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HETEROCYCLIZATION OF FUNCTIONALIZED HETEROCUMULENES WITH C,N- AND C,O-BINUCLEOPHILES. 1. CYCLOCONDENSATION OF 1-CHLOROALKYLHETERO-CUMULENES AND N-(1-CHLOROALKYLIDENE)-URETHANES WITH 2-CYANOMETHYLPYRIDINE

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The interaction of 1-chloroalkyl isocyanates, 1-chloroalkylcarbodiimides, 1,1-dichloroalkyl isocyanates, and N-(1-chloroethylidene)-O-methylurethanes with 2-cyanomethylpyridine has been investigated. An effect of organic base has been detected on the regioselectivity of the cyclocondensation of 1-chloroalkyl isocyanates, which leads to 2,3-dihydro-1H-pyrido[1,2-c]pyrimidin-1-one or the isomeric 2,3-dihydro-1H-pyrido[1,2-c]pyrimidin-3-one. Irrespective of the cyclization conditions 1-chloroalkylcarbodiimides react with the formation of 1-imino-2,3-dihydro-1H-pyrido-[1,2-c]pyrimidines. One type of product, a 1H-pyrido[1,2-c]pyrimidin-1-one, was also isolated from 1,1-dichloroalkyl isocyanates and N-(1-chloroalkylidene)urethanes.

Keywords: 1H-pyrido[1,2-*c*]pyrimidines, 1-chloroalkyl isocyanates, 1-chloroalkylcarbodiimides, N-(1-chloroalkylidene)urethanes, 2-cyanomethylpyridine, cyclocondensation.

Results correlated by us recently [1] on the chemical behavior of functionally 1-substituted alkylheterocumulenes (isocyanates and carbodiimides) enabled the conclusion that they are promising as 1,3-bielectrophilic $[–C=N–C=]^{2+}$ synthons in intra- and intermolecular cyclizations with O,O-, O,S-, and N,S-bifunctional reagents. However their interaction with C,N-binucleophiles is limited to the examples of 1-cyclohexenyldialkylamines [2] and β-N-methylaminocrotonic acid ethyl ester [3]. The formation in the latter case of 4-oxo(imino)tetrahydropyrimidine derivatives served as a strong reason for the involvement in similar reactions of compounds in which the nitrogen atom is the element of the heterocycle which should enable development of an efficient approach to a condensed pyrimidine system. For this reason the interaction of 1-chloroalkylheterocumulenes and some derivatives with 2-cyanomethylpyridine has been studied in the present work with the aim of obtaining new pyrido[1,2-*c*]pyrimidines. We note that previously the [4+2] cycloaddition reaction of 2-vinylpyridines to acyl isocyanates [4] and the electrocyclization of 2-(2-heterocumuleno)-vinylpyridines [5,6] were used for the synthesis of pyrido[1,2-*c*]pyrimidine derivatives. Overall, the constant attention to this type of compounds is caused by the wide spectrum of their biological activity [6,7].

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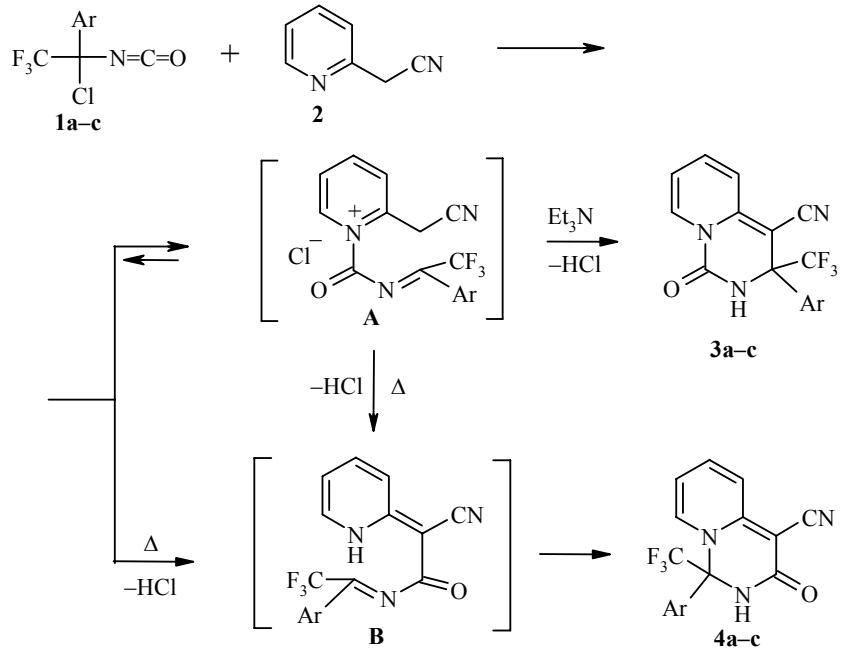
It was established by us that 1-chloroalkyl isocyanates **1a-c** react comparatively readily with 2-cyanomethylpyridine **2** with the formation of products of a pyrido[1,2-*c*]pyrimidine structure. In a series of reactions of 1-chloroalkyl isocyanates with binucleophilic reagents the influence of the conditions leading to the structure of the final products was discovered for the first time. The interaction of the reactants in benzene solution in the presence of triethylamine leads to 2,3-dihydro-1H-pyrido[1,2-*c*]pyrimidin-1-ones **3a-c** and heating in this solvent in the absence of an organic base is accompanied by the formation of the isomeric 2,3-dihydro-1H-pyrido[1,2-*c*]pyrimidin-3-ones **4a-c** (Table 1). We suggest that on mixing reactants **1** and **2** N-carbamoylation of the pyridine ring takes place with the formation of salt **A**. This is probably an equilibrium process, confirmation of which is the appearance and gradual increase in the ^{19}F NMR spectra of signals at ~ -72 ppm [8], the intensity of which after 7-8 days became the same as the intensity of the signals of the initial isocyanates (~ -80 ppm). Addition of an organic base to the mixture leads to the formation of an anionic center on the cyanomethyl group, attack of which on the electrophilic azomethine bond closes the ring. On heating the reaction mixture, evidently displacement of the equilibrium towards the starting materials occurs followed by C-carbamoylation of the cyanomethyl group with the formation of intermediates of type **B,** which are then cyclized into **4a-c**.



