

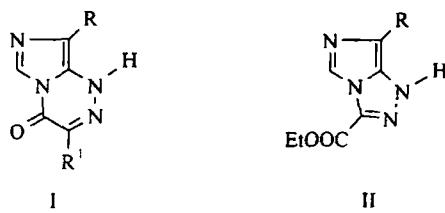
SYNTHESIS OF 1,4-DIHYDROIMIDAZO[5,1-*c*]-1,2,4-TRIAZIN-4-ONES AND IMIDAZO[5,1-*c*]-1,2,4-TRIAZOLES

M. A. Bezmaternykh, V. S. Mokrushin, and T. A. Pospelova

*Azo compounds obtained by the coupling of 5-diazoimidazoles with diethyl esters of nitro-, chloro-, bromo-, and acetylaminomalonic acids under conditions of base catalysis are cyclized to give 1,4-dihydroimidazo[5,1-*c*]-1,2,4-triazin-4-ones or imidazo[5,1-*c*]-1,2,4-triazoles. The chloro, bromo, and nitro groups in the bicyclic products are readily replaced by action of nucleophiles. The imidazotriazinones are converted to chloroimidazotriazines by reaction with thionyl chloride or phosphorus oxychloride*

Hydrazones are obtained by coupling of diazoazoles with derivatives of ethyl cyanoacetate, diethyl malonate, ethyl acetoacetate, and acetylacetone. The obtained hydrazones depending on the reaction conditions, are cyclized to give azolo[5,1-*c*]-1,2,4-triazines or azolo[5,1-*c*]-1,2,4-triazoles. These reactions have been extensively studied for derivatives of pyrazole, 1,2,3-triazole, and 1,2,4-triazole [1-3]. In continuation of our work [4] on the study of imidazotriazines and their properties, the synthesis of bicyclic products containing nitro, chloro, bromo, mercapto, hydrazino, and acetyl amino groups in the triazine ring seems to be of interest.

The aim of the present work was the synthesis new derivatives of imidazo[5,1-*c*]-1,2,4-triazin-4(H)-one (I) and ethyl ester of imidazo[5,1-*c*]-1,2,4-triazole-3-carboxylic acid (II) as potential biologically active compounds.

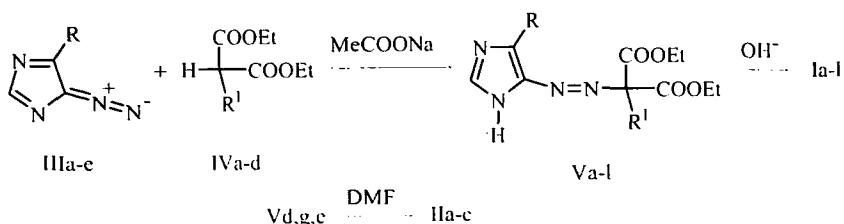


I a,b R = CONH₂, a R' = NO₂, b R' = Cl, c,d R = CONHMe, c R' = NO₂, d R' = Cl,
e-h R = COOEt, e R' = NO₂, f R' = Cl, g R' = Br, h R' = NHCOMe, i-k R = NO₂, i R' = Cl,
j R' = Br, k R' = NHCOMe, l R = COOH, R' = NO₂, II a R = CONHMe, b R = COOEt, c R = NO₂

In order to synthesize these compounds using the procedures reported earlier [6-14], we prepared the known substituted 5-diazoimidazoles IIIa-e. The azo coupling of the compounds IIIa-e with malonic acid derivatives Iva-d was carried out under conditions described in our previous work [4]. The azo compounds obtained cyclize in 1% ethanolic KOH to give imidazotriazinones Ia-l. The cyclization of the compound VI involved hydrolysis of the carboxazide group carboxyimidazotriazinone II.

Pyrazolylazomalonate halides are converted into pyrazolotriazoles upon heating at reflux in benzene in the presence of triethylamine [5]. The cyclization of azo compounds Vd,g,j is not observed under analogous conditions. The synthesis of imidazotriazoles IIa-c was realized although in low yields upon the prolonged heating of azohalomalonates Vd,g,j in dimethylformamide with triethylamine. Nitro derivatives V could not be converted into imidazotriazoles II under the same conditions.

Urals State Technical University—UPI, 620002 Yekaterinburg, Russia; e-mail: mokr@htf.ustu.ru. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 11, pp. 1544-1553, November, 1999. Original article submitted July 24, 1998, submitted after revision February 14, 1999.



