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SYNTHESIS OF FUNCTIONALLY SUBSTITUTED PYRROLO[3,2-*g*]QUINOLINES FROM 6-AMINO-7-METHOXY-1,2,3-TRIMETHYLINDOLE

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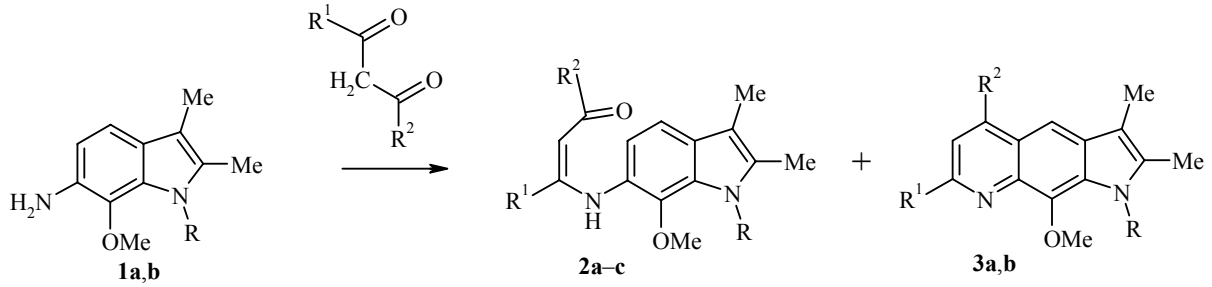
The comparative reactivities of 6-amino-1,2,3-trimethyl- and 6-amino-7-methoxy-2,3-dimethylindoles with acetylacetone, dibenzoylmethane, and with aceto- and trifluoroacetoacetic esters have been studied. Methods have been developed for the preparation of some functionally substituted pyrrolo-[3,2-g]quinolines.

Keywords: 6-amino-7-methoxy-1,2,3-trimethylindole, acetylacetone, acetoacetic ester, dibenzoylmethane, functionally substituted pyrrolo[3,2-*g*]quinolines, trifluoroacetoacetic ester.

Enamines prepared from 6-amino-2,3-dimethyl-7-methoxyindole (**1a**) and dicarbonyl compounds are converted to the corresponding pyrrolo[3,2-*g*]quinolines under acid conditions or *via* thermal cyclization [1]. Continuing our research in this area we have studied the behavior of 6-amino-7-methoxy-1,2,3-trimethylindole (**1b**) in reactions with the same β-dicarbonyl compounds and also with trifluoroacetoacetic ester.

The result of the reaction of the aminoindole **1b** with acetylacetone depends on the duration of the process. Hence refluxing compound **1b** in excess acetylacetone over 1 h gives basically the enamino ketone **2a** which contains traces of the pyrroloquinoline **3a**. A more prolonged reflux (3 h) gives exclusively product **3a**. It was unexpectedly found that the result of briefly (1.5 h) holding the aminoindole **1b** with dibenzoylmethane at 180-185°C gave the corresponding pyrroloquinoline **3b** immediately with an admixture of traces of the enamino ketone **2b**.



1a,**b** **2a–c** **3a**,**b**

1a R = H; **1b**, **2a–c**, **3a** R = Me; **2a**, **3a** $R^1 = R^2$ = Me; **2b**, **3b** $R^1 = R^2$ = Ph; **2c** R^1 = Me, R^2 = OEt

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It should be noted that the nonmethylated aminoindole **1a** forms only the primary products of condensation (the corresponding enamino ketones of type **2** (R = H) [1]) under the same conditions both with acetylacetone and with dibenzoylmethane.

The ^{1}H NMR spectra of the enamino ketones **2a,b** (Table 1) show singlet signals for the methoxy and three methyl groups of the indole fragment, the vinyl proton, and the NH group proton of the substituent at position 6 as well as two signals as doublets for the protons H-4 and H-5. The location of the signal for the NH group proton at low field (12.27 ppm for compound **2a** and 13.15 ppm for compound **2b**) shows that the proton is chelated [2]. These spectra also show signals for the protons of the R^1 and R^2 substituents as two singlets for the methyl groups in compound **2a** and a ten proton multiplet for the two phenyl substituents in compound **2b**.

The mass spectra of the enamino ketones **2a,b** are typified by molecular ion peaks (28 and 32% respectively) and also a peak at 43* (for compound **2a**) or 105 (compound **2b**) which point to the ease of fission of an acetyl or benzoyl group respectively. This is in good agreement with known literature data [3].

The UV spectra of compounds **2a,b** and their analogs obtained previously from the aminoindole **1a** [1] are virtually identical and also confirm their structure.