a Ar = Ph; **b** Ar = 4-MeC_6H_4 ; **c** Ar = 4-$MeOC_6H_4$

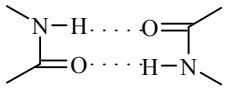
The differences between structures **3** and **4** were recorded by IR and ^1H, ^{19}F, and ^{13}C NMR spectroscopy (Tables 2, 3). In the IR spectra of compounds **3a-c** bands for the C=O group were found at 1732-1735 cm^{-1}, but for **4a-c** they were displaced to a lower frequency region (1630-1634 and 1648-1650 cm^{-1}), which may be caused by participation in conjugation with the hexatriene bond system. A more detailed analysis of the IR spectra of compounds **3a** and **4a** showed that for **3a** bands were observed for ν(C=O) at 1735, for ν(C≡N) at 2195, and for ν(N–H) at 3261 cm^{-1} in the solid state. In solution in CH_2Cl_2 (c = 0.018 M) the frequencies of these bands appeared at 1733, 2199, and 3385 cm^{-1} respectively, i.e. only the band for ν(N–H) was changed. Its shape was also changed, which is evidently caused by the participation of the N–H group in the formation of intermolecular associates in the solid state between the unshared electron pair of the node nitrogen atom of one molecule and the N–H group proton of another. The C=O group does not participate in such a process, consequently in the initial solutions and in solutions diluted 4.5 and 13 times its intensity and frequency are the same as in the solid state.

TABLE 1. Characteristics of the Synthesized Compounds **3a-c**, **4a-c**, **6a-c**, and **9a,b**

Compound	Empirical formula	Found, % / Calculated, %			mp, °C	Yield*, % (method)
		C	H	N		
3a	$C_{16}H_{10}F_3N_3O$	60.79 / 60.57	3.09 / 3.18	13.40 / 13.24	188-189	60
3b	$C_{17}H_{12}F_3N_3O$	61.37 / 61.63	3.61 / 3.65	12.81 / 12.68	187-188	71
3c	$C_{17}H_{12}F_3N_3O_2$	59.07 / 58.79	3.51 / 3.48	12.29 / 12.10	185-186	74
4a	$C_{16}H_{10}F_3N_3O$	60.29 / 60.57	3.24 / 3.18	13.36 / 13.24	230-231	44
4b	$C_{17}H_{12}F_3N_3O$	61.50 / 61.63	3.78 / 3.65	12.53 / 12.68	228-229	46
4c	$C_{17}H_{12}F_3N_3O_2$	59.92 / 58.79	3.54 / 3.48	11.94 / 12.10	214-215	39
6a	$C_{22}H_{17}F_3N_4$	68.20 / 67.97	4.21 / 4.22	14.03 / 13.79	116-117	50 (A), 40 (B)
6b	$C_{23}H_{19}F_3N_4$	68.47 / 68.56	4.69 / 4.56	13.41 / 13.33	125-126	38
6c	$C_{23}H_{19}F_3N_4O$	65.76 / 66.05	4.32 / 4.39	12.99 / 12.84	156-157	43
9a	$C_{10}H_4F_3N_3O$	50.36 / 50.22	1.54 / 1.69	17.70 / 17.57	207-208	52 (A), 37 (B) 41 (C), 30 (D)
9b	$C_{10}H_4Cl_3N_3O$	41.80 / 41.63	1.57 / 1.40	14.31 / 14.56	220-221	56 (A), 47 (C)

* Compounds **3a-c**, **4a-c**, **6a-c**, and **9a** were recrystallized from ethanol, compound **9b** from ethanol–dioxane, 2:1.