III a R = CONH₂, b R = CONHMe, c R = COOEt, d R = NO₂, e R = CON₃;

IV a R' = NO₂, b R' = Cl, c R' = Br, d R' = NHCOMe;

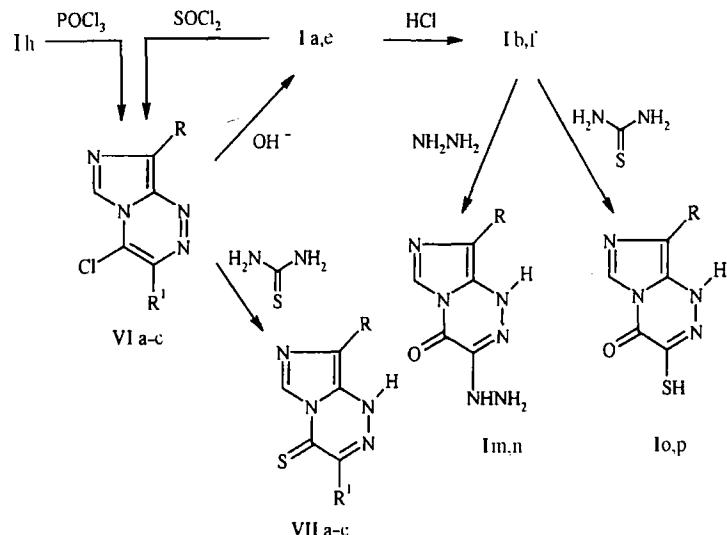
V a,b R = CONH₂, a R' = NO₂, b R' = Cl, c,d R = CONHMe, c R' = NO₂, d R' = Cl, e-h R = COOEt, e R' = NO₂, f R' = Cl, g R' = Br, h R' = NHCOMe, i-k R = NO₂, i R' = Cl, j R' = Br, k R' = NHCOMe, l R = CON₃, R' = NO₂

TABLE I. Characteristics of Compounds Synthesized

Com- ound	Empirical formula	Found, %				R _f (CHCl ₃ -EtOH)	mp, °C	Yield, %
		C	H	N	S/Cl/Br			
1	2	3	4	5	6	7	8	9
Ia	C ₆ H ₄ N ₆ O ₄	32.7 32.1	1.7 1.8	37.9 37.5		0.35	280-281	60
Ib	C ₆ H ₄ CIN ₅ O ₂	34.2 33.7	1.8 1.9	32.7 32.8	16.5 16.6	0.23	255-257	70
Ic	C ₇ H ₆ N ₆ O ₄	35.4 35.3	2.7 2.5	35.75 35.3		0.27	298-300	57
Id	C ₇ H ₆ CIN ₅ O ₂	37.1 36.9	2.5 2.6	30.9 30.8	15.65 15.6	0.34	254-256	68
Ie	C ₈ H ₇ N ₅ O ₃	38.0 37.95	2.8 2.8	27.8 27.7		0.4	269-271	56
If	C ₈ H ₇ CIN ₅ O ₃	39.7 39.6	3.0 2.9	23.3 23.1	14.7 14.6	0.46	259-262	72
Ig	C ₈ H ₇ BrN ₅ O ₃	33.8 33.45	2.5 2.4	20.0 19.5	28.0 27.9	0.3	295-298	75
Ih	C ₁₀ H ₁₁ N ₅ O ₄	45.5 45.3	4.1 4.15	26.7 26.4		0.17	279-281	65
Ii	C ₅ H ₂ CIN ₅ O ₃	27.9 27.8	1.2 0.9	32.7 32.5	16.7 16.5	0.25	276-277	67
Ij	C ₅ H ₂ BrN ₅ O ₃	23.5 23.1	0.85 0.8	27.2 26.9	31.2 30.8	0.43	254-255	65
Ik	C ₇ H ₆ N ₆ O ₄	35.5 35.3	2.6 2.5	35.7 35.3		0.37	186-189	58
Il	C ₆ H ₅ N ₅ O ₅	32.5 32.0	1.4 1.3	31.5 31.1		0.23	197-199	60
Im	C ₆ H ₅ N ₅ O ₂	34.6 34.45	3.5 3.4	47.2 46.9		0.67	268-270	77
In	C ₈ H ₁₀ N ₆ O ₃	40.7 40.34	4.1 4.2	35.9 35.3		0.46	214-216	75
Io	C ₆ H ₅ N ₅ O ₂ S	34.4 34.1	2.5 2.4	33.4 33.2	15.5 15.2	0.34	205-207	52
Ip	C ₈ H ₈ N ₆ O ₃ S	39.6 40.0	3.3 3.3	23.4 23.3	13.4 13.3	0.48	197-199	52
Ila	C ₉ H ₁₁ N ₅ O ₃	45.7 45.6	4.6 4.6	30.0 29.5		0.17	156	42
Ilb	C ₁₀ H ₁₂ N ₄ O ₄	47.9 47.6	4.9 4.8	22.5 22.2		0.2	160	45
Ilc	C ₇ H ₇ N ₅ O ₄	37.5 37.3	3.2 3.1	31.1 31.1		0.19	148	42