Compounds **2a,b** are cyclized to the corresponding pyrroloquinolines **3a,b** at 140-180°C or in trifluoroacetic acid without heating in contrast to those not methylated on the indole nitrogen atom [1] which are converted to the pyrroloquinolines only when heated in trifluoroacetic acid. The structure of compounds **3a,b** was confirmed using ^{1}H NMR spectroscopic data. Hence the spectrum of the pyrroloquinoline **3a** shows singlet signals for the protons of the 1-, 2-, 3-, 5-, 7-CH_3, and 9-OCH_3 groups and also for the H-4 and H-6 protons. The spectrum of compound **3** differs in the absence of the signals for the 5- and 7-CH_3 groups and the presence of signals for the protons of the phenyl substituents (two ABC systems). The signals for the protons of the 7-C_6H_5 group appear at lower field than the 5-C_6H_5, particularly the *ortho* protons which are shifted by 0.7 ppm. This is evidently associated with the effect of the closely located pyridine ring nitrogen atom.

The mass spectra of compounds **3a,b** shown molecular ion peaks with maximum intensity which points to the stability of the molecule towards electron impact. There are also low intensity peaks for the ions $[M-15]^+$ (9%) and $[M-15-28]^+$ (21%) which are typical of 7-OCH_3 substituted indoles [4]. The electronic spectra of compounds **3a,b** agree well with the spectra of the analogs unmethylated at the nitrogen atom (R = H) [1]. In the presence of dimethylsulfate in basic medium the latter are readily converted to the pyrroloquinolines **3a,b**.

The aminoindole **1b** reacts with acetoacetic ester as readily as with the diketones. The acetyl group takes part in the reaction to form the aminocrotonate **2c**.

The ^{1}H NMR spectrum of compound **2c** shows characteristic signals for the protons of the OC_2H_5 group, singlet signals for the protons of five methyl groups, the vinyl proton, and the NH group proton, as well as doublet signals for H-5 and H-4. The position of the NH group signal at 10.09 ppm supports the fact that it is chelated [2].

The strongest signals in the mass spectrum of compound **2** are those for the molecular ion (100%) and the $[M-46]^+$ ion. Subsequent fragmentation is similar to that of the pyrroloquinoline cyclization product **4** of the aminocrotonate **2c** (see below) which points to formation of **4** in the mass spectrometer.

Short refluxing (5-10 min) of compound **2c** in diphenyl gave ready cyclization to the pyrroloquinoline **4** (Scheme 1).

The nature of the ^{1}H NMR spectrum of compound **4** suggests that it exists in DMSO-d_6 in equilibrium with its tautomer **5**. According to the intensities of the signals characteristic of the H-6 and 7-CH_3 protons which appear to low field in the hydroxyquinoline of structure **5** the ratio of compounds **4** to **5** is 3:1. The spectrum also contains two singlets close in chemical shift for the H-4 proton of each tautomer and four signals for methyl groups which coincide for both tautomers.

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* Here, and subsequently, the *m/z* values of (I_{rel}, %) are shown for the ion peaks.

