Study of regioselectivity of intramolecular cyclization of *N*-(*m*-R-phenyl)- and *N*-(α-naphthyl)-2-allyl(methallyl)-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes

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Regioselectivity of the intramolecular electrophilic substitution in a series of *N*-(*m*-R-phenyl)- and *N*-(α-naphthyl)-2-allyl(methallyl)-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes in reactions with phosphoric acid was studied. The reactions of *N*-(*m*-R-phenyl)-substituted derivatives proceed nonregioselectively to form mixtures of 2-R- and 4-R-substituted isoindolo[2,1-*a*]quinolines, whereas the reactions of *N*-(α-naphthyl)-substituted derivatives occur regioselectively at the β position of the naphthyl fragment.

Key words: homoallylamines, intramolecular Diels—Alder reaction, intramolecular [4+2]-cycloaddition, 3a,6-epoxyisoindoles, isoindolo[2,1-*a*]quinolines.

Procedures for the synthesis of isoindolo[2,1-*a*]quinolines are few in number.[1—8] All these procedures involve many steps and, in some cases, are based on rather difficultly accessible starting compounds. In the last decade, compounds active against N_2-induced hypoxia[9] and topoisomerase inhibitors[10] were found among isoindolo[2,1-*a*]quinoline derivatives, which are homologs of berberinic alkaloids.

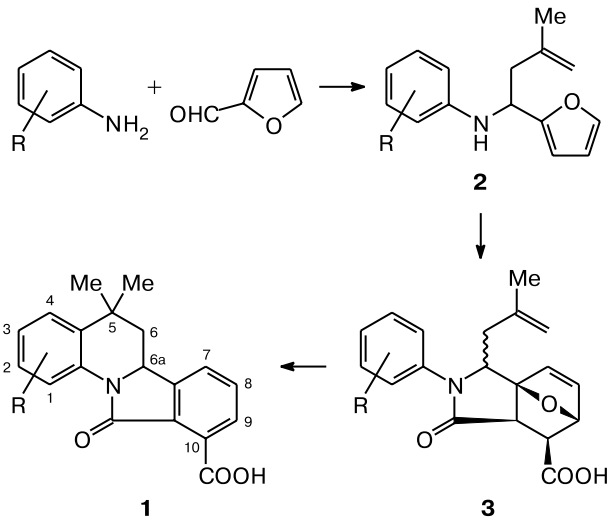
Recently, we have described[11] the synthesis of 11-oxoisoindolo[2,1-*a*]quinoline-10-carboxylic acids **1** based on transformations of *N*-aryl-substituted 4-amino-4-(2′-furyl)but-1-enes **2**. The key step of this method involves electrophilic cyclization of 3-allyl-3a,6-epoxyisoindole-7-carboxylic acids **3**, which are prepared by the reaction of furylamines **2** [11—13] with maleic anhydride (Scheme 1).

The use of *ortho*- or *para*-substituted anilines provides a way of preparing 1- or 3-substituted isoindoloquinolines **1**,[11] respectively. By contrast, the reactions with the use of *meta*-substituted anilines can give mixtures of isomeric 2-R- and 4-R-substituted acids **1** in the last step (see Scheme 1).

The aim of the present study was to extend the synthetic scope of this method involving *meta*-substituted anilines and α-naphthylamine and to investigate the regioselectivity of its key step, *viz.*, electrophilic cyclization.

The starting allylamines **4** and **5** were prepared according to a procedure described earlier[11] by the reaction of methallyl- or allylmagnesium halides with the corresponding Schiff bases **6** (Scheme 2). The latter are easily generated by condensation of *meta*-substituted anilines with furfurol.

Scheme 1



R = H (*o* or *p*), Alk, OR′

Homoallylamines **4** and **5** were isolated under reduced pressure in 47—75% yields as colorless mobile oils. The highest yields of the amines were observed in the reactions with *N*-(*m*-tolyl)-substituted amines **4a** and **5a** (R = Me). The physicochemical characteristics of furfuryl-

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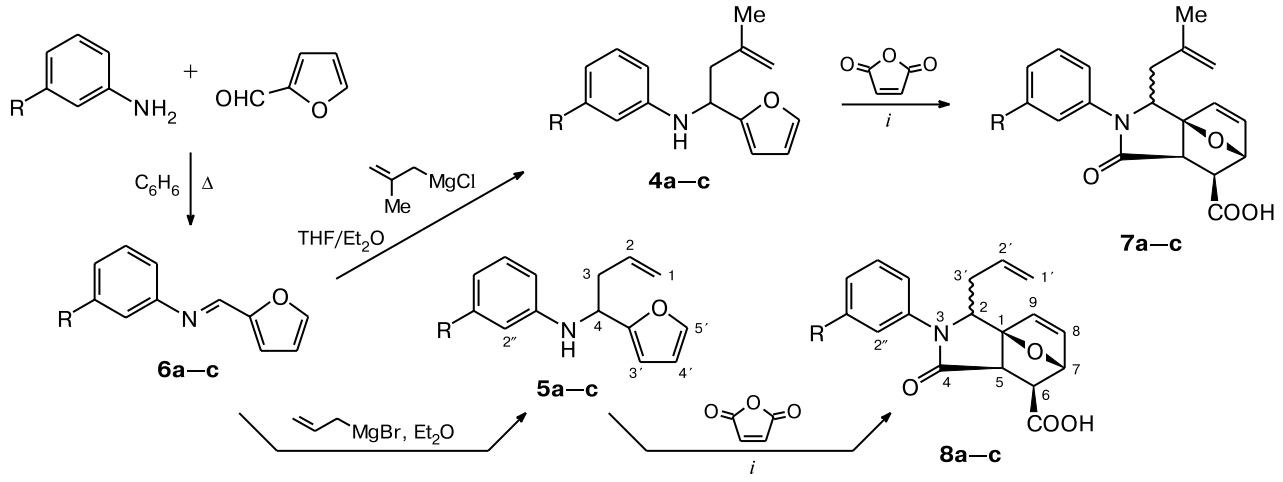
Scheme 2



R = Me (**a**), OMe (**b**), Cl (**c**)

i. C_6H_6, 20 °C, 2—7 days.

amines **4** and **5** are given in Table 1. The ^{1}H NMR spectroscopic data are listed in Tables 2 and 3.

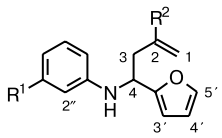
Compounds **4** and **5** were transformed into the corresponding 3a,6-epoxyisoindolocarboxylic acids **7** and **8**, respectively, in 68—89% yields by the reactions with maleic anhydride[14] at 20 °C (Table 4). Cycloaddition occurs srereoselectively to give *exo* Diels—Alder adducts **7** and **8**. The structures of tricyclic compounds **7** and **8** were established by ^{1}H NMR spectroscopy (Tables 5 and 6) by comparing the spin-spin coupling constants of the protons of the oxabicycloheptene fragment with the published data.[15] For example, the H(6) proton in the *exo*-adducts appears as a doublet at δ 2.55—3.26 with $J_{5,6}$ = 9.1—9.3 Hz (in the *endo* adducts, the H(6) protons would be observed as a

Table 1. Yields, physicochemical characteristics, elemental analysis data, and selected spectroscopic characteristics for homoallylamines **4a—c**, **5a—c**, and **16a,b**

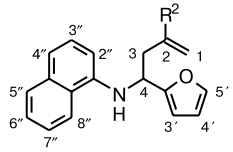
Compound	Yield (%)	B.p./°C (*p*/Torr)	R_f	Found / Calculated (%)			Molecular formula	Molecular weight Found, $[M]^+$ / Calculated	IR, ν/cm^{-1}	
				C	H	N			ν(C=C)	ν(NH)
4a	75	135—137 (3)	0.31[a]	79.65 / 79.63	7.96 / 7.94	5.80 / 5.80	$C_{16}H_{19}NO$	241 / 241	1594	3389
4b	59	161—163 (2)	0.60[a]	74.70 / 74.68	7.47 / 7.44	5.43 / 5.44	$C_{16}H_{19}NO_2$	257 / 257	1598	3392
4c	52	164—165 (5)	0.27[b]	68.83 / 68.83	6.19 / 6.16	5.35 / 5.35	$C_{15}H_{16}NOCl$	261 (^{35}Cl) / 261.5	1579	3388
5a	74	150—155 (4)	0.63[c]	79.28 / 79.26	7.54 / 7.54	6.19 / 6.16	$C_{15}H_{17}NO$	227 / 227	1596	3393
5b	55	168 (3)	0.52[b]	74.06 / 74.05	7.05 / 7.04	5.78 / 5.76	$C_{15}H_{17}NO_2$	243 / 243	1635	3381
5c	47	137 (1)	0.51[b]	67.90 / 67.88	5.72 / 5.70	5.65 / 5.65	$C_{14}H_{14}NOCl$	247 (^{35}Cl) / 247.5	1635	3400
16a	77	200—202 (5)	0.40[a]	82.28 / 82.28	6.93 / 6.90	5.07 / 5.05	$C_{19}H_{19}NO$	277 / 277	1614	3396
16b	52	193 (4)	0.42[b]	82.12 / 82.10	6.54 / 6.51	5.30 / 5.32	$C_{18}H_{17}NO$	263 / 263	1630	3415

[a] Ethyl acetate—hexane (1 : 2).
[b] Ethyl acetate—hexane (1 : 10).
[c] Ethyl acetate—hexane (1 : 3).