TABLE 1. (continued)

1	2	3	4	5	6	7	8	9
Va	C ₁₁ H ₁₄ N ₆ O ₇	38.9 38.6	4.3 4.1	24.9 24.6		0.76	174-177	65
Vb	C ₁₁ H ₁₄ ClN ₆ O ₅	40.0 39.8	4.3 4.2	21.4 21.1	10.7 10.7	0.7	159-161	74
Vb	C ₁₂ H ₁₆ N ₆ O ₇	40.7 40.45	4.5 4.5	23.8 23.6		0.8	158-160	60
Vb	C ₁₂ H ₁₆ ClN ₆ O ₅	42.1 41.7	4.7 4.6	20.5 20.3	10.35 10.3	0.69	164-167	70
Ve	C ₁₃ H ₁₇ N ₅ O ₈	42.5 42.05	4.6 4.6	19.0 18.9		0.67	156-158	64
Vf	C ₁₃ H ₁₇ ClN ₄ O ₆	43.0 43.3	4.6 4.7	16.0 15.5	10.0 9.85	0.87	139-141	74
Vg	C ₁₃ H ₁₇ BrN ₄ O ₆	38.7 38.5	4.4 4.2	13.9 13.8	19.9 19.75	0.67	153-155	80
Vh	C ₁₅ H ₂₁ N ₅ O ₇	47.3 47.0	5.5 5.5	18.5 18.3		0.7	176-178	87
Vi	C ₁₀ H ₁₂ ClN ₅ O ₆	36.4 36.0	3.3 3.6	21.3 20.9	10.7 10.65	0.64	155-157	70
Vj	C ₁₀ H ₁₂ BrN ₅ O ₆	31.7 31.75	3.3 3.2	18.5 18.5	21.4 21.2	0.78	140-142	73
Vk	C ₁₂ H ₁₆ N ₆ O ₇	40.55 40.45	4.7 4.5	23.3 23.6		0.64	187-189	86
Vi	C ₁₁ H ₁₂ N ₈ O ₇	36.1 35.9	3.0 3.3	30.7 30.4		0.67	134 (dec.)	58
Vla	C ₆ H ₃ ClN ₆ O ₃	30.0 29.7	1.4 1.2	34.7 34.6	14.8 14.6	0.45	248-250	60
Vlb	C ₈ H ₆ ClN ₅ O ₄	35.7 35.4	2.4 2.2	25.9 25.8	12.8 13.1	0.37	235-238	62
Vlc	C ₁₀ H ₁₀ ClN ₅ O ₃	42.7 42.3	3.2 3.5	24.9 24.7	12.85 12.5	0.39	265-268	70
VIIa	C ₆ H ₄ N ₆ O ₃ S	29.8 30.0	1.9 1.7	35.5 35.0	12.9 13.3	0.27	238-240	58
VIIb	C ₈ H ₇ N ₃ O ₄ S	35.95 35.7	2.7 2.6	25.7 26.0	11.9 11.6	0.36	278-281	56
VIIc	C ₁₀ H ₁₁ N ₅ O ₃ S	43.35 42.7	4.0 3.9	24.9 24.9	11.9 11.4	0.38	256-257	57



I m, o R = CONH_2 , n, p R = COOEt ;
VI, VII a, b $\text{R}' = \text{NO}_2$, a R = CONH_2 , b R = COOEt , b $\text{R}' = \text{NHCOMe}$, R = COOEt