TABLE 1. Spectroscopic Characteristics of Compounds **2-11**

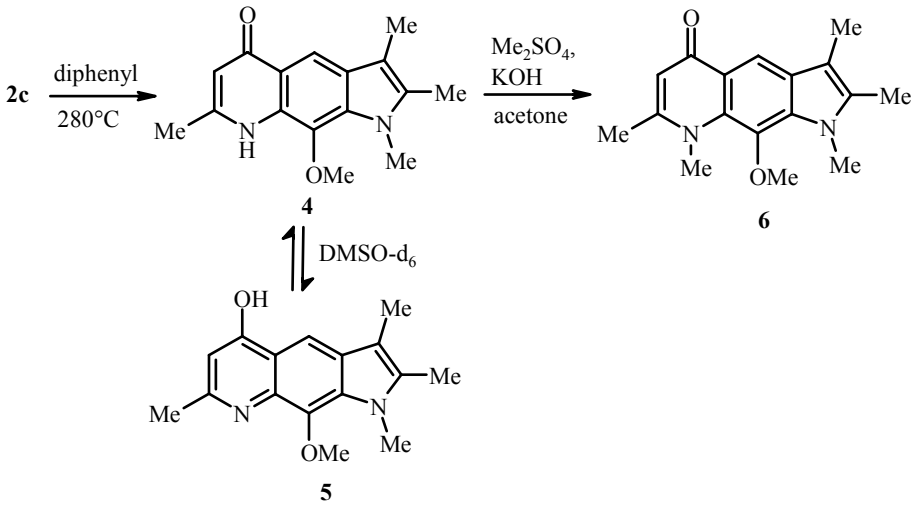
Compound	Mass spectrum, *m/z* (I_{rel}, %)	UV spectrum		^{1}H NMR spectrum, δ, ppm (*J*, Hz)
		λ_{max}	lg ε	
1	2	3	4	5
2a	286 $[M]^+$ (29), 271 (16), 243 (6), 229 (24), 214 (31), 188 (22), 43 (100)	234 310	4.80 4.48	1.72 (3H, s, CH_3C=); 1.99 (3H, s, CH_3CO); 2.10 (3H, s, 3-CH_3); 2.24 (3H, s, 2-CH_3); 3.89 (6H, s, 7-OCH_3, 1-CH_3); 5.20 (1H, s, C<u>H</u>CO); 6.55 (1H, d, *J* = 8, H-5); 6.65 (1H, d, *J* = 8, H-4); 12.27 (1H, s, NH)
2b	410 $[M]^+$ (32), 305 (21), 291 (10), 290 (11), 105 (87), 77 (100)	230 300 (sh) 340	4.71 4.17 4.27	2.30 (3H, s, 3-CH_3); 2.43 (3H, s, 2-CH_3); 3.76 (3H, s, 1-CH_3); 3.89 (3H, s, 7-OCH_3,); 6.10 (1H, d, *J* = 8.0, H-5); 6.11 (1H, s, C<u>H</u>CO); 6.30 (1H, d, *J* = 8.0, H-4); 7.50-8.00 (10H, m, $2C_6H_5$); 13.15 (1H, s, NH)
2c	316 $[M]^+$ (100), 301 (12), 270 (71), 255 (43), 229 (24), 227 (46), 214 (19), 188 (20)	233 303	4.68 4.41	1.29 (3H, t, *J* = 7.0, $OCH_2C\underline{H}_3$); 1.70 (3H, s, CH_3C=); 2.11 (3H, s, 3-CH_3); 2.25 (3H, s, 2-CH_3), 3.87 (3H, s, 1-CH_3); 3.89 (3H, s, 7-OCH_3); 4.04 (2H, q, *J* = 7.0, $OC\underline{H}_2CH_3$); 4.60 (1H, s, C<u>H</u>CO); 6.55 (1H, d, *J* = 8.0, H-5); 6.65 (1H, d, *J* = 8.0, H-4); 10.09 (1H, s, NH)
3a	268 $[M]^+$ (100), 253 (9), 225 (21)	211 233 263 345	4.59 4.76 4.67 4.19	2.33 (3H, s, 3-CH_3); 2.59 (3H, s, 2-CH_3); 2.61 (3H, s, 5-CH_3); 2.69 (3H, s, 7-CH_3); 3.99 (3H, s, 1-CH_3); 4.02 (3H, s, 9-OCH_3); 6.84 (1H, s, H-6); 7.05 (1H, s, H-4)
3b	392 $[M]^+$ (100), 377 (15), 359 (2)	211 250 294 364	4.82 4.92 4.69 4.36	2.39 (3H, s, 3-CH_3); 2.84 (3H, s, 2-CH_3); 3.84 (3H, s, 1-CH_3); 4.01 (3H, s, 9-OCH_3); 6.80 (1H s, H-4); 7.44 (1H, t, *J* = 8.0, H-$4_{5\text{-Ph}}$); 7.54 (3H, t, *J* = 8.0, H-$3_{5\text{-Ph}}$, H-$4_{7\text{-Ph}}$); 7.60 (2H, t, *J* = 8.0, H-$3_{7\text{-Ph}}$); 7.67 (2H, d, *J* = 8.0, H-$2_{5\text{-Ph}}$); 7.80 (1H, s, H-6); 8.34 (2H, t, *J* = 8.0, H-$2_{7\text{-Ph}}$)
4*	270 $[M]^+$ (100), 269 (58), 255 (58), 241 (10), 239 (13), 227 (28), 225 (10)	208 237 263 345	4.10 4.48 4.40 3.89	2.31 (3H, s, 3-CH_3); 2.40 (3H, s, 2-CH_3); 2.58 (3H, s, 7-CH_3); 3.92 (3H, s, 1-CH_3); 3.98 (3H, s, 9-OCH_3); 5.90 (1H, s, H-6); 7.17 (1H, s, H-4); 9.28 (1H, s, H-8)
5*				2.31 (3H, s, 3-CH_3); 2.40 (3H, s, 2-CH_3); 2.65 (3H, s, 7-CH_3); 3.92 (3H, s, 1-CH_3); 3.98 (3H, s, OCH_3); 6.60 (1H, s, H-6); 7.00 (1H, s, H-4); 10.45 (1H, s, 5-OH)

TABLE 1 (continued)