In the solid state compound **4a** is characterized by a broad absorption band for the C=O group at 1634 cm^{-1} with a high frequency shoulder at 1650 cm^{-1}. In the region of ν(N–H) absorption there was a broad band at 3157 cm^{-1}. In CH_2Cl_2 solution (c = 0.018 M) two bands were observed for the C=O group (1641 and 1669 cm^{-1}) and a band for the N–H group at 3390 cm^{-1}. The bands at 1669 and 3390 cm^{-1} are the bands for ν(C=O) and ν(N–H) of monomeric molecules, which indicates the existence of intermolecular associates with two hydrogen bonds in the solid state.



In the ^{1}H NMR spectra of pyrido[1,2-*c*]pyrimidin-1-ones **3a-c** the singlets for the N-H protons at 9.76-9.84 ppm are representative, as are the doublets for the 8-H protons in the low field portion of the spectrum (7.93-7.95 ppm), caused by the deshielding effect of the carbonyl group. For the pyrido[1,2-*c*]pyrimidin-3-ones **4a-c** the analogous signals for 8-H and N-H are displaced towards high field by approximately 0.9 ppm.

Comparison of the ^{19}F NMR spectra of compounds **3a-c** and **4a-c** shows that the signals of the CF_3 group resonate in approximately the same range (from -75 to -76 ppm) irrespective of their position in the pyrimidine ring, although in the C–C(CF_3)–N bond system of **3a-c** a high field displacement (~0.5 ppm) compared with the N–C(CF_3)–N bond system of **4a-c** is observed.

The ^{13}C NMR spectra confirm the cyclic structure of the reaction products of isocyanates **1a-c** with 2-cyanomethylpyridine **2** and have distinctive features for each cyclic isomer. For compounds **3a-c** the singlet for the $C_{(1)}$ atom (C=O group) is at 146, and the quartet for the $C_{(3)}$ atom is at 63 ppm ($J_{C–F}$ = 29 Hz). However for compounds **4a-c** the $C_{(1)}$ atom is displayed as a quartet at 81 ($J_{C–F}$ = 30-31 Hz), but the $C_{(3)}$ atom (C=O group) shows as a singlet at 160 ppm.