TABLE 2. Spectral Characteristics of Compounds Synthesized

Compound	C=O	IR spectrum, ν, cm^{-1}	NH	NO ₂	PMR spectrum, δ, ppm , spin-spin coupling constants (J, Hz)	
la	1650, 1700	3380, 3400	1360, 1540		9.70 (1H, s, NH); 8.40 (1H, s, 6-H); 7.90 (2H, br. s, CONH ₂)	
lb	1650, 1710	3350, 3400	1380, 1540		9.40 (1H, s, NH); 8.50 (1H, s, 6-H); 7.70 (2H, br. s, CONH ₂)	
lc	1650, 1710	3370, 3410	1380, 1540		9.85 (1H, q, $J = 4.9, \text{NH}_2$); 9.39 (1H, s, CONH ₂); 8.75 (1H, s, 6-H); 3.89 (3H, $J = 4.9, \text{d, CH}_3$)	
ld	1660, 1700	3270, 3345	1370, 1540		9.36 (1H, q, $J = 4.8, \text{NH}_2$); 9.36 (1H, s, CONH ₂); 8.87 (1H, s, 6-H); 3.74 (3H, $J = 4.8, \text{d, CH}_3$)	
le	1700, 1730	3370	1360, 1540		10.08 (1H, s, NH); 8.45 (1H, s, 6-H); 4.32 (2H, q, $J = 8.0, \text{CH}_2$); 1.22 (3H, t, $J = 8.0, \text{CH}_3$)	
lf	1700, 1720		1380		10.18 (1H, s, NH); 8.48 (1H, s, 6-H); 4.25 (2H, q, $J = 7.8, \text{CH}_3$); 1.25 (3H, t, $J = 7.8, \text{CH}_3$)	
lg	1700, 1720		1350		10.35 (1H, s, NH); 8.37 (1H, s, 6-H); 4.33 (2H, q, $J = 7.7, \text{CH}_3$); 1.17 (3H, t, $J = 7.7, \text{CH}_3$)	
lh	1690, 1700, 1720	3320, 3400			10.74 (1H, br. s, NHCO); 10.44 (1H, s, NH); 8.55 (1H, s, 6-H); 4.23 (2H, q, $J = 7.9, \text{CH}_3$); 2.09 (3H, s, COCH ₃)	
li	1690		3360	1245, 1560	10.35 (1H, s, NH); 8.37 (1H, s, 6-H)	
lj	1700		3360	1360, 1560	9.85 (1H, s, NH); 8.65 (1H, s, 6-H)	
lk	1690, 1710	3320, 3400	1350, 1560		10.95 (1H, br. s, NHCO); 10.65 (1H, s, NH); 8.67 (1H, s, 6-H); 2.19 (3H, s, CH ₃)	
ll	1690, 1720	3430	1380, 1540		10.65 (1H, s, NH); 9.80 (1H, s, COOH); 8.75 (1H, s, 6-H)	
lm	1650, 1700	3290, 3350-3400			10.90 (1H, s, NH); 9.56 (1H, br. s, NH); 8.67 (1H, s, 6-H); 7.9 (2H, br. s, CONH ₂); 6.79 (2H, br. s, NH ₂)	
ln	1700, 1725	3330, 3400-3450			10.54 (1H, s, NH); 9.47 (1H, br. s, NH); 8.45 (1H, s, 6-H); 6.79 (2H, br. s, NH ₂); 4.28 (2H, q, $J = 7.4, \text{CH}_2$); 1.27 (3H, t, $J = 7.4, \text{CH}_3$)	
lo	1650, 1700	3270, 3450 ²			10.69 (1H, s, NH); 8.47 (1H, s, 6-H); 8.05 (2H, br. s, CONH ₂); 1.25 (1H, s, CH)	
lp	1700, 1730	3400 ²			10.54 (1H, s, NH); 9.47 (1H, br. s, NH); 8.45 (1H, s, 6-H); 6.79 (2H, br. s, NH ₂); 4.28 (2H, q, $J = 7.4, \text{CH}_2$); 1.27 (3H, t, $J = 7.4, \text{CH}_3$); 1.19 (1H, s, CH)	
la	1660, 1720	3330, 3400			10.74 (3H, d, $J = 4.78, \text{NHCH}_2$); 1.33 (3H, t, $J = 7.2, \text{CH}_3$); 8.49 (1H, s, 6-H); 4.25 (2H, q, $J = 7.2, \text{CH}_2$)	
lb	1720, 1730	3370			10.27 (1H, s, NH); 8.27 (1H, s, 5-H); 4.34 (2H, q, $J = 7.8, \text{CH}_3$); 4.25 (2H, q, $J = 7.5, \text{CH}_2$); 1.33 (3H, t, $J = 7.8, \text{CH}_3$); 1.25 (3H, t, $J = 7.5, \text{CH}_3$)	
lc	1720	3340	1380, 1560		9.25 (1H, s, NH); 8.79 (1H, s, 5-H); 4.45 (2H, q, $J = 7.2, \text{CH}_2$); 1.40 (3H, t, $J = 7.2, \text{CH}_3$)	
va	1650, 1720, 1730	3345, 3400	1370, 1560		8.83 (1H, s, 2-H); 7.87 (2H, br. s, CONH ₂); 4.54 (4H, 2q, $J = 7.2, 7.0, 2\text{CH}_3$) [*]	
vb	1650, 1710, 1730	3360			1.37, 1.33 (6H, t, $J = 7.2, 7.0, 2\text{CH}_3$) [*]	
vc	1660, 1700, 1725	3330, 3390	1360, 1540		8.80 (1H, s, 2-H); 7.85 (2H, br. s, CONH ₂); 4.44, 4.35 (4H, 2q, $J = 7.2, 7.1, 2\text{CH}_3$) [*]	
vd	1660, 1710, 1720	3280, 3360			1.39, 1.36 (6H, t, $J = 7.2, 7.1, \text{CH}_3$) [*]	
					9.40 (1H, q, $J = 4.9, \text{NHCH}_2$); 8.70 (1H, s, 2-H); 4.34, 4.36 (4H, 2q, $J = 7.4, 7.3, 2\text{CH}_3$)	
					3.67 (3H, d, $J = 4.9, \text{NHCH}_2$) [*] ; 1.30, 1.28 (6H, 2q, $J = 7.4, 7.3, 2\text{CH}_3$) [*]	
					9.80 (1H, q, $J = 4.8, \text{NHCH}_2$); 8.90 (1H, s, 2-H); 4.40, 4.38 (4H, 2q, $J = 7.5, 7.4, 2\text{CH}_3$) [*]	
					3.47 (3H, d, $J = 4.8, \text{NHCH}_2$) [*] ; 1.36, 1.33 (6H, t, $J = 7.5, 7.4, 2\text{CH}_3$) [*]	