1	2	3	4	5
6	284 $[M]^+$ 100, 283 (16), 269 (64), 241 (21)	217 238 256 323	4.16 4.37 4.28 3.75	2.32 (3H, s, 3-CH_3); 2.59 (3H, s, 7-CH_3); 2.67 (3H, s, 2-CH_3); 3.97 (6H, s, 1-,8-CH_3); 3.98 (3H, s, OCH_3); 6.77 (1H, s, H-6); 6.96 (1H, s, H-4)
7	326 $[M]^+$ (100), 311 (11), 398 (12), 283 (35), 255 (18)			1.37 (3H, t, J = 7.0, $OCH_2C\underline{H}_3$); 2.35 (3H, s, 3-CH_3); 2.70 (3H, s, 2-CH_3); 2.85 (3H, s, 7-CH_3); 4.02 (6H, s, 1-CH_3, OCH_3); 4.36 (2H, q, J = 7.0, $OC\underline{H}_2CH_3$); 7.02 (1H, s, H-4); 8.65 (1H, s, H-5)
8	354 $[M]^+$ (100), 339 (12), 325 (10), 311 (12)	217 274 364	4.33 4.57 4.05	1.39 (3H, t, J = 7.0, $OCH_2C\underline{H}_3$); 2.43 (3H, s, 3-CH_3); 2.71 (3H, s, 2-CH_3); 2.89 (3H, s, 7-CH_3); 4.04 (3H, s, 1-CH_3); 4.10 (3H, s, OCH_3); 4.40 (2H, q, J = 7.0, $COC\underline{H}_2CH_3$); 10.04 (1H, s, H-5); 10.60 (1H, s, CHO)
9a	328 $[M]^+$ (55), 310 (12), 295 (10), 267 (18), 259 (100)	235 303	4.19 3.74	2.29 (3H, s, 3-CH_3); 2.39 (3H, s, 2-CH_3); 2.85 (1H, d, J = 15.0, -$C\underline{H}_2CO$); 2.92 (1H, d, J = 15.0, -$C\underline{H}_2CO$); 3.93 (3H, s, OCH_3); 6.43 (1H, s, OH); 6.79 (1H, s, H-4); 8.40 (1H, s, H-8); 10.65 (1H, s, NH)
9b	342 $[M]^+$) (83), 327 (23), 324 (8), 309 (2), 285 (13), 281 (16), 273 (100)	230 303	4.58 4.04	2.25 (3H, s, 3-CH_3); 2.39 (3H, s, 2-CH_3); 2.83 (1H, d, J = 15.0, -$C\underline{H}_2CO$); 2.97 (1H, d, J = 15.0, -$C\underline{H}_2CO$); 3.85 (3H, s, 1-CH_3); 3.90 (3H, s, OCH_3); 6.74 (1H, s, OH); 6.80 (1H, s, H-4); 8.80 (1H, s, H-8)
10a	310 $[M]^+$ (74), 295 (35), 267 (100)	237 280 352	4.0 4.06 3.58	2.27 (3H, s, 3-CH_3); 2.43 (3H, s, 2-CH_3); 3.90 (3H, s, OCH_3); 6.70 (1H, s, H-4); 6.79 (1H, s, H-6); 9.90 (1H, s, H-8); 11.31 (1H, s, NH)
10b	324 $[M]^+$ (100), 309 (33), 381 (79)	230 278 345	4.51 4.27 3.65	2.32 (3H, s, 3-CH_3); 2.60 (3H, s, 2-CH_3); 3.97 (3H, s, 1-CH_3); 4.02 (3H, s, OCH_3); 6.80 (1H, s, H-4); 6.90 (1H, s, H-6); 9.42 (1H, s, H-8)
11	338 $[M]^+$ (100), 323 (43), 295 (36)	233 274 370	4.69 4.30 3.74	2.35 (3H, s, 3-CH_3); 2.68 (3H, s, 2-CH_3); 4.00 (6H, s, 1-, 8-CH_3); 4.08 (3H, s, OCH_3); 6.85 (1H, s, H-6); 7.12 (1H, s, H-4)

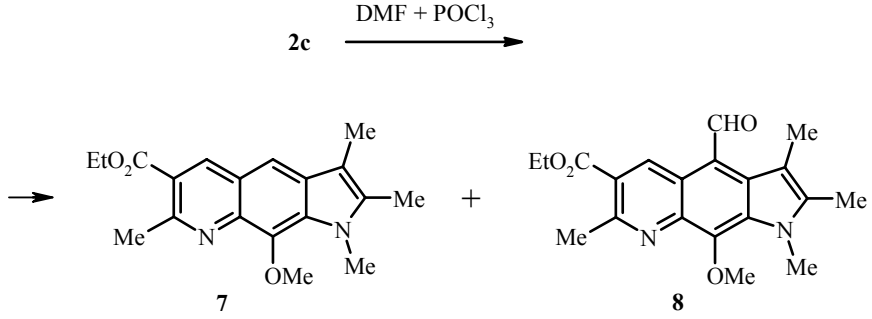
* ^{1}H NMR data obtained from the spectrum of a 3:1 mixture of compounds **4** and **5**.

Scheme 1



Using dimethylsulfate in basic medium the pyrroloquinoline **4** is converted to compound **6** which is methylated on both nitrogen atoms. The ^{1}H NMR spectrum of the pyrroloquinoline **6** agrees well with the spectrum of the γ-quinolone **4**. The mass spectrum of compound **4** shows a molecular ion peak (100%) and signals for the fragment ions 255 (58%) and 227 (28%), corresponding to loss from the molecular ion of a methyl radical and then a CO molecule. The pyrroloquinolone **6** methylated at both nitrogens undergoes fission by the same route.