Table 2. Chemical shifts (δ) of protons in the ^{1}H NMR spectra of solutions of homoallylamines **4a—c**, **5a—c**, and **16a,b** in $CDCl_3$ (400 MHz)



4a—c, 5a—c



16a,b

Compound	δ														
	1_{cis}	1_{trans}	R^2	3a	3b	4	Atoms of furan			Ar					NH
							3′	4′	5′	2″	R^1	4″	5″	6″	
4a	4.79 (br.s)	4.85 (br.s)	1.67 (s, Me)	2.45 (dd)	2.70 (dd)	4.57 (m)	6.15 br.d	6.26 (dd)	7.32 (dd)	6.42 (br.s)	2.23 (s, Me)	6.51 (d)	7.01 (t)	6.39 (dd)	3.88 (br.s)
4b	4.81 (br.s)	4.87 (br.s)	1.68 (s, Me)	2.64 (dd)	2.55 (dd)	4.56 (dd)	6.17 br.d	6.28 (dd)	7.33 (dd)	6.16 (t)	3.73 (s, OMe)	6.22 (dd)	7.03 (t)	6.26 (dd)	3.99 (br.s)
4c	4.81 (m)	4.88 (m)	1.67 (br.s, Me)	2.65 (dd)	2.57 (ddd)	4.54 (ddd)	6.16 (dt)	6.28 (dd)	7.34 (dd)	6.57 (t)	—	6.65 (ddd)	7.02 (t)	6.45 (ddd)	4.04 (d)
5a	5.16 (ddt)	5.19 dq	5.78 (ddt, H)	2.68 (ddt)		4.58 (t)	6.19 (ddd)	6.31 (dd)	7.37 (dd)	6.47 (br.s)	2.28 (s, Me)	6.56 (dt)	7.07 (t)	6.45 (dd)	3.97 (br.s)
5b	5.16 (dd)	5.20 (dd)	5.78 (m, H)	2.68 (br.t)		4.57 (t)	6.20 (m)		7.37 (dd)	6.20 (m)	3.76 (s, OMe)	6.25—6.31 (m)	7.08 (dt)	6.25—6.31 (m)	4.06 (br.s)
5c	5.16 (m)	5.19 (m)	5.75 (ddt, H)	2.65—2.68 (m)		4.54 (br.t)	6.17 (dt)	6.31 (dd)	7.37 (dd)	6.60 (t)	—	6.67 (ddd)	7.05 (t)	6.48 (ddd)	4.09 (br.s)
16a	5.00 (m)		1.75 (s, Me)	2.78 (dd)	2.84 (dd)	4.80 (dd)	6.24 br.d	6.33 (dd)	7.40 (dd)	6.60 (dd, H(2″)); 7.26 (br.d, H(4″)); 7.31 (t, H(3″)); 7.48 (m, H(5″), H(8″)); 7.81—7.89 (m, H(7″), H(6″))					4.84 (br.s)
16b	5.25 (ddd)	5.33 (ddd)	5.88 (ddt, H)	2.85 (br.t)		4.80 (t)	6.23 (dd)	6.33 (dd)	7.41 (dd)	6.62 (dd, H(2″)); 7.28 (br.d, H(4″)); 7.33 (dd, H(3″)); 7.47—7.51 (m, H(5″), H(8″)); 7.81—7.89 (m, H(7″), H(6″))					4.83 (br.s)

Table 3. Spin-spin coupling constants (*J*) of protons in the ^{1}H NMR spectra of homoallylamines **4a—c**, **5a—c**, and **16a,b**

Compound	*J*/Hz															
	1_{cis}, R^2	1_{trans}, R^2	1_{cis}, 1_{trans}	R^2, 3a	R^2, 3b	3a, 4	3b, 4	a, b	3′, 4′	3′, 5′	4′, 5′	2″, 4″	2″, 6″	4″, 5″	4″, 6″	5″, 6″
4a	—	—	—	—	—	~7.6	~7.6	14.1	3.4	0.8	1.8	—	—	7.9	—	7.9
4b	—	—	—	—	—	6.1	8.2	14.2	3.1	0.7	1.7	2.1	2.1	8.0	[a]	8.0
4c[a]	—	—	—	—	—	5.4	8.9	14.1	3.2	0.8	1.8	2.0	2.0	8.0	0.9	8.0
5a	10.1	17.2	1.5	7.0	7.0	6.3	6.3	—	3.2	0.9	1.8	0.8	0.8	7.6	0.8	7.6
5b[b]	10.1	17.2	1.3	7.0	7.0	6.2	6.2	—	3.2	0.8	1.7	—	—	8.1	—	8.1
5c[c]	10.1	17.1	1.7	7.1	7.1	6.2	6.2	—	3.2	0.8	1.8	2.1	2.1	8.1	2.1	8.1
16a	—	—	—	—	—	5.6	8.5	14.1	3.2	0.9	1.8	$J_{2'',3''} = J_{3'',4''} = 7.3$, $J_{2'',4''} = 1.2$				
16b[d]	10.1	17.1	1.9	7.1	7.1	~6.8	~6.8	—	3.2	0.6	1.8	$J_{2'',3''} = 7.3$, $J_{3'',4''} = 8.1$, $J_{2'',4''} = 1.2$				

[a] $J_{3b,1} = 0.8$ Hz, $J_{4,NH} = 4.7$ Hz, and $J_{3',NH} = 0.8$ Hz.
[b] $J_{2'',5''} = 0.8$ Hz.
[c] $J_{3',4} = 0.8$ Hz.
[d] $J_{3,1cis} = 0.9$ Hz and $J_{3,1trans} = 1.4$ Hz.

Table 4. Yields, physicochemical parameters, and selected spectroscopic characteristics of epoxyisoindolones **7a—c**, **8a—c**, **17a,b**, isoindolo[2,1-*a*]quinolinecarboxylic acids **9a—c**, **10a—c**, **11a-c—14a-c**, **18**, **19a,b**, and 1-oxoisoindoline-7-carboxylic acids **15a—c**