TABLE 2 (continued)

	1	2	3	4	5
V _g	1720, 1730, 1735	3340	1370, 1560		8.94 (1H, s, 2-H); 4.35; 4.32 (6H, 3q, <i>J</i> = 7.8, 7.7, 7.6, 3CH ₂); 1.5; 1.47; 1.44 (9H, 3t, <i>J</i> = 7.8, 7.7, 7.6, 3CH ₃) [*]
V _f	1720, 1730, 1735	3450			8.64 (1H, s, 2-H); 4.15; 4.17; 4.23 (6H, 3q, <i>J</i> = 7.0, 7.1, 7.2, 3CH ₂); 1.25; 1.28; 1.32 (9H, 3t, <i>J</i> = 7.0, 7.1, 7.2, 3CH ₃) [*]
V _g	1710, 1720, 1740	3400			8.76 (1H, s, 2-H); 4.18; 4.24; 4.35 (6H, 3q, <i>J</i> = 7.0, 7.1, 7.2, 3CH ₂); 1.28; 1.34; 1.37 (9H, 3t, <i>J</i> = 7.0, 7.1, 7.2, 3CH ₃) [*]
V _h	1690, 1710, 1720, 1740	3300, 3420			10.95 (1H, br.s, NHCO); 8.66 (1H, s, 24H); 4.28 (6H, 3q, <i>J</i> = 7.2, 7.3, 7.3, 3CH ₂); 2.19 (3H, s, COCH ₃); 1.19; 1.23; 1.25 (9H, 3t, <i>J</i> = 7.2, 7.3, 7.6, CH ₃) [*]
V _i	1720, 1730	3460	1370, 1560		8.70 (1H, s, 2-H); 4.28; 4.30 (4H, 2q, <i>J</i> = 7.0, 6.97, 2CH ₂); 1.21; 1.23 (6H, 3t, <i>J</i> = 7.0, 6.97, 2CH ₃) [*]
V _j	1720, 1730	3440	1370, 1560		8.78 (1H, s, 2-H); 4.24; 4.26 (4H, 2q, <i>J</i> = 7.0, 7.1, 2CH ₂); 1.23; 1.27 (6H, 3t, <i>J</i> = 7.0, 7.1, 2CH ₃) [*]
V _k	1690, 1720, 1725	3330, 3400	1370, 1560		9.70 (1H, br.s, NH); 8.90 (1H, s, 2-H); 4.20 (4H, 2q, <i>J</i> = 7.2, 7.1, 2CH ₂); 2.24 (3H, s, COCH ₃); 1.30 (6H, 2t, <i>J</i> = 7.2, 7.1, 2CH ₃) [*]
V _l	1670, 1700, 1720	3450	1370, 1560 *		8.56 (1H, s, 2-H); 4.27; 4.25 (4H, 2q, <i>J</i> = 7.0, 7.1, 2CH ₂); 1.23 (6H, 2t, <i>J</i> = 7.0, 7.1, 2CH ₃) [*]
V _{la}	1650	3300	1370, 1540		8.70 (1H, s, 6-H); 7.50 (2H, br.s, CONHs)
V _{lb}	1720		1380, 1540		8.67 (1H, s, 6-H); 4.30 (2H, 4t, <i>J</i> = 7.1, CH ₃); 1.22 (3H, t, <i>J</i> = 7.1 CH ₃)
V _{lc}	1700, 1730	3310			9.70 (1H, s, NH); 8.57 (1H, s, 6-H); 4.32 (2H, q, <i>J</i> = 7.1, CH ₂); 2.26 (3H, s, COCH ₃); 1.25 (3H, 1, <i>J</i> = 7.1, CH ₃)
V _{la}	1650	3330-3390	1360, 1560		10.40 (1H, br.s, NH); 8.54 (1H, s, 6-H); 7.80 (1H, br.s, CONH)
V _{lb}	1720	3380	1370, 1560		10.54 (1H, br.s, NH); 8.62 (1H, s, 6-H); 4.25 (2H, q, <i>J</i> = 7.5, CH ₃); 1.35 (3H, t, <i>J</i> = 7.5, CH ₃)
V _{lc}	1700, 1720	3330, 3390			10.50 (1H, br.s, NH); 9.80 (1H, br.s, NHCO); 8.56 (1H, s, 6-H); 4.50 (2H, q, <i>J</i> = 7.7, CH ₃); 1.35 (3H, t, <i>J</i> = 7.7, CH ₃); 2.24 (3H, s, COCH ₃)