The behaviour of the crotonate **2c** under Vilsmeier conditions differs from that of the nonmethylated analog (R = H) [1]. Refluxing compound **2c** with the DMF + $POCl_3$ complex in chloroform for 6 h gave the two pyrroloquinolines **7** and **8**.



The structure of compound **7** was identified from the ^{1}H NMR spectrum which contained signals for all of the substituents together with the aromatic protons H-4 and H-5. Fission of the pyrroloquinoline **7** under electron impact conditions did not differ fundamentally from that of the structures **4, 6** already discussed.

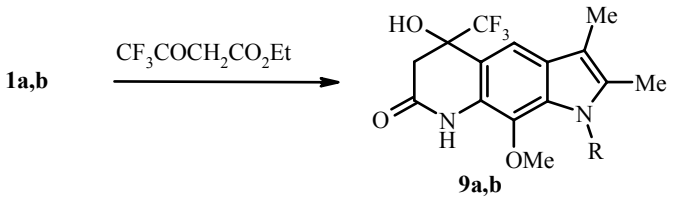
The formation of the second reaction product **8** is due to formylation of the pyrroloquinoline **7** at position 4 under the Vilsmeier conditions. When compared with the ^{1}H NMR spectrum of the pyrroloquinoline **7** that of compound **8** shows the absence of the H-4 proton signal and the presence of a CHO group singlet proton signal at 10.60 ppm. The aldehyde group at position 4 causes a low field shift of the H-5 proton from 7.02 ppm in compound **7** to 10.04 ppm in compound **8**.

The presence of the formyl group in the pyrroloquinoline **8** is also confirmed by IR data which shows the presence of a strong band at 1665 cm^{-1} as well the stretching vibration of the ester carbonyl at 1711 cm^{-1}.

The mass spectrum of compound **8** shows peaks at 354 $[M]^+$ (100%), 339 $[M-15]^+$ (15%), and 311 $[M-15-28]^+$ (15%) characteristic of the pyrroloquinolines **4, 6** and also an ion peak at 329 $[M-29]^+$ (14%) corresponding to loss of the CHO group ion.

The ease of formylation at position 4 in the pyrroloquinoline **7** is evidently due to the electron-donor effect of the NMe group which somewhat increases not only the basicity of the starting amine **1b** but also allows a build up of electron density on the C-4 atom sufficient for introduction of the formyl group under Vilsmeier conditions. In fact, under the same conditions the pure compound **7** is converted to the 4-formyl derivative **8** whereas the pyrroloquinolines of type **3** (R = H) are not formylated [1].

The conditions for carrying out the reaction of the aminoindoles **1a,b** with trifluoroacetoacetic ester influence the course of the reaction. Hence, in contrast to the nonfluorinated analog, refluxing in benzene in the presence of traces of glacial acetic acid causes reaction at the ester group to give the cyclic amides **9a,b** which can also be formed from the amines **1a,b** at 10-15°C in the presence of a dehydrating agent. This contrasts with the 5-aminoindoles for which the main reaction products under these conditions are the aminocrotonates [5].



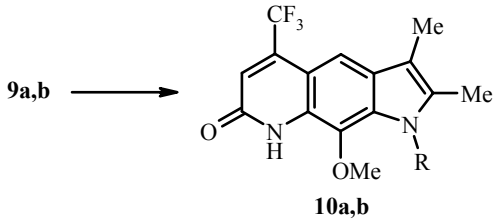
9a,b

a R = H; **b** R = Me

We have previously reported the formation of cyclic amides from 7-aminoindoles [6]. The structure of compounds **9a,b** is confirmed by ^{1}H NMR data which shows signals for protons of three (for compound **9a**) or four (compound **9b**) methyl groups, single singlets for the H-1 (for structure **9a**), H-4,8 and 5-OH protons as well as two doublet signals for the methylene protons at 2.8-3.0 ppm with a spin-spin coupling of 15 Hz. The nonequivalence of these protons is evidently associated with the differing effects of the trifluromethyl and hydroxyl groups. The existence of two bands at 1661 and 1698 cm^{-1} in the IR spectra are very likely due to the presence of each of compounds **9a,b** as two conformers.

The strongest signals in the mass spectra of the amides **9a,b** are the ion peaks $[M-69]^+$ (100%) which correspond to the protonated forms of the pyrroloquinolines with hydroxyl groups at positions 5 and 7. Under electron impact conditions the latter are formed from the $[M]^+$ of the amides (55% for **9a** and 83% for **9b**) *via* elimination of the trifluromethyl radical.