Compound	Yield (%)	M.p./°C	R_f	Found / Calculated (%)			Molecular formula	Molecular weight Found, $[M]^+$ / Calculated	IR, ν/cm^{-1}	
				C	H	N			ν(COO)	ν(NCO)
7a	89	168—169	0.20[a]	70.79	6.26	4.15	$C_{20}H_{21}NO_4$	339	1731	1663[b]
				70.78	6.24	4.13		339		
7b	84	164—166	0.13[a]	67.61	5.98	3.96	$C_{20}H_{21}NO_5$	355	1732	1645[b]
				67.59	5.96	3.94		355		
7c	80	182—183	0.30[a]	63.44	5.01	3.89	$C_{19}H_{18}NO_4Cl$	359 (^{35}Cl)	1731	1669[b]
				63.43	5.04	3.89		359.5		
8a	82	140.5—141.5	0.28[c]	70.14	5.90	4.32	$C_{19}H_{19}NO_4$	325	1743	1660[b]
				70.14	5.89	4.30		325		
8b	80	113—115	0.20[a]	66.87	5.61	4.10	$C_{19}H_{19}NO_5$	341	1740	1677[b]
				66.85	5.61	4.10		341		
8c	71	144—146	0.35[a]	62.55	4.68	4.02	$C_{18}H_{16}NO_4Cl$	345 (^{35}Cl)	1710	1698[b]
				62.52	4.66	4.05		345.5		
9a, **10a**	52	247—248[d]	0.32[e]	74.77	5.92	4.34	$C_{20}H_{19}NO_3$	321	1713	1665
				74.75	5.96	4.36		321		
9b, **10b**	57	225—226[d]	0.15[e]	71.21	5.66	4.18	$C_{20}H_{19}NO_4$	337	1719	1669
				71.20	5.68	4.15		337		
9c, **10c**	63	267—268[d]	0.23[e]	66.79	4.74	4.10	$C_{19}H_{16}NO_3Cl$	341 (^{35}Cl)	1719	1669
				66.77	4.72	4.10		341.5		
11a—14a	41	178.5—180.5[d]	0.65[c]	74.23	5.60	4.59	$C_{19}H_{17}NO_3$	307	1727	1625
				74.25	5.58	4.56		307		
11b—14b	40	143[d]	0.25[e]	70.60	5.31	4.34	$C_{19}H_{17}NO_4$	323	1728	1627
				70.58	5.30	4.33		323		
11c—13c	44	200—202[d]	0.30[e]	65.98	4.33	4.25	$C_{18}H_{14}NO_3Cl$	327 (^{35}Cl)	1716	1607
				65.96	4.31	4.27		327.5		
15a	75	116—117.5[d]	0.54[e]	74.27	5.59	4.58	$C_{19}H_{17}NO_3$	307	1713	1610
				74.25	5.58	4.56		307		
15b	68	109.5—110.5[d]	0.42[e]	70.59	5.28	4.33	$C_{19}H_{17}NO_4$	323	1722	1613
				70.58	5.30	4.33		323		
15c	63	166.5—168.5[d]	0.36[e]	65.96	4.32	4.29	$C_{18}H_{14}NO_3Cl$	327 (^{35}Cl)	1704	1635
				65.96	4.31	4.27		327.5		
17a	68	240—242	0.20[a]	73.56	5.65	3.74	$C_{23}H_{21}NO_4$	375	1720	1670[b]
				73.58	5.64	3.73		375		
17b	48	232.5—234.5	0.25[a]	73.14	5.32	3.88	$C_{22}H_{19}NO_4$	361	1730	1675[b]
				73.12	5.30	3.88		361		
18	58	234—236[d]	0.31[e]	77.31	5.36	3.91	$C_{23}H_{19}NO_3$	357	1706	1663
				77.29	5.36	3.92		357		
19a, **19b**	46	201.5—203.5[d]	0.41[e]	76.98	4.99	4.12	$C_{22}H_{17}NO_3$	343	1730	1615
				76.95	4.99	4.08		343		

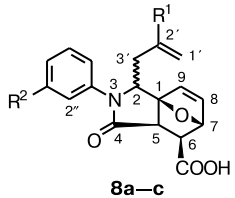
[a] Ethyl acetate—chloroform (1 : 2).
[b] The C=C absorption band of the olefinic fragment overlaps with the band of the amide group.
[c] Ethyl acetate.
[d] From a Pr^iOH—DMF mixture.
[e] Ethyl acetate—chloroform (1 : 10).

doublet of doublets with the coupling constants $J_{6,7}$ = 1.5—2.0 Hz and $J_{5,6}$ = 8.5—10 Hz).[16]

The results of ^1H NMR spectroscopy demonstrated that all *exo*-epoxyisoindolones **7** and **8** were formed as two geometric isomers, which differ in the arrangement of the olefinic fragment with respect to the 1,7-epoxide bridge. The ratio of these isomers varies, but it is, on the average, 1 : 1. Since acids **7** and **8** are poorly soluble in most organic solvents, we did not attempt to separate the diastereomeric mixtures.

Intramolecular cyclization of acids **7** and **8** to isoindolo[2,1-*a*]quinolinecarboxylic acids **9**, **10**, and **11—14** was carried out using phosphoric acid in a temperature range of 120—155 °C (Schemes 3 and 4). 2-Methallyl-

Table 5. Chemical shifts (δ) of protons in the ^{1}H NMR spectra of solutions of epoxyisoindolones **7a—c**, **8a—c**, and **17a,b** in DMSO-d_6 (400 MHz)



8a—c

Compound	Isomer[a]	δ											
		2	5	6	7	8	9	1′*cis*	1′*trans*	R^1	3′a	3′b	COOH	Ar
7a	maj	4.73—4.79 (m)	3.21 (d)	2.56 (d)	4.86 (br.s)	6.36 (dd)	6.53 (d)	4.73—4.79 (m)		1.71 (s, Me)	2.18—2.40 (m)		12.19 (br.s)	2.31 (s, Me(3″)); 7.01—7.07 (m, 3 H_{Ar}); 7.40 (br.s, H(2″))
	min	5.00—5.07 (m)	2.94 (d)	2.55 (d)	4.86 (br.s)	6.47 (dd)	6.57 (d)	5.00—5.07 (m)		1.71 (s, Me)	2.18—2.40 (m)		12.19 (br.s)	2.30 (s, Me(3″)); 7.24—7.33 (m, 3 H_{Ar}); 7.40 (br.s, H(2″))
7b	maj	5.03 (t)	2.94 (d)	2.57 (d)	5.07 (d)	6.37 (dd)	6.52 (d)	4.76 and 4.87 (br.s)		1.72 (s, Me)	2.33 (d)		12.18 (br.s)	3.75 (s, OMe(3″)); 6.75 (ddd, H(4″)); 6.82 (ddd, H(6″)); 6.85 (br.s, H(2″)); 7.29 (t, H(5″)
	min	4.79 (t)	3.22 (d)	2.56 (d)	5.01 (d)	6.48 (dd)	6.58 (d)	4.79 and 4.87 (br.s)		1.73 (s, Me)	2.42—2.56 (m)		12.18 (br.s)	3.74 (s, OMe(3″)); 6.75 (ddd, H(4″)); 7.09 (ddd, H(6″)); 7.23 (t, H(2″)); 7.33 (t, H(5″))
7c	maj	4.86 (dd)	3.26 (d)	2.57 (br.d)	5.08 (br.s)	6.58 (dd)	6.48 (d)	4.84 and 4.86 (br.s)		1.72 (s, Me)	2.42 (m)		12.23 (br.s)	7.21—7.48 (m, 3 H_{Ar}); 7.80 (br.s, H(2″))
	min	5.09 (dd)	2.97 (d)	2.59 (br.d)	5.01 (br.s)	6.53 (dd)	6.37 (d)	4.77 and 4.79 (br.s)		1.72 (s, Me)	2.22 (m)		12.23 (br.s)	7.21—7.48 (m, 3 H_{Ar}); 7.80 (br.s, H(2″))
8a[b]	maj	4.66 (dd)	3.04 (d)	2.58 (d)	5.02 (d)	6.52 (dd)	6.73 (d)	5.13 (m)	5.15 (m)	5.77 (m, H)	2.55—2.65 (m)		[c]	2.32 (s, Me(3″)); 6.95—7.15 and 7.22—7.45 (m, 4 H_{Ar}); 2.32 (s, Me(3″)); 6.95—7.15 and 7.22—7.45 (m, 4 H_{Ar})
	min	4.81 (dd)	2.95 (d)	2.59 (d)	5.09 (d)	6.42 (dd)	6.56 (d)	5.00—5.10 (m)		5.77 (m, H)	2.55—2.65 (m)		[c]	
8b[b]	maj	4.71 (dd)	3.06 (d)	2.58 (d)	5.02 (d)	6.52 (dd)	6.73 (d)	5.12 and 5.14 (m)		5.79 (m, H)	2.22—2.45 and 2.56—2.64 (m)		[c]	3.76 (s, OMe(3″)); 6.70—6.90, 7.10 and 7.20—7.35 (m, 4 H_{Ar})
	min	4.83 (dd)	2.96 (d)	2.59 (d)	5.10 (d)	6.42 (dd)	6.55 (d)	4.98—5.03 and 5.09—5.11 (m)		5.79 (m, H)	2.22—2.45 and 2.56—2.64 (m)		[c]	3.76 (s, OMe(3″)); 6.70—6.90, 7.10 and 7.20—7.35 (m, 4 H_{Ar})
8c	maj	4.81 (dd)	3.09 (d)	2.58 (d)	5.01 (d)	6.52 (dd)	6.74 (d)	5.11 (br.d)	5.11 (br.d)	5.81 (ddt, H)	2.62 (m)		12.28 (br.s)	7.22 (ddd, H(6″)); 7.41 (t, H(5″)); 7.49 (ddd, H(4″)); 7.82 (t, H(2″))
	min	4.89 (dd)	2.99 (d)	2.57 (d)	5.08 (d)	6.41 (dd)	6.53 (d)	5.01 (br.d)	5.04 (br.d)	5.73 (ddt, H)	2.36 (m)	2.20 (ddd)	12.28 (br.s)	7.22 (ddd, H(6″)); 7.41 (t, H(5″)); 7.49 (ddd, H(4″)); 7.82 (t, H(2″))
17a	maj	5.10 (dd)	3.02 (d)	2.63 (d)	5.18 (d)	6.40 (dd)	6.61 (d)	4.53 and 4.63 (m)		1.59 (s, Me)	1.81 (dd)	2.21 (dd)	[c]	7.40—7.60 (m, 4 H_{Ar}); 7.89—8.03 (m, 3 H_{Ar})
	min	5.02 (dd)	3.27 (d)	2.60 (d)	5.11 (d)	6.50 (dd)	6.61 (d)	4.51 and 4.56 (m)		1.49 (s, Me)	2.33 (m)	2.75 (dd)	[c]	7.40—7.60 (m, 4 H_{Ar}); 7.89—8.03 (m, 3 H_{Ar})
17b	maj	4.90 (dd)	3.04 (d)	2.63 (d)	5.20 (d)	6.45 (dd)	6.63 (d)	4.87 (m)	4.86 (m)	5.60 (m, H)	1.91 and 2.22 (m)		[c]	7.42 (dt, 1 H, H(7″)); 7.50—7.55 (m, 3 H_{Ar}); 7.58 (t, 1 H, H(3″)); 7.92—7.97 (m, 2 H, H_{Ar})
	min	4.76 (m)	2.61 (d)	3.04 (d)	5.12 (d)	6.55 (dd)	6.62 (d)	4.86—4.90 (m)		5.57 (m, H)	Overlapping		[c]	7.42 (m, 1 H, H_{Ar}); 7.50—7.58 (m, 4 H_{Ar}); 7.92—7.97 (m, 2 H, H_{Ar})