* The signal of the imidazole ring NH proton is not seen due to broadening of the spectrum.

^{**} A weak vibrational band for the SH group is also seen at 2540 cm⁻¹.

^{***} The spectrum also contains a vibrational band for the NH group at 2155 cm⁻¹.

The nitro group in the compounds Ia,e is rather labile and is readily substituted by the action of nucleophiles. Thus, chloroimidazotriazinones Ib,f identical to those obtained in the cyclization of Vb,f (mp, R_f and IR and PMR spectral data) were obtained upon heating the compounds Ia, e in ethanolic hydrogen chloride. In previous work [11], we reported decomposition of the triazine ring upon boiling of azotriazines in hydrazine hydrate at reflux. On the other hand, in the present case, stirring of 3-chloroimidazo[5,1-c]-1,2,4-triazin-4(H)-ones Ib,f in hydrazine hydrate or boiling of these compounds in ethanol with thiourea leads to formation of 3-hydrazino-(Im, n) and 3-mercaptopimidazo[5,1-c]-1,2,4-triazin-4(H)-ones (Io,p) correspondingly. Treating of the compounds Ia,e with thionyl chloride leads to substitution of the oxo group by chlorine atom and to formation of compounds VIa,b, as indicated by the absence of PMR signal for the NH group at 9.5 ppm. In order to confirm the structures of the compounds VIa,b, these compounds were converted by hydrolysis into starting imidazotriazinones Ia,lc. The formation of the imidazotriazine ring (compound VIc) also occurs in the reaction of the compound Ih with phosphorus oxychloride.

Heating of imidazo[5,1-c]-1,2,4-triazines VIa-c with thiourea at reflux leads to the corresponding imidazo[5,1-c]-1,2,4-triazin-4(1H)-thiones VIIa-c. The obtained imidazotriazinones I, imidazotriazoles II, imidazotriazines VI, and imidazotriazin-4(1H)-thiones VII were identified using IR and PMR spectral data.

Thus, azoderivatives of imidazolyls V undergo cyclization at the ester group to give imidazotriazinones I, while azo compounds V containing bromine or chlorine atom are converted upon prolonged heating in dimethyl formamide at reflux into imidazotriazoles II. Haloimidazotriazinones I and haloimidazotriazines VI readily react with nucleophiles.

EXPERIMENTAL

The IR spectra of the compounds synthesized were recorded on a Specord IR-75 spectrometer for KBr pellets. The PMR spectra were taken on a Bruker WP-80 spectrometer at 80 MHz in DMSO-d₆ with TMS as the internal standard. The course of the reactions and purity of the products were monitored by thin-layer chromatography on Silufol UV-254 and Sorbfil UV-254 plates with STX-1A silica gel as the adsorbent and chloroform-ethanol as the eluent. The characteristics of these products are reported in Table 1 and the PMR and IR spectral data are given in Table 2.