Under thermal (250°C) or acidic conditions (CF_3COOH, 20-78°C) aromatization of compounds **9a,b** readily occurs with the loss of a molecule of water. The trifluromethyl-substituted pyrroloquinolones **10a,b** are formed in good yields.



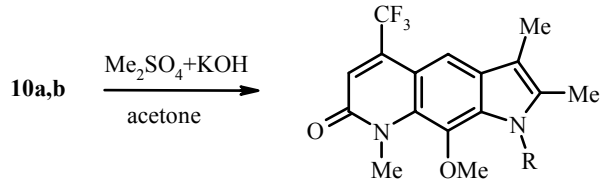
10a,b

a R = H; **b** R = Me

The ^{1}H NMR spectra of compounds **10a,b** show singlet signals for the protons of three (for compound **10a**) or four (for compound **10b**) methyl and also protons H-1 (for compound **10a**), H-4, H-6, and H-8. The nature of the fission of the pyrroloquinolines **10a,b** under electron impact conditions is similar to that of

compounds **4** and **6** and show strong $[M]^+$ ion peaks (74% for **10a**, 100% for **10b**), $[M-15]^+$ (33%), and $[M-15-28]^+$ (100% for **10a** and 79% for **10b**).

The pyrroloquinolone **11** fully methylated at the nitrogen atoms is readily obtained by methylation of compounds **10a,b** and is even more stable towards electron impact. This is shown by the relationship of the relative strengths of the fragment ions $[M]^+$ (100%), $[M-15]^+$ (43%), and $[M-15-28]^+$ (36%).



11

The UV and ^1H NMR spectra of compound **11** agree fully with spectroscopic data for the pyrroloquinolones **10a,b**.

TABLE 2. Physicochemical Characteristics of the Compounds Synthesized

Compound	Empirical formula	Found, % / Calculated, %			R_f (system)	mp, °C*	Yield, % (method)
		C	H	M			
2a	$C_{17}H_{22}N_2O_2$	71.48 / 71.30	7.55 / 7.74	286 / 286	0.59 (d)	96	73
2b	$C_{27}H_{26}N_2O_2$	78.71 / 79.00	6.75 / 6.38	410 / 410	0.56 (a)	165-166	3
2c	$C_{18}H_{24}N_2O_3$	67.96 / 68.33	8.18 / 7.65	316 / 316	0.60 (b)	123-124	69
3a	$C_{17}H_{20}N_2O$	75.69 / 76.09	8.02 / 7.51	268 / 268	0.35 (f)	174-175	25 (A), 48 (B), 59 (C)
3b	$C_{27}H_{24}N_2O$	82.34 / 82.62	6.50 / 6.16	392 / 392	0.75 (a)	184-185	31
4	$C_{16}H_{18}N_2O_2$	70.79 / 71.09	7.11 / 6.71	270 / 270	0.80 (g)	252-253	81
6	$C_{17}H_{20}N_2O_2$	71.47 / 71.81	7.54 / 7.09	284 / 284	0.59 (h)	218-219	49 (A), 59 (B)
7	$C_{19}H_{22}N_2O_3$	69.66 / 69.92	6.22 / 6.79	326 / 326	0.73 (c)	179-180	20
8	$C_{20}H_{22}N_2O_4$	67.63 / 67.78	6.60 / 6.26	354 / 354	0.54 (c)	204-205	15
9a	$C_{15}H_{15}F_3N_2O_3$	54.76 / 54.88	4.78 / 4.61	328 / 328	0.29 (e)	284	27
9b	$C_{16}H_{17}F_3N_2O_3$	56.00 / 56.14	5.22 / 5.01	342 / 342	0.50 (f)	196-197	34
10a	$C_{15}H_{13}F_3N_2O_2$	57.96 / 58.07	4.37 / 4.22	310 / 310	0.23 (e)	315	60
10b	$C_{16}H_{15}F_3N_2O_2$	59.13 / 59.26	4.84 / 4.66	324 / 324	0.18 (f)	221-222	76
11	$C_{17}H_{17}F_3N_2O_2$	60.20 / 60.35	5.28 / 5.06	338 / 338	0.84 (a)	169-170	63 (A), 57 (B)

* Solvent for crystallization: hexane (**2a, 7, 8**), petroleum ether (**2c, 9b**), benzene–petroleum ether (**3b, 10b**), ethanol (**3b, 4, 6, 11**), benzene (**9a, 10a**).