[a] The data for the major (maj) and minor (min) isomers are given.

[b] The spectra were recorded on an instrument operating at 200 MHz.

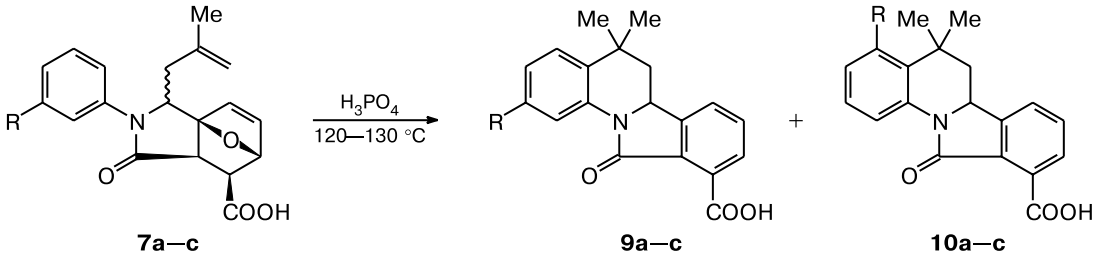
[c] The signals for the protons of the COOH group are absent in the spectrum due to exchange with the residual protons of DMSO-d_6.

Table 6. Spin-spin coupling constants (*J*) of protons in the ^{1}H NMR spectra of epoxyisoindolones **7a—c**, **8a—c**, and **17a,b**

Compound	*J*/Hz														
	2, 3′a	2, 3′b	5, 6	7, 8	8, 9	1′$_{cis}$, 2′	1′$_{trans}$, 2′	2′, 3′a	2′, 3′b	3′, 3′	2″, 4″	2″, 6″	4″, 5″	4″, 6″	5″, 6″
7a	*	*	9.1	1.3	5.6	—	—	—	—	*	*	*	*	*	*
	*	*	9.1	1.5	5.7	—	—	—	—	*	*	*	*	*	*
7b	7.3	7.3	9.1	1.7	5.7	—	—	—	—	*	2.5	2.5	8.3	0.8	8.3
	*	*	9.1	1.7	5.8	—	—	—	—	*	2.0	2.0	8.1	0.7	8.1
7c	*	*	9.2	0.8	5.7	—	—	—	—	16.0	*	*	*	*	*
	*	*	9.2	0.6	5.5	—	—	—	—	*	*	*	*	*	*
8a	4.3	6.4	9.2	1.8	6.1	10.1	18.0	*	*	*	*	*	*	*	*
	4.6	10.1	9.2	1.8	5.8	10.1	18.0	*	*	*	*	*	*	*	*
8b	4.0	6.4	9.2	1.8	5.8	10.2	17.6	7.1	*	*	*	*	*	*	*
	4.3	10.1	9.2	1.8	5.8	10.1	17.6	7.1	*	*	*	*	*	*	*
8c	3.6	6.4	9.1	1.6	5.8	10.6	17.3	7.0	7.0	15.0	1.9	1.9	8.1	1.0	8.1
	4.0	10.6	9.1	1.7	5.7	10.1	17.2	7.0	7.0	*	2.0	2.0	8.1	0.9	8.1
17a	3.9	10.5	9.1	1.7	5.7	—	—	—	—	13.5			*		
	4.7	10.1	9.3	1.6	5.8	—	—	—	—	15.5			*		
17b	4.5	10.6	9.2	1.7	5.7	10.8	16.5	6.6	6.6	*	$J_{7'',6''} = J_{7'',8''} = 8.5$; $J_{7'',5''} = 1.3$; $J_{3'',2''} = J_{3'',4''} = 8.5$				
	5.0	10.0	9.1	1.7	5.8	~9.8	~16.8	*	*	*			*		

* The coupling constants were not determined because of overlapping of the signals.

Scheme 3



9, 10	R	Ratio of isomers		Total yield (%)
		9	**10**	
a	Me	2	1	52
b	OMe	4.5	1	57
c	Cl	1	1.6	63

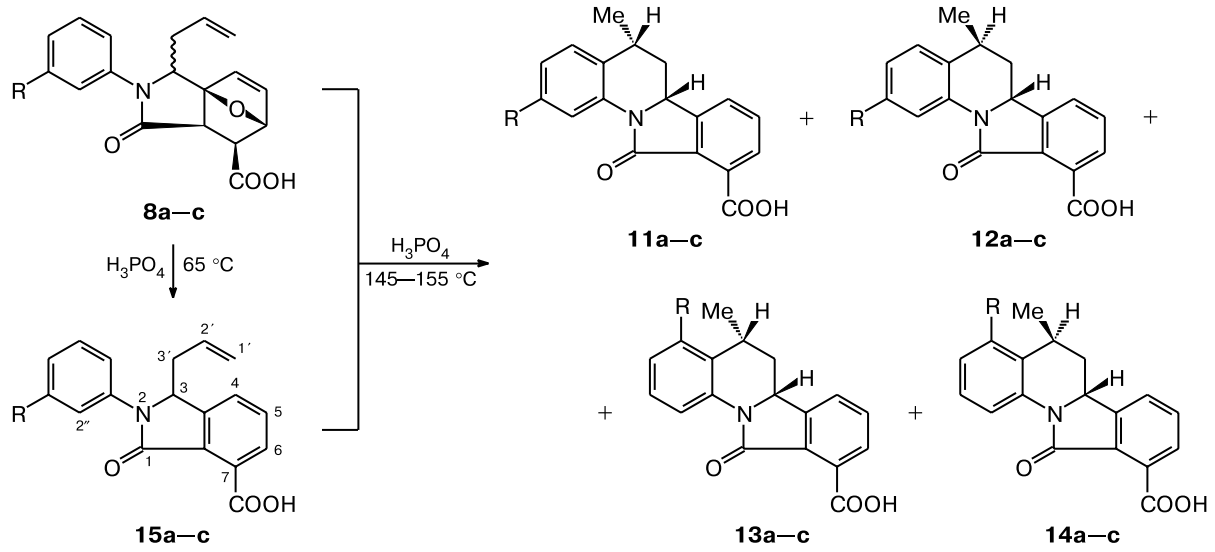
substituted adducts **7a—c** (see Scheme 3) were subjected to cyclization at lower temperature (120—130 °C) than their allyl-substituted analogs **8a—c** (145—155 °C, see Scheme 4). This is associated with a greater ease of formation and higher stability of the tertiary carbocation generated upon protonation of the methallyl fragment compared to the secondary carbocation generated from the allylic fragment.

Electrophilic cyclization of the olefinic fragment in methallyl-containing tricyclic compounds **7** (see Scheme 3) occurs at both *ortho* positions of the *N*-aryl fragment. After recrystallization, the total yield of cyclization products **9** and **10** was 52—63%. The nature of the *meta* substituents has no effect on the yield of the cyclization products. The compositions of isomeric mixtures were determined by ^{1}H NMR spectroscopy from the intensities of the signals of the 5-Me groups (Tables 7 and 8).