8-R-3-R'-Dihydroimidazo[5,1-c]-1,2,4-triazin-4-ones (Ia-l). Sample of 1.2 mmol of azo compound Va-l was added to 30 ml of 1% ethanolic KOH. The reaction mixture was heated at reflux for 1.5 h and cooled to room temperature. Then, 1 N solution of HCl was added to pH 6.5 and the mixture was stirred at room temperature for 0.5 h. The precipitate of the compound I was filtered off and crystallized from 70% aqueous ethanol.

8-R-3-Chloro-1,4-dihydroimidazo[5,1-c]-1,2,4-triazin-4-ones (Ib,f). Suspension of 3.95 mmol of Ia,e in 50 ml of absolute ethanol was cooled to 5-7°C and dry hydrogen chloride was passed with stirring for 6 h. The formed precipitate of products Ib, f was filtered off and washed with water. Products Ib,f were identical in their spectral indices and melting points to samples of imidazotriazinones Ib,f obtained by cyclization of azo derivatives Vb,f.

8-R-3-Nitro-1,4-dihydroimidazo[5,1-c]-1,2,4-triazin-4-ones (Ia,e). Suspension of 3.64 mmol of chloroimidazotriazine VIa,b in 15 ml of 2 N methanolic NaOH was maintained for 15 min at 50°C. After rapid cooling, 2 N HCl was added to pH 5.5. The precipitate formed was filtered off, washed with water, and recrystallized from methanol. Products Ia,e were identical in their spectral indices and melting points to imidazotriazinones Ia,e obtained the cyclization of azo derivatives Va,e.

8-R-3-Hydrazino-1,4-dihydroimidazo[5,1-c]-1,2,4-triazin-4-ones (Im,n). Solution of 8.25 mmol of compound Ib,f in 40 ml of ethanol was cooled to 10°C and 3 ml of 85% hydrazine hydrate were added. The mixture was stirred for 1 h at room temperature. The precipitate of Im,n was filtered off and crystallized from 70% aqueous ethanol.

8-R-3-Mercapto-1,4-dihydroimidazo[5,1-c]-1,2,4-triazin-4-ones (Io,p). Sample of 9.9 mmol of thiourea and two drops of 88% formic acid were added to solution of 8.25 mmol of compounds Ib,f in 30 ml of absolute ethanol. The reaction mixture was heated for 10 h at reflux and evaporated in vacuum to dryness. The residue was crystallized from methanol.

Ethyl Esters of 7-R-Imidazo[5,1-c]-1,2,4-triazole-3-carboxylic Acids (IIa-c). Sample of 1.2 mmol of azoimidazole Vd,g,j and 0.2 ml of triethylamine were added to 5 ml of dimethyl formamide. The reaction mixture was heated for 14 h at reflux and evaporated in vacuum to dryness. The residue was triturated with ether, filtered, and washed with ether.

Diethyl Esters of (4-R-Imidazolyl-5-azo)nitromalonic Acids (Va,c,e). Sample of 8.8 mmol of diethyl nitromalonate IVa and 3 mmol of sodium acetate were added with rapid stirring to solution of 7.3 mmol of 5-diazoimidazole IIIa-c in 30 ml of acetone at temperature not higher than 5°C. The reaction mixture was stirred at this temperature for 12 h and 5 ml of cold water were added. The precipitate of products Va,c,e was filtered off, washed were with 60% aqueous ethanol, and crystallized from ethanol.

Diethyl Esters of (4-R-Imidazolyl-5-azo)chloromalonic Acids (Vb,d,f,i). Sample of 10 mmol of diethyl chloromalonate IVb,d 3 mmol of sodium acetate were added to solution of 7.3 mmol of 5-diazoimidazole IIIa-d in 50 ml of acetone. The reaction mixture was stirred at room temperature for 3 h. The precipitate of Vb,d,f, or Vi was filtered off and crystallized from 70% aqueous ethanol.

Diethyl Esters of (4-R-Imidazolyl-5-azo)bromomalonic Acids (Vg,j). Sample of 11 mmol of diethyl bromomalonate IVc and 3 mmol of sodium acetate were added to solution of 7.3 mmol of 5-diazoimidazole IIIc,d in 50 ml of acetone. The reaction mixture was stirred at room temperature for 1.5 h. The precipitate of Vg,j was filtered off and crystallized from 70% aqueous ethanol.