Analysis of the result of this and earlier [1] work shows that the aminoindole **1b** methylated at the N-1 atom is certainly more active than its analog **1a** which is not methylated at the indicated nitrogen atom and this can be explained by the positive inductive effect of an N-methyl group. One of the criteria for working out the reactivity of aromatic amines is the value of the charge on the nitrogen atom of the amino group (initial condensation) and on the carbon atom in an *ortho* position relative to the C atom bearing the NH_2 group (ring formation). We have carried out quantum chemical calculations for the amines **1a,b** by the AM1 method using the Hyper Chem 5.0 program package. The results obtained shown that the charge on the nitrogen atom of the amino group of the nonmethylated aminoindole **1a** is higher than on the same atom in the methylated aminoindole **1b** (0.082 compared with 0.067) and this indirectly confirms the higher basicity of the amine with the introduction of the methyl group at atom N-1. The charges on the *ortho* atoms C-5 (-0.157 for **1a** and -0.160 for **1b**) are similarly different but to a smaller degree. The rather high reactivity of the amino group and the nucleophilicity of the carbon atoms of the benzene ring make it possible to use the aminoindole **1b** to prepare substituted pyrrolo[3,2-*g*]quinolines and both the initial condensation and the subsequent cyclization can be carried out under quite mild conditions.

EXPERIMENTAL

^{1}H NMR spectra were recorded on a Bruker DRX-500 (500 MHz) instrument using DMSO-d_6 and are relative to TMS. Mass spectra were obtained on a Finnigan MAT INCOS-50 mass spectrometer with direct introduction of the sample into the ion source and with an ionization energy of 70 eV. Electronic spectra were recorded on a Specord spectrophotometer using ethanol as solvent. Purification of the reaction products was carried out using column chromatography on Al_2O_3 (neutral, I and II Brockmann activity). Monitoring of the course of the reaction, the purity of the compounds obtained, and the determination of R_f were performed using TLC on Silufol UV-254 plates using the systems benzene–ethyl acetate, 20:1 (a), 9:1(b), 8:1 (c), 3:1(d), 3:2(e), and 1:1(f); ethyl acetate–methanol, 5:1 (g), 4:1 (h), or chloroform–petroleum ether, 2:1 (i).

The physicochemical and spectroscopic characteristics for the compounds obtained are given in Tables 1 and 2.

(*Z*)-4-(7-Methoxy-1,2,3-trimethyl-1H-indol-6-ylamino)pent-3-en-2-one (2a). A mixture of the aminoindole **1b** (0.44 g, 2.16 mmol) and acetylacetone (3 ml) was refluxed for 30 min. At the end of the reaction the excess acetylacetone was removed in vacuo. The residue was dissolved in a mixture of benzene and petroleum ether and the solution was concentrated by evaporation, cooled, and the precipitated solid compound **2a** was filtered off. For purification from traces of compound **3a** it was dissolved in benzene and filtered through a layer of Al_2O_3 (2 cm). The yield of pure compound **2a** was 0.45 g.

(*Z*)-3-(7-Methoxy-1,2,3-trimethyl-1H-indol-6-ylamino)-1,3-diphenylprop-2-en-1-one (2b) and 9-Methoxy-1,2,3-trimethyl-5,7-diphenyl-1H-pyrrolo[3,2-*g*]quinoline (3b). A. A mixture of the aminoindole **1b** (0.3 g, 1.47 mmol) and dibenzoylmethane (0.66 g, 2.94 mmol) was held for 1.5 h at 180-185°C. The reaction products **2b** and **3b** were separated by preparative chromatography on a thick layer of Al_2O_3 using the system "h" to give compound **2b** (0.019 g) and compound **3b** (0.18 g).

B. A five-fold excess of dimethylsulfate and potassium hydroxide were added to a solution of 9-methoxy-2,3-dimethyl-5,7-diphenyl-1H-pyrrolo[3,2-*g*]quinoline (0.068 g, 0.18 mmol) [1]. The mixture was refluxed for 4 h. The acetone was distilled off and water (30 ml) was added to the residue. The precipitated solid was filtered off, washed repeatedly with water, and dried in air to give compound **3b** (0.03 g).

Ethyl (*Z*)-3-(7-Methoxy-1,2,3-trimethyl-1H-indol-6-ylamino)crotonate (2c). A mixture of the aminoindole **1b** (1.3 g, 6.37 mmol) and acetoacetic ester (0.83 g, 6.38 mmol) in absolute benzene (200 ml) was refluxed for 5 h in a Dean and Stark apparatus. At the end of the reaction the benzene was distilled off, the residue was dissolved in a mixture of petroleum ether and benzene, and the solution was filtered through a layer of Al_2O_3 (3-4 cm). Evaporation of the solution gave compound **2c** (1.4 g).

9-Methoxy-1,2,3,5,7-pentamethyl-1H-pyrrolo[3,2-*g*]indole (3a). A. A mixture of the aminoindole **1b** (0.70 g, 3.43 mmol) and acetylacetone (3 ml) was refluxed for 3 h using the method of synthesis of compound **2a** to give compound **3a** (0.23 g).

B. A solution of the enamino ketone **2a** (0.1 g, 0.35 mmol) in a ten-fold excess of trifluoroacetic acid was refluxed for 20 min. The cooled reaction mixture was poured into aqueous ammonia (10-12%) with ice and the precipitated solid was filtered off, washed repeatedly with water, and dried in air to give compound **3a** (0.045 g).