The reactions of *meta*-Me- and *meta*-OMe-substituted epoxyisoindolones **7a,b** afforded mixtures of regioisomers, with 2-substituted regioisomer **9a,b** predominating, whereas the reaction of *meta*-Cl-substituted derivative **7c** gave predominantly 4-substituted isomer **10c** (see Scheme 3).

The ^{1}H NMR spectra of the mixtures of regioisomers **9** and **10** (see Tables 7 and 8) show double sets of signals, which are easily identifiable in a low-field regions. The assignment of the signals of the protons to particular iso-

Scheme 4



11—14	R	Ratio of isomers				Total yield (%)
		11	**12**	**13**	**14**	
a	Me	35	11	5	1	41
b	OMe	18	7	2.5	1	40
c	Cl	1.3	1	1	0	44

mers was made based on the multiplicities and coupling constants of the aromatic protons in the quinoline moiety of the molecule. For example, the H(1) proton in the spectra of 2-R-substituted isomers **9** appears as a lowest-field doublet at δ 7.86—8.33 ($J_{1,3}$ = 2.1—2.6 Hz), whereas the H(4) proton appears as a doublet at δ 7.44—7.60 ($J_{4,3}$ = 8.6—8.8 Hz). The spectra of 4-R-substituted compounds **10** contain the signal for the H(1) proton as a doublet at δ 8.08—8.33 ($J_{1,2}$ = 7.9—8.2 Hz) and the signal for the H(2) proton as a triplet at δ 7.21—7.35 ($J_{2,1}$ = $J_{2,3}$ = 7.9—8.2 Hz).

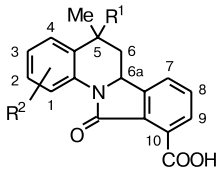
As mentioned above, cyclization of allyl-containing tricyclic compounds **8** occurs under more drastic conditions compared to cylclization of their methallyl analogs (>150 °C), resulting in a decrease in the yield of isoindoloquinolines to ~40% (see Scheme 4, Table 4).

Theoretically, the intramolecular electrophilic substitution in 2-allylisoindolones **8** can afford four products **11—14** (see Scheme 4). This is associated with the fact that all 2-R- and 4-R-substituted isoindoloquinolines can exist as two geometric isomers with the *cis*- or *trans*-oriented H(5) and H(6a) protons.

It was experimentally demonstrated that the cyclization products of isoindolones **8** (see Scheme 4) contained 2-substituted isoindolo[2,1-*a*]quinolinecarboxylic acids **11** and **12** as the major isomers. All four theoretically possible isomers **11a,b—14a,b** generated from compounds **8a** and **8b**, respectively, were isolated, whereas only three isomers, **11c**, **12c**, and **13c**, derived from **8c** were isolated. The isomer ratios **11** : **12** : **13** : **14** are given in Scheme 4. All diastereomeric pairs contained predominantly the geometric isomers with the pseudoequatorial orientation of the Me group at position 5 (**11** and **13**). Its orientation was established from the spin-spin coupling constants of the H(5) proton. The following coupling constants were found in the spectra of isomers **11** and **13** with the pseudoaxial arrangement of the H(5) proton: $J_{5_{ax},6_{ax}}$ = 10.8—12.2 Hz and $J_{5_{ax},6_{eq}}$ = 5.2—5.8 Hz. In the spectra of isomers **12** and **14** with the pseudoequatorial arrangement of H(5), these coupling constants are less different from one another: $J_{5_{eq},6_{ax}}$ = 8.9—10.0 Hz and $J_{5_{eq},6_{eq}}$ = 6.2—8.3 Hz.

Investigation of allyl-substituted epoxyisoindolocarboxylic acids **8** demonstrated (see Scheme 4) that the electrophilic substitution is preceded by dehydration of the oxabicycloheptene fragment accompanied by its aromatization. Treatment of these derivatives with phosphoric acid at moderate temperature (65 °C) afforded 1-oxoisoindoline-7-carboxylic acids **15** in 63—75% yields. Compounds **15** were isolated in the individual state and characterized (Tables 4, 9, and 10). Treatment of isoindolinones **15** with phosphoric acid at 145—155 °C produced isoindoloquinolines **11—14** in 70—80% yields with an isomeric composition approximately equal to that obtained upon cyclization of the corresponding epoxyisoindolones **8**. The one- and two-step meth-

Table 7. Chemical shifts (δ) of protons in the ^{1}H NMR spectra of solutions of isoindolo[2,1-*a*]quinolinecarboxylic acids **9a—c**, **10a—c**, **11a—c**, and **12a,b** in $CDCl_3$ (400 MHz)[a]



9—14

Compound	δ													
	1	2	3	4	R^1	Me(5)	6_{ax}	6_{eq}	6a	7	8	9	R^2	COOH
9a	8.10 (br.s)	—	7.05 (br.d)	7.44 (d)	1.43 (s, Me)	1.35 (s)	1.56 (t)	2.48 (br.d)	5.13 (br.d)	8.03 (m)	7.85 (t)	8.07 (m)	2.32 (s, Me)	[b]
10a	8.16 (d)	7.21 (t)	7.05 (d)	—	1.46 (s, Me)	1.57 (s)	[c]		5.13 (br.d)	8.03 (m)	7.85 (m)	8.07 (m)	2.55 (s, Me)	[b]
9b	7.88 (d)	—	6.83 (dd)	7.46 (d)	1.42 (s, Me)	1.34 (s)	1.55 (t)	2.47 (dd)	5.14 (dd)	7.99 (d)	7.85 (t)	8.06 (d)	3.77 (s, OMe)	[b]
10b	8.08 (d)	7.30 (t)	6.93 (br.d)	—	1.44 (s, Me)	1.53 (s)	1.55 (t)	2.43 (dd)	5.08 (dd)	7.93 (d)	7.85 (t)	7.99 (d)	3.85 (s, OMe)	[b]
9c$_{min}$	8.33 (dd)	—	7.28 (dd)	7.60 (d)	1.44 (s, Me)	1.36 (s)	1.58 (t)	2.51 (dd)	5.15 (dd)	8.00 (m)	7.84 (t)	7.99 (m)	—	[b]
10c$_{maj}$	8.32 (d)	7.35 (t)	7.31 (dd)	—	1.58 (s, Me)	1.67 (s)	1.64 (t)	2.51 (dd)	5.13 (dd)	8.00 (m)	7.85 (t)	8.00 (m)	—	[b]
11a[d]	8.22 (d)	—	7.06 (dd)	7.32 (d)	3.28 (tq, H)	1.44 (d)	1.48 (ddd)	2.72 (ddd)	4.86 (dd)	7.70—7.80 (m)		8.46 (dd)	2.39 (s, Me)	15.8 (br.s)
12a[d]	8.22 (d)	—	7.09 (br.d)	7.32 (d)	3.44 (m, H)	1.27 (d)	1.61 (ddd)	2.98 (ddd)	4.76 (dd)	7.70—7.80 (m)		8.44 (dd)	2.42 (s, Me)	15.8 (br.s)
11b[d]	8.00 (d)	—	6.78 (dd)	7.32 (d)	3.26 (tq, H)	1.43 (d)	1.48 (dt)	2.71 (ddd)	4.88 (dd)	7.70—7.80 (m)		8.45 (dd)	3.83 (s, OMe)	15.73 (br.s)
12b[d]	8.00 (d)	—	6.78 (dd)	7.26 (d)	3.40 (ddq, H)	1.37 (d)	1.43 (dt)	2.88 (ddd)	4.74 (dd)	7.88 (d)	7.80 (t)	8.45 (dd)	3.88 (s, OMe)	15.67 (br.s)
11c	8.34 (d)	—	7.24 (dd)	7.50 (br.d)	3.22 (m, H)	1.35 (d)	1.32 (m)	2.77 (ddd)	5.07 (dd)	7.96 (d)	7.84 (t)	8.00 (br.d)	—	[b]

[a] The signals for the protons of minor isomers **12c**, **13a—c**, and **14a—c** overlap with the signals of the corresponding major isomers; the structures of compounds **9a—c**, **10a—c**, **11a—c**, and **12a,b** were established by 2D homonuclear ^{1}H—^{1}H correlation NMR spectroscopy.

[b] The signals for the protons of the COOH group in the NMR spectrum are absent because of exchange with the residual protons of DMSO-d_6.

[c] The signals for these protons overlap with the signals of the major isomer.