Diethyl Ester of (4-Azidocarbonylimidazolyl-5-azo)nitromalonic Acid (VI). Sample of 1.2 ml (6.75 mmol) of diethyl nitromalonate IVa and 0.15 g (1.83 mmol) of sodium acetate were added to solution of 1 g (6.14 mmol) of 4-azidocarbonyl-5-diazoimidazole IIIe in 35 ml of acetone. The reaction mixture was stirred for 10 h at 3-5°C. Then, 5 ml of cold water were added. The precipitate of the product VI was filtered off and washed with water and a small amount of ether.

8-R-3-Nitro-4-chloroimidazo[5,1-c]-1,2,4-triazines (VIa,b). Sample of 1 ml of thionyl chloride was added to solution of 3.95 mmol of the compound Ia, e in 30 ml of absolute benzene. The reaction mixture was heated at reflux for 3 h and evaporated in vacuum to dryness. The residue was triturated with a small amount of ether.

3-Acetylamino-4-chloro-8-ethoxycarbonylimidazo[5,1-c]-1,2,4-triazine (VIc). Mixture of 1 g (3.77 mmol) of 3-acetylamino-1,4-dihydroimidazo[5,1-c]-1,2,4-triazin-4-one I_h, 0.6 ml of N,N-dimethylaniline, and 25 ml of POCl₃ was heated at reflux with stirring for 30 min. Excess of POCl₃ was distilled off. The obtained oily product was extracted with chloroform, which was then evaporated in vacuum. The residue was triturated with a small amount of ether.

8-R-3-R¹-1,4-Dihydroimidazo[5,1-c]-1,2,4-triazine-4-thiones (VIIa-c). Sample of 8.8 mmol of thiourea and two drops of 88% formic acid were added to solution of 7.36 mmol of compound VIa-c in 30 ml of absolute ethanol. The reaction mixture was heated at reflux for 10 h, evaporated in vacuum to dryness, and crystallized from methanol.

REFERENCES

1. M. Tisler and B. Stanovnic, *Khim. Geterotsikl. Soedin.*, No. 5, 579 (1980).
2. M. H. Elnagdi, E. M. Zayed, and S. Abdou, *Heterocycles*, **19**, 559 (1982).
3. V. L. Rusinov and O. N. Chupakhin, *Nitroazines* [in Russian], Nauka, Novosibirsk (1991).
4. M. A. Bezmaternykh, V. S. Mokrushin, T. A. Pospelova, and O. S. El'tsov, *Khim. Geterotsikl. Soedin.*, No. 6, 805 (1998).
5. M. N. Elnagdi, M. R. H. Elmoghayar, E. M. Kandeel, and M. K. A. Ibrahim, *J. Heterocycl. Chem.*, **14**, 227 (1977).
6. M. F. G. Stevens and G. U. Baig, *J. Chem. Soc., Perkin Trans. I*, No. 5, 665 (1981).
7. M. Kocevar, D. Kolman, S. Polanc, B. Porovne, B. Stanovnic, and M. Tisler, *Tetrahedron*, **32**, 725 (1976).
8. G. U. Baig, M. F. G. Stevens, R. Stone, and E. Lunt, *J. Chem. Soc., Perkin Trans. I*, No. 8, 1811 (1982).
9. T. Novinson, T. Okabe, R. K. Robins, and T. R. Matthews, *J. Med. Chem.*, **19**, 517 (1976).

10. J. F. Shealy, R. F. Struck, L. B. Holm, and J. A. Montgomery, *J. Org. Chem.*, **26**, 2396 (1961).
11. V. S. Mokrushin, V. I. Ofitsarov, T. V. Repakova, A. G. Tsaur, and Z. V. Pushkareva, *Khim. Geterotsikl. Soedin.*, No. 4, 556 (1976).
12. V. S. Mokrushin, I. S. Selezneva, T. A. Pospelova, V. K. Usova, S. M. Malinskaya, G. M. Anoshina, T. É. Zubova, and Z. V. Pushkareva, *Khim.-Farm. Zh.*, No. 3, 303 (1982).
13. V. I. Nifontov, I. S. Selezneva, V. S. Mokrushin, Z. V. Pushkareva, and V. A. Trofimov, *Khim. Geterotsikl. Soedin.*, No. 7, 984 (1979).
14. J. F. Shealy, C. A. Krauth, R. Pitillo, and D. E. Hunt, *J. Pharm. Sci.*, **56**, 147 (1967).
15. M. F. G. Stevens, J. A. Hickman, N. W. Gibson, G. U. Baig, E. Lant, and C. G. Newton, *J. Med. Chem.*, **27**, 196 (1984).