-CH_3); 2.45 (3H, s, 2-CH_3). ^{13}C-NMR δ 161.86 (9-C); 148.23 (12-C); 146.53 (13-C); 140.75 (8a-C); 139.44 (10-C); 133.74 (3-C); 128.89 (7-C); 127.92 (5-C); 117.75 (6-C); 117.25 (14-C or 15-C); 115.57 (8-C); 115.08 (2-C or CN); 114.97 (CN or 2-C); 108.54 (15-C or 14-C); 105.47 (11-C); 101.81 (CH_2); 83.06 (1-C); 21.06 (7-CH_3), 12.96 (2-CH_3). Anal. calcd. for $C_{19}H_{15}N_3O_3$ (333.35): C, 68.46; H, 4.54; N, 12.60%. Found: C, 68.26; H, 4.49; N, 12.68%.

1-Cyano-2-methyl-3-[(3-trifluoromethylphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (31). IR ν 3297, 3073, 2204, 1669, 1541. ^{1}H-NMR (δ ppm, *J* Hz): 8.71 (1H, d, 7.6, 5-H); 8.60 (1H, m, 10-H); 8.11 (1H, s, NH); 8.05 (1H, bs, 13-H); 7.82 (1H, bd, 8.1, 17-H); 7.49-7.62 (4H, m, 7-H, 8-H, 9-H, 16-H); 7.48 (1H, bd, 7.9, 15-H); 6.82 (1H, d, 7.6, 6-H); 2.75 (3H, s, 2-CH_3). ^{13}C-NMR δ 159.24 (11-C); 139.04 (12-C); 135.26 (10b-C); 131.70 (14-C, q, 32.3); 129.78 (16-C); 129.69 (6a-C); 129.29 (8-C or 9-C); 128.41 (9-C or 8-C); 127.11 (7-C); 125.60 (10a-C); 123.80 (5-C); 123.13 (10-C, 17-C); 122.83 (2-C); 121.40 (15-C, q, 3.7); 119.40 (CF_3, 271.4); 118.60 (3-C); 117.47 (CN); 116.88 (13-C, q, 3.7); 114.04 (6-C); 86.42 (1-C); 12.69 (2-CH_3). Anal. calcd. for $C_{229}H_{14}F_3N_3O$ (393.37): C, 67.17; H, 3.59; N, 10.68%. Found: C, 67.21; H, 3.64; N, 10.48%.
1-Cyano-3-[(3-methoxyphenyl)carbamoyl]pyrrolo[2,1-a]isoquinoline (32). IR ν 3363, 3130, 2213, 1658, 1547. ^{1}H-NMR (δ ppm, *J* Hz): 9.16 (1H, d, 7.6, 5-H); 8.73 (1H, m, 10-H); 8.33 (1H, bs, NH); 7.69-7.79 (3H, m, 7-H, 8-H, 9-H); 7.72 (1H, s, 2-H); 7.35 (1H, t, 8.1, 16-H); 7.23 (1H, d, 7.6, 6-H); 7.15 (1H, t, 2.3, 13-H); 7.06 (1H, dd, 8.1, 2.3, 17-H); 6.86 (1H, dd, 8.1, 2.3, 15-H); 3.88 (3H, s, CH_3). ^{13}C-NMR δ 159.70 (11-C); 159.60 (14-C); 138.15 (12-C); 136.74 (10b-C); 130.40 (16-C); 130.27 (8-C or 9-C); 129.17 (6a-C); 129.07 (C-9 or C-8); 124.33 (10-C); 124.28 (10a-C); 123.37 (5-C); 121.16 (2-C); 119.36 (3-C); 116.21 (CN); 115.92 (6-C); 115.40 (17-C); 112.26 (15-C); 108.85 (13-C); 83.21 (1-C); 55.71 (CH_3). Anal. calcd. for $C_{21}H_{15}N_3O_2$ (341.37): C, 73.89; H, 4.43; N, 12.31%. Found: C, 73.93; H, 4.53; N, 12.38%.

Acknowledgements

S.C. Oltchim S.A., Romania, supported this work, in part.

References

1. Katritzky, A. R.; Rees C. W. *Comprehensive Heterocyclic Chemistry*, Potts, K. T., Ed.; Pergamon Press: Oxford, New York; 1984.
2. Hermecz, I.; Meszaros M. *Adv. Heterocyclic Chem*. **1983**, *33*, 241.
3. Huisgen, R. *Angew. Chem., Int. Ed.* **1963**, *2*, 565.
4. Zugrăvescu, I.; Petrovanu, M. *N-Ylides Chemistry*, McGraw-Hill Int.: New York, 1976.
5. Zugrăvescu, I.; Petrovanu, M, Eds.; *Cicloadiţii 3+2 dipolare*, Academiei: Bucureşti, 1987.
6. Huisgen, R.; Grashey, R.;. Steingruber, E. *Tetrahedron Lett.* **1963**, 1441.
7. Hendrick, C. A.; Ritchie, E.; Taylor, W. C. *Aust. J. Chem.* **1967**, *20*, 2467.
8. Basketter, N. S.; Plunkett, A. O. *J. Chem. Soc.,Chem. Commun.* **1973**, 188.
9. Kakei, A.; Ito, S. *Bull. Chem. Soc. Jpn.* **1974**, *47*, 938.
10. Frohlich, J.; Kronke, F. *Chem. Ber.* **1971**, *104*, 1621.
11. Wei, X.; Hu, Y.; Li, T.; Hu, H. *J. Chem. Soc., Perkin Trans. 1* **1993**, *20*, 2487.
12. Zhou, J.; Hu, Y.; Hu, H. *J. Chem. Res., Synop*. **1999**, *2*, 136.
13. Iuhas, P. C.; Georgescu, F; Georgescu, E., *Sci. Bull. Univ. POLITEHNICA Bucharest* **1999**, *B*, *61(3-4)*, 85.