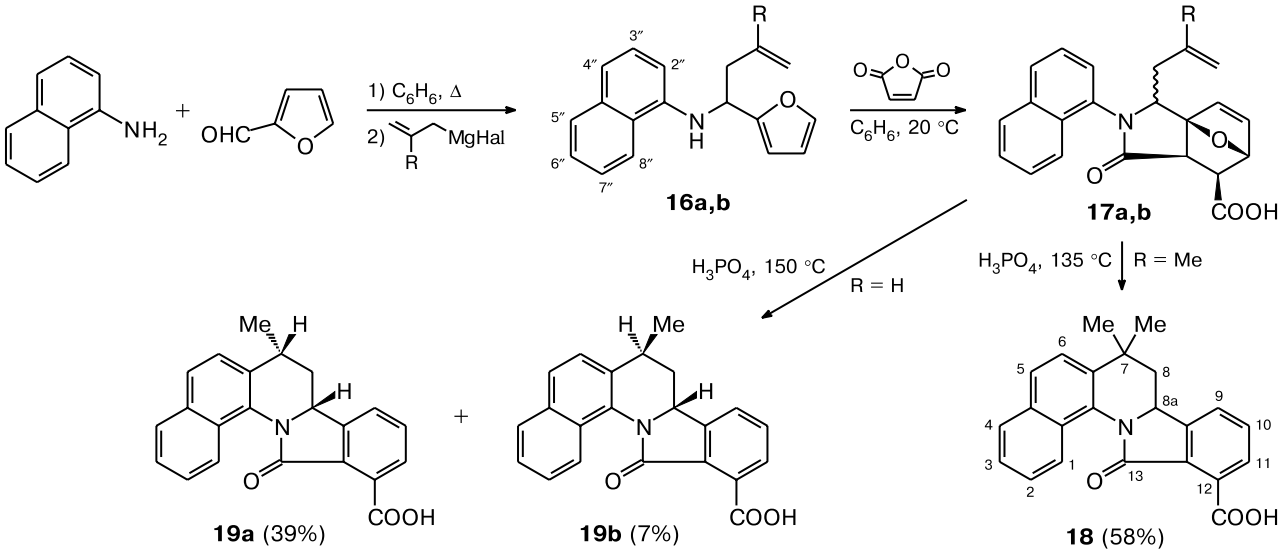
[d] In DMSO-d_6.

Table 8. Spin-spin coupling constants (J) of protons in the ^{1}H NMR spectra of isoindolo[2,1-*a*]quinolinecarboxylic acids **9a—c**, **10a—c**, **11a—c**, and **12a,b**

Compound	J/Hz									
	5, 6_{ax}	5, 6_{eq}	5, Me	6a, 6_{ax}	6a, 6_{eq}	6_{ax}, 6_{eq}	7, 8	7, 9	8, 9	Other protons
9a	—	—	—	12.8	*	12.8	7.7	*	7.7	$J_{3,4}$ = 7.9
10a	—	—	—	~12.8		*	*	*	*	$J_{1,2} = J_{2,3}$ = 8.0
9b	—	—	—	12.8	2.3	12.8	7.7	*	7.7	$J_{1,3}$ = 2.6; $J_{3,4}$ = 8.8
10b	—	—	—	13.2	2.6	13.2	7.7	*	7.7	$J_{1,2} = J_{2,3}$ = 8.2
9c	—	—	—	12.6	2.8	12.6	8.4	*	8.4	$J_{1,3}$ = 2.1; $J_{3,4}$ = 8.6
10c	—	—	—	12.6	2.1	12.6	8.4	*	8.4	$J_{1,2} = J_{2,3}$ = 7.9, $J_{1,3}$ = 1.7
11a	10.8	5.8	7.0	12.4	2.7	13.2	*	1.7	7.0	$J_{1,3}$ = 1.0; $J_{3,4}$ = 8.0
12a	8.9	8.3	7.0	12.1	4.3	13.5	*	1.7	7.0	$J_{1,3}$ = 1.0; $J_{3,4}$ = 8.0
11b	12.0	5.7	6.4	12.4	2.4	13.1	*	1.5	7.2	$J_{1,3}$ = 2.5; $J_{3,4}$ = 8.6
12b	10.0	7.8	6.8	12.7	3.0	13.4	*	1.5	7.2	$J_{1,3}$ = 2.5; $J_{3,4}$ = 8.0
11c	12.2	5.2	6.8	12.0	2.4	12.7	7.5	*	7.5	$J_{1,3}$ = 2.3; $J_{3,4}$ = 8.5

* The coupling constants were not determined because of overlapping of the signals for the corresponding protons.

Scheme 5



16, 17: R = H (**a**), Me (**b**)

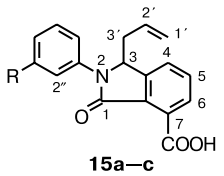
ods afforded acids **11—14** in approximately equal total yields.

The structures of compounds **9—14** were confirmed by IR spectroscopy and mass spectrometry. The mass spectra of isoindoloquinolines **9—14** have molecular ion peaks corresponding to the molecular formula and the peak $[M - 44]^+$ corresponding to elimination of the CO_2 molecule (Table 11). The IR spectra show stretching bands of both the amide (1607—1665 cm^{-1}) and carboxylic (1706—1728 cm^{-1}) groups.

We also studied the regioselectivity of cyclization (Scheme 5) of 3-methallyl- and 3-allyl-2-(α-naphthyl)epoxyisoindole-6-carboxylic acids **17a,b**. The latter were synthesized through amines **16a,b** analogously to compounds **7** and **8**.

Theoretically, cyclization of the methallyl (allyl) substituent in acids **17a,b** can occur both at the β and *peri* positions of the *N*-α-naphthyl fragment. The transformation of tricyclic compound **17a** (R = Me) with phosphoric acid occurs regioselectively. Only the cyclization product of the methallyl fragment at the β position of the naphthyl fragment, *viz.*, benzo[*h*]annelated 12-carboxy-13-oxoisoindolo[2,1-*a*]tetrahydroquinoline **18**, was isolated in moderate yield (58%). Cyclization of allyl-substituted tricyclic compound **17b** also occurs regioselectively at the β position of the *N*-α-naphthyl fragment. As ex-

Table 9. Chemical shifts (δ) of protons in the ^{1}H NMR spectra of 1-oxoisoindoline-7-carboxylic acids **15a—c** (400 MHz)



15a—c

Compound	δ													
	3	4	5	6	1′$_{cis}$	1′$_{trans}$	2′	3′a	3′b	2″	R	4″	5″	6″
15a[a]	5.38 (dd)	7.75—7.80 (m)		8.42 (m)	4.99 (br.d)	4.86 (br.d)	5.25 (m)	2.79 (br.dd)	2.59 (m)	7.33 (br.s)	2.43 (s, Me)	7.28 (d)	7.39 (t)	7.19 (br.d)
15b[a]	5.36 (dd)	7.77 (d)	7.81 (t)	8.47 (dd)	5.01 (br.d)	4.88 (br.d)	5.28 (m)	2.63 (ddd)	2.82 (m)	7.11 (t)	3.86 (s, OMe)	6.93 (ddd)	7.43 (t)	7.06 (ddd)
15c[b]	5.81 (dd)	7.99 (d)	7.85 (t)	8.04 (br.d)	4.87 (dd)	4.76 (dd)	5.21 ddt	2.86 (ddd)	2.57 (m)	7.81 (t)	—	7.62 (ddd)	7.55 (t)	7.42 (ddd)

[a] In $CDCl_3$.
[b] In DMSO-d_6.

Table 10. Spin-spin coupling constants (J) of protons in the ^{1}H NMR spectra of 1-oxoisoindoline-7-carboxylic acids **15a—c**

Compound	J/Hz														
	3, 3′a	3, 3′b	4, 5	5, 6	1′$_{cis}$, 1′$_{trans}$	1′$_{cis}$, 2′	1′$_{trans}$, 2′	2′, 3′a	2′, 3′b	3′a, 3′b	2″, 4″	2″, 6″	4″, 5″	4″, 6″	5″, 6″
15a	3.6	5.9	*	*	—	10.1	16.8	6.4	6.4	14.3	—	—	7.7	—	7.7
15b	5.7	3.3	7.0	7.0	1.2	9.3	16.6	7.7	*	14.2	2.1	2.1	7.7	0.8	7.7
15c	3.5	5.1	7.7	7.7	2.0	10.0	17.0	7.1	7.1	14.9	2.0	2.0	7.9	1.0	7.9

* The coupling constants were not determined because of overlapping of the signals.