C. Methylation similar to the synthesis of compound **3b** (but over the course of 3.5 h) using 9-methoxy-2,3,5,7-tetramethyl-1H-pyrrolo[3,2-*g*]quinoline (0.045 g, 0.18 mmol) gave compound **3a** (0.08 g).

9-Methoxy-1,2,3,7-tetramethyl-5,8-dihydro-1H-pyrrolo[3,2-*g*]quinolin-5-one (4). A mixture of the aminocrotonate **2c** (0.2 g, 0.63 mmol) and diphenyl (5 ml) was refluxed for 5-10 min. The hot solution was diluted with petroleum ether and the precipitate was filtered off and washed repeatedly with hot hexane to give the pyrroloquinolone **4** (0.14 g).

9-Methoxy-1,2,3,7,8-pentamethyl-5,8-dihydro-1H-pyrrolo[3,2-*g*]quinolin-5-one (6). A. Methylation of the pyrroloquinoline **4** (0.17 g, 0.625 mmol) over 5 h by the method for the synthesis of compound **3b** gave compound **6** (0.086 g).

B. Similarly by methylation of the previously synthesized [1] 9-methoxy-2,3,7-trimethyl-5,8-dihydro-1H-pyrrolo[3,2-*g*]quinolin-5-one (0.123 g, 0.48 mmol) over 6.5 h to give the pyrroloquinolone **6** (0.08 g.).

Ethyl 9-Methoxy-1,2,3,7-tetramethyl-1H-pyrrolo[3,2-*g*]quinoline-6-carboxylate (7) and Ethyl 4-Formyl-9-methoxy-1,2,3,7-tetramethyl-1H-pyrrolo[3,2-*g*]quinoline-6-carboxylate (8). The Vilsmeier reagent prepared from DMF (1.5 ml, 165.9 mmol) and $POCl_3$ (1 ml, 10.6 mmol) was added to compound **2c** (0.38 g, 1.2 mmol) in chloroform (40 ml). The reaction mixture was refluxed for 7 h, the chloroform was distilled off, ethanol (2-3 ml) was added to the residue, and then aqueous KOH solution (20 ml) to pH 9. The precipitate was filtered off and repeatedly washed with water to neutral reaction. Preparative TLC of the washed precipitate on an unbonded thick layer of Al_2O_3 using the system "c" gave compound **7** (0.052 g) and compound **8** (0.065 g).

5-Hydroxy-9-methoxy-2,3-dimethyl-5-trifluoromethyl-5,6,7,8-tetrahydro-1H-pyrrolo[3,2-*g*]quinolin-7-one (9a). A mixture of the aminoindole **1a** (0.55 g, 2.89 mmol) and ethyl trifluoroacetoacetate (0.54 g, 2.90 mmol) was refluxed for 17 h using the method for the synthesis of compound **2c**. The volume of the reaction mixture was reduced by distillation of benzene to 20 ml. The precipitated amide **9a** was filtered off and repeatedly washed with benzene to give 0.9 g of product.

5-Hydroxy-9-methoxy-1,2,3-trimethyl-5-trifluoromethyl-5,6,7,8-tetrahydro-1H-pyrrolo[3,2-g]-quinolin-7-one (9b) was obtained similarly to the synthesis of compound **9a** from the aminoindole **1b** (1.13 g, 5.54 mmol) for 10 h in 0.65 g yield.

9-Methoxy-2,3-dimethyl-5-trifluoromethyl-7,8-dihydro-1H-pyrrolo[3,2-*g*]quinolin-7-one (10a). A mixture of the amide **9a** (0.9 g, 2.7 mmol) and a ten-fold excess of trifluoroacetic acid was refluxed for 2 h. The cooled reaction mixture was poured into aqueous ammonia (10-12%) with ice and the precipitate was filtered off, washed repeatedly with water, and dried in air to give the pyrroloquinolone **10a** (0.5 g).

9-Methoxy-1,2,3-trimethyl-5-trifluoromethyl-7,8-dihydro-1H-pyrrolo[3,2-*g*]quinolin-7-one (10b) was prepared similarly to the synthesis of compound **10a** from the amide **9b** (0.25 g,0.73 mmol) for 1 h in 0.18 g yield.

9-Methoxy-1,2,3,8-tetramethyl-5-trifluoromethyl-7,8-dihydro-1H-pyrrolo[3,2-g]quinolin-7-one (11). A. Methylation (see the synthesis of compound **3b**, method B) of the pyrroloquinolone **10a** (0.13 g, 0.42 mmol) over 4 h gave compound **11** (0.089 g).

B. Similarly, methylation of the pyrroloquinolone **10b** (0.08 g, 0.25 mmol) over 3 h gave the pyrroloquinolone **11** (0.047 g).

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