Table 11. Results of mass spectrometry (EI, 70 eV) of compounds **7—15** and **17—19**

Compound	m/z (I_{rel} (%))
7a	339 $[M]^+$ (5), 284 (19), 240 (9), 186 (100), 135 (12), 117 (9), 107 (6), 99 (7), 91 (22), 77 (5), 65 (7), 55 (6), 39 (5)
7b	355 $[M]^+$ (12), 337 (5), 322 (9), 300 (16), 176 (12), 161 (10), 134 (35), 117 (19), 99 (20), 91 (26), 77 (31), 65 (12), 55 (26), 39 (21)
7c	359 $[M]^+$ (for ^{35}Cl) (1), 304 (13), 260 (9), 208 (32), 206 (100), 204 (9), 138 (9), 135 (7), 117 (5), 111 (7), 99 (14), 91 (8), 77 (5), 55 (6)
8a	325 $[M]^+$ (6), 284 (8), 240 (8), 226 (9), 186 (100), 145 (5), 121 (13), 99 (8), 91 (27), 77 (10), 65 (7)
8b	341 $[M]^+$ (6), 300 (6), 256 (6), 242 (9), 202 (100), 186 (12), 176 (9), 158 (7), 134 (11), 121 (19), 99 (10), 91 (18), 77 (21), 65 (8), 55 (6)
8c	345 $[M]^+$ (for ^{35}Cl) (2), 304 (5), 246 (10), 206 (100), 138 (9), 121 (6), 111 (11), 99 (13), 91 (10), 77 (6), 41 (7)
9a, **10a**	321 $[M]^+$ (96), 306 (100), 297 (5), 288 (33), 278 (16), 277 (66), 262 (15), 245 (12), 232 (18), 221 (11), 115 (11), 91 (6), 44 (11), 28 (11)
9b, **10b**	337 $[M]^+$ (61), 322 (100), 304 (22), 293 (26), 278 (8), 261 (12), 248 (10), 233 (6), 205 (7), 139 (12), 115 (6), 91 (12), 77 (16), 63 (8), 51 (9), 41 (19)
9c, **10c**	341 $[M]^+$ (for ^{35}Cl) (69), 326 (67), 308 (25), 297 (100), 284 (6), 282 (21), 280 (7), 266 (7), 252 (11), 241 (5), 238 (6), 232 (6), 217 (11), 204 (5), 178 (6), 141 (11), 115 (11), 108 (10), 89 (6), 75 (5), 44 (16), 36 (7), 28 (11)
11a—14a	307 $[M]^+$ (91), 292 (33), 274 (16), 263 (100), 248 (34), 232 (12), 218 (24), 204 (12), 178 (6), 158 (14), 144 (9), 108 (6), 91 (4), 44 (9), 28 (12)
11b—14b	323 $[M]^+$ (100), 308 (88), 290 (21), 279 (79), 264 (24), 248 (6), 234 (9), 219 (8), 204 (6), 131 (10), 132 (18), 110 (2), 95 (6), 77 (12), 63 (8), 39 (9)
11c—13c	327 $[M]^+$ (for ^{35}Cl) (79), 312 (13), 294 (8), 283 (100), 268 (19), 232 (6), 204 (10), 164 (6) 115 (7), 102 (19), 89 (8), 77 (8)
15a	307 $[M]^+$ (10), 266 (100), 222 (12), 194 (14), 152 (5), 91 (19), 77 (7), 65 (13), 41 (8)
15b	323 $[M]^+$ (18), 282 (100), 238 (14), 195 (5), 178 (5), 167 (13), 141 (6), 107 (5), 92 (12), 77 (13)
15c	327 $[M]^+$ (for ^{35}Cl) (3), 286 (100), 242 (22), 214 (21), 178 (12), 152 (20), 128 (8), 111 (28), 102 (5), 75 (30), 63 (6), 51 (10), 39 (14)
17a	375 $[M]^+$ (11), 320 (14), 276 (7), 241 (15), 222 (100), 204 (9), 192 (21), 181 (5), 167 (20), 154 (22), 140 (18), 127 (63), 115 (35), 105 (10), 99 (68), 91 (39), 77 (26), 65 (23), 55 (54), 45 (21), 39 (43)
17b	361 $[M]^+$ (8), 286 (31), 241 (13), 222 (72), 192 (12), 167 (12), 143 (29), 127 (76), 99 (43), 91 (69), 77 (100), 65 (35), 55 (52), 39 (100)
18	357 $[M]^+$ (100), 342 (62), 324 (24), 313 (21), 298 (12), 282 (5), 268 (14), 254 (6), 194 (6), 165 (7), 152 (5), 133 (5), 126 (5), 44 (9)
19a, **19b**	343 $[M]^+$ (100), 328 (23), 310 (13), 299 (70), 284 (42), 266 (59), 254 (32), 241 (6), 228 (11), 180 (12), 165 (12), 152 (29), 139 (8), 127 (28), 115 (12), 102 (10), 91 (20), 77 (22), 65 (17), 51 (14), 44 (47)

pected, the reaction afforded a mixture of diastereomers **19a** and **19b** in a ratio of 6 : 1 (^{1}H NMR spectroscopic data) in a total yield of 46%. In the major isomer **19a**, the methyl group at position 7 is in the pseudoequatorial orientation, which was established from the spin-spin coupling constants of the H(7) proton ($J_{7_{ax},8_{ax}}$ = 13.1 Hz, $J_{7_{ax},8_{eq}}$ = 6.6 Hz).

The H(8a) proton in benzoannelated isoindoloquinolines **18** and **19** is in the pseudoaxial position ($J_{8a,8_{ax}}$ = 10.8—11.5 Hz, $J_{8a,8_{eq}}$ = 3.5—4.0 Hz) analogously to the H(6a) proton in isoindoloquinolines **9—14**.

To summarize, we found that intramolecular electrophilic cyclization of *N*-(*m*-R-phenyl)-2-allyl(methallyl)-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes under the action of phosphoric acid occurs nonregioselectively to give both 2-R- and 4-R-substituted isoindolo[2,1-*a*]quinolines. Under the same conditions, intramolecular electrophilic cyclization of *N*-(α-naphthyl)-2-allyl(methallyl)-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes occurs regioselectively at the β position of the naphthyl fragment. The nature of the substituents R has virtually no effect on the yields of the reaction products. The H(6a) protons in compounds **9—14** and the H(8a) protons in compounds **18** and **19** are in the pseudoaxial positions (^{1}H NMR spectroscopic data; $J_{6a,6_{ax}}$ = 11.5—13.4 Hz, $J_{6a,6_{eq}}$ = 2.1—3.5 Hz).

Experimental

The reagents were purchased from Acros Organics. The IR spectra were recorded on a UR-20 instrument in KBr pellets for solid compounds and in films for oils. The ^{1}H NMR spectra were measured on Bruker WP-200 (200 MHz) and Bruker WH-400 (400 MHz) spectrometers in 2% $CDCl_3$ or DMSO-d_6 solutions at 30 °C; the residual signals of the protons of the solvents (δ 7.26 for $CDCl_3$ and 2.49 for DMSO-d_6) were used as the internal standard. The electron-impact mass spectra were obtained on a Varian MAT-112 spectrometer with direct inlet of

the sample into the ion source (ionizing voltage was 70 eV). Thin-layer chromatography was carried out on Silufol UV-254 plates (visualization with iodine vapor).

4-(2´-Furyl)-2-methyl-4-*N*-(*m*-methylphenyl)- (4a), 4-(2´-furyl)-2-methyl-4-*N*-(*m*-methoxyphenyl)- (4b), and 4-(2´-furyl)-2-methyl-4-*N*-(*m*-chlorophenyl)aminobut-1-enes (4c); 4-(2´-furyl)-4-*N*-(*m*-methylphenyl)- (5a), 4-(2´-furylphenyl)-4-*N*-(*m*-methoxy)- (5b), and 4-(2´-furyl)-4-*N*-(*m*-chlorophenyl)aminobut-1-enes (5c); 4-(2´-furyl)-2-methyl-4-*N*-(α-naphthyl)aminobut-1-ene (16a) and 4-(2´-furyl)-4-*N*-(α-naphthyl)aminobut-1-ene (16b) (general procedure). Schiff base **6** or 2-(α-naphthyliminomethyl)furan (0.30 mol) was added dropwise at reflux to a stirred solution of allylmagnesium bromide, which was prepared from allyl bromide (39 mL, 0.45 mol) and magnesium turnings (22.0 g, 0.90 mol) in diethyl ether (300 mL) (for amines **5**), or to a solution of methallylmagnesium chloride, which was prepared from methallyl chloride (41 mL, 0.45 mol) and magnesium turnings (22.0 g, 0.90 mol) in a 1 : 1 THF—diethyl ether mixture (300 mL) (for amines **4** and **16**). After the addition of the imine, the reaction mixture was stirred at ~20 °C for 1 h, cooled, and poured into a saturated aqueous NH_4Cl solution (300 mL). Then the mixture was extracted with diethyl ether (3×100 mL). The organic layer was dried over magnesium sulfate and concentrated. The residue was distilled under reduced pressure. Products **4a—c**, **5a—c**, and **16a,b** were obtained as colorless oils. Their physicochemical properties, elemental analysis data, and spectroscopic characteristics are given in Table 1. The ^{1}H NMR spectroscopic data are listed in Tables 2 and 3.

***N*-(*m*-Methylphenyl)- (7a), *N*-(*m*-methoxyphenyl)- (7b) and *N*-(*m*-chlorophenyl)-2-methallyl-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes (7c); *N*-(*m*-methylphenyl)- (8a), *N*-(*m*-methoxyphenyl)- (8b), and *N*-(*m*-chlorophenyl)-2-allyl-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes (8c); *N*-(α-naphthyl)-2-methallyl- (17a) and *N*-(α-naphthyl)-2-allyl-6-carboxy-4-oxo-3-aza-10-oxatricyclo[5.2.1.0^{1,5}]dec-8-enes (17b) (general procedure).** The corresponding amine **4**, **5**, or **16** (0.1 mol) was dissolved in benzene (100 mL). Then an equimolar amount of maleic anhydride (9.8 g, 0.1 mol) was added. The reaction mixture was stirred at ~20 °C for 2—7 days. The crystalline product that formed was filtered off, washed with benzene (2×100 mL) and diethyl ether (2×80 mL), and dried at 100 °C. Products **7**, **8**, and **17** were obtained as white powders. Their physicochemical properties, elemental analysis data, and selected spectroscopic characteristics are given in Table 4. The ^{1}H NMR spectroscopic data are listed in Tables 5 and 6, and the mass spectrometric data are given in Table 11.

2- and 4-Methyl- (9a, 10a), 2- and 4-methylmethoxy- (9b, 10b), and 2- and 4-methylchloro-5,5-dimethyl-5,6,6a,11-tetrahydro-11-oxo-10-carboxyisoindolo[2,1-*a*]quinolines (9c, 10c); 2- and 4-methyl- (11a—14a), 2- and 4-methylmethoxy- (11b—14b), and 2- and 4-methylchloro-5-methyl-5,6,6a,11-tetrahydro-11-oxo-10-carboxyisoindolo[2,1-*a*]quinolines (11c—14c); 7,8,8a,13-tetrahydro-7,7-dimethyl-13-oxobenzo[*h*]isoindolo[2,1-*a*]quinoline-12-carboxylic acid (18); 7,8,8a,13-tetrahydro-7-methyl-13-oxobenzo[*h*]isoindolo[2,1-*a*]quinoline-12-carboxylic acids (19a, 19b) (general procedure). A mixture of thoroughly ground adduct **7**, **8**, or **17** (0.01 mol) and H_3PO_4 (50 mL) was stirred at 120—130 °C (for **7** or **17b**) or 145—155 °C (for **8** or **17a**) for 1—2 h (TLC control). Then the reaction mixture was cooled and poured into water (100 mL). The precipitate was filtered off, washed successively with cold (5×80 mL) and hot (1×100 mL) water and diethyl ether (2×50 mL), dried at 100 °C to a constant weight, and recrystallized from a Pr^{i}OH—DMF mixture. Isoindoloquinolinecarboxylic acids **9—14**, **18**, and **19** were prepared as colorless crystals. Their physicochemical properties, elemental analysis data, and selected spectroscopic characteristics are given in Table 4. The mass spectrometric data are listed in Table 11, and the ^{1}H NMR spectroscopic data for compounds **9**, **10**, and **11—14** are given in Tables 7 and 8.

Compound 18. ^{1}H NMR (DMSO-d_6), δ: 1.41 and 1.44 (both s, 3 H each, 2 Me(7)); 1.63 (dd, 1 H, $H_{ax}(8)$, $J_{8_{ax},8_{eq}}$ = 13.3 Hz, $J_{8_{ax},8a}$ = 11.5 Hz); 2.58 (dd, 1 H, $H_{eq}(8)$, $J_{8_{ax},8_{eq}}$ = 13.3 Hz, $J_{8_{eq},8a}$ = 3.5 Hz); 5.32 (dd, 1 H, H(8*a*), $J_{8_{ax},8a}$ = 11.5 Hz, $J_{8_{eq},8a}$ = 3.5 Hz); 7.51 (m, 2 H, H(5), H(6)); 7.70 (d, 2 H, H(1), H(4), $J_{1,2} = J_{3,4}$ = 8.7 Hz); 7.89 (t, 1 H, H(10), $J_{9,10} = J_{10,11}$ = 7.7 Hz); 7.90 (br.d, 2 H, H(2), H(3), $J_{1,2} = J_{3,4}$ = 8.7 Hz); 8.04 (br.d, 1 H, H(9), $J_{9,10}$ = 7.7 Hz); 8.12 (br.d, 1 H, H(11), $J_{10,11}$ = 7.7 Hz); 9.88 (br.s, 1 H, COOH). **Major isomer 19a$_{maj}$.** ^{1}H NMR (DMSO-d_6), δ: 1.36 (d, 3 H, Me(7), $J_{Me(7),7}$ = 6.9 Hz); 1.45 (dt, 1 H, $H_{ax}(8)$, $J_{8_{ax},8_{eq}} = J_{8_{ax},7_{ax}}$ = 13.2 Hz, $J_{8_{ax},8a}$ = 10.9 Hz); 2.88 (ddd, 1 H, $H_{eq}(8)$, $J_{8_{ax},8_{eq}}$ = 13.2 Hz, $J_{8_{eq},8a}$ = 4.0 Hz, $J_{8_{eq},7_{ax}}$ = 6.6 Hz); 3.35 (m, 1 H, $H_{ax}(7)$, $J_{8_{ax},7_{ax}}$ = 13.2 Hz, $J_{8_{eq},7_{ax}}$ = 6.6 Hz, $J_{Me(7),7}$ = 6.9 Hz); 5.25 (dd, 1 H, H(8a), $J_{8_{ax},8a}$ = 10.9 Hz, $J_{8_{eq},8a}$ = 4.0 Hz); 7.50—7.53 (m, 2 H, H(5), H(6)); 7.64 (d, 2 H, H(1), H(4), $J_{1,2} = J_{3,4}$ = 8.5 Hz); 7.89 (t, 1 H, H(10), $J_{9,10} = J_{10,11}$ = 7.5 Hz); 7.90 (br.d, 2 H, H(2), H(3), $J_{1,2} = J_{3,4}$ = 8.5 Hz); 8.02 (d, 1 H, H(9), $J_{9,10}$ = 7.5 Hz); 8.12 (d, 1 H, H(11), $J_{10,11}$ = 7.5 Hz); 9.75 (br.s, 1 H, COOH). **Minor isomer 19b$_{min}$.** ^{1}H NMR (DMSO-d_6), δ: 1.03 (d, 3 H, Me(7), $J_{Me(7),7}$ = 6.1 Hz); 3.35 (m, 1 H, $H_{eq}(7)$); 5.29 (dd, 1 H, H(8a), $J_{8_{ax},8a}$ = 9.7 Hz, $J_{8_{eq},8a}$ = 4.2 Hz). The signals for other protons of the minor isomer **19b** overlap with the signals for analogous protons of the major isomer **19a$_{maj}$**.

***N*-(*m*-Methylphenyl)- (15a), *N*-(*m*-methoxyphenyl)- (15b), and *N*-(*m*-chlorophenyl)-3-allyl-7-carboxyisoindolin-1-ones (15c) (general procedure).** A mixture of thoroughly ground adduct **8** (0.01 mol) and H_3PO_4 (50 mL) was stirred at 65 °C for 1 h (TLC control). Then the reaction mixture was cooled and poured into water (100 mL). The precipitate was filtered off, washed with cold water (5×80 mL), dried at 100 °C to a constant weight, and recrystallized from a Pr^{i}OH—DMF mixture. Carboxyisoindolinones **15a—c** were obtained as colorless crystals. Their physicochemical properties, elemental analysis data, and selected spectroscopic characteristics are given in Table 4. The mass spectrometric data are listed in Table 11, and the ^{1}H NMR spectroscopic data are given in Tables 9 and 10.

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