TABLE 2. Spectral Characteristics of the Synthesized Compounds

Compound	^{1}H NMR spectrum, δ, ppm (*J*, Hz)	^{19}F NMR spectrum, δ, ppm	IR spectrum, ν, cm^{-1}		
			C=O	C≡N	N–H
3a	6.19-6.24 (1H, m, 7-H); 6.80 (1H, d, *J* = 9.3, 5-H); 7.09-7.15 (1H, m, 6-H); 7.42-7.53 (3H, m, H_{Ar}); 7.62 (2H, d, *J* = 8.0, H_{Ar}); 7.95 (1H, d, *J* = 7.3, 8-H); 9.84 (1H, s, NH)	-76.47	1735	2195	3261
3b	2.37 (1H, s, CH_3); 6.30 (1H, m, 7-H); 6.79 (1H, d, *J* = 9.4, 5-H); 7.10-7.24 (1H, m, 6-H); 7.27 (2H, d, *J* = 8.1, H_{Ar}); 7.49 (2H, d, *J* = 8.1, H_{Ar}); 7.93 (1H, d, *J* = 7.4, 8-H); 9.78 (1H, NH)	-76.46	1732	2199	3259
3c	3.82 (3H, s, CH_3O); 6.38-6.50 (1H, m, 7-H); 6.82 (1H, d, *J* = 9.4, 5-H); 6.99-7.02 (2H, d, *J* = 9.0, H_{Ar}); 7.11-7.30 (1H, m, 6-H); 7.53 (2H, d, *J* = 9.0, H_{Ar}); 7.93 (1H, d, *J* = 7.4, 8-H); 9.76 (1H, s, NH)	-76.57	1734	2202	3276
4a	6.43-6.49 (1H, m, 7-H); 6.93-6.95 (1H, d, *J* = 7.0, 5-H); 7.09-7.12 (1H, d, *J* = 9.0, 8-H); 7.49-7.54 (1H, m, 6-H); 7.47-7.58 (3H, m, H_{Ar}); 7.62-7.66 (2H, m, H_{Ar}); 8.96 (1H, s, NH)	-75.69	1634, 1650	2210	3157
4b	2.41 (3H, s, CH_3); 6.43-6.48 (1H, m, 7-H); 6.94 (1H, d, *J* = 7.0, 5-H); 7.09 (1H, d, *J* = 9.1, 8-H); 7.37 (2H, d, *J* = 8.3); 7.45-7.58 (1H, m, 6-H); 7.55 (2H, d, *J* = 8.3, H_{Ar}); 8.93 (1H, s, NH)	-75.89	1630, 1647	2210	3178
4c	3.84 (3H, s, CH_3O); 6.44-6.52 (1H, m, 7-H); 6.96 (1H, d, *J* = 7.0, 5-H); 7.05-7.17 (3H, 8-H + H_{Ar}); 7.46-7.55 (1H, m, 6-H); 7.59 (2H, d, *J* = 8.5, H_{Ar}); 8.92 (1H, s, NH)	-76.02	1632, 1648	2212	3163
6a*	2.31 (3H, s, CH_3); 6.13-6.17 (1H, m, 7-H); 7.03-7.56 (11H, m, 5-H + 6-H + H_{Ar}); 7.70 (1H, *J* = 7.2, 8-H); 8.98 (1H, s, NH)	75.44		2197	3385
6b*[2]	2.31 (6H, br. s, CH_3); 6.09-6.21 (1H, m, 7-H); 7.01-7.17 (6H, m, 5-H + 6-H + H_{Ar}); 7.42-7.55 (4H, m, H_{Ar}); 7.68 (1H, d, *J* = 7.2, 8-H); 8.95 (1H, s, NH)	-75.45		2198	3318
6c*[3]	2.29 (3H, s, CH_3); 3.75 (3H, s, CH_3O); 6.08-6.19 (1H, m, 7-H); 6.86-7.11 (6H, m, 5-H + 6-H + H_{Ar}); 7.42-7.45 (4H, m, H_{Ar}); 7.67 (1H, d, *J* = 6.8, 8-H); 8.93 (1H, s, NH)	-75.69		2190	3318
9a	7.91-7.96 (1H, m, 7-H); 8.19 (1H, d, *J* = 8.5, 5-H); 8.50-8.55 (1H, m, 6-H); 9.35 (1H, d, *J* = 6.8, 8-H)	-68.18	1709	2235	
9b	7.82-7.87 (1H, m, 7-H); 8.20 (1H, d, *J* = 8.4, 5-H); 8.43-8.48 (1H, m, 6-H); 9.27 (1H, d, *J* = 6.9, 8-H)		1714	2237	

* ν(C=N) 1665 cm^{-1}.
*[2] ν(C=N) 1663 cm^{-1}.
*[3] ν(C=N) 1659 cm^{-1}.

The special features of the molecular and crystal structure of compound **4a** were also studied by X-ray structural analysis. The overall form of the **4a** molecule is shown in Fig. 1, the main bond lengths and valence angles are given in Table 4. The central bicyclic system $N_{(1)}N_{(2)}C_{(1\text{-}8)}$ is markedly non-planar, the deviation of the atoms from the mean-square plane is 0.323 Å. The $N_{(1)}C_{(2)}C_{(5\text{-}8)}$ ring is planar to within 0.032 Å, and the heterocycle $N_{(1)}N_{(2)}C_{(1\text{-}4)}$ has the conformation of a flattened half-chair (the modified Cremer–Pople parameters [9] *S*, θ, and ψ were 0.48, 53.4, and 5.8° respectively). By virtue of the steric conditions the benzene ring $C_{(9\text{-}14)}$

TABLE 3. ^{13}C NMR Spectra of the Obtained Compounds, δ, ppm (*J*, Hz)

Com-pound	$C_{(1)}$	$C_{(3)}$	$C_{(4)}$	$C_{(4a)}$	$C_{(5)}$	$C_{(6)}$	$C_{(7)}$	$C_{(8)}$	C≡N	CF_3	CCl_3	C_{Ar}	$C_{Ar'}$	Other signals
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
3a	146.93	63.66 (q, *J* = 29)	68.00	148.09	119.44	136.21	108.50	128.98	117.49	125.38 (q, *J* = 292)		136.60 (*i*) 127.31 (*o*) 128.64 (*m*) 129.11 (*p*)		
3b	146.86	63.46 (q, *J* = 29)	68.18	147.91	119.38	135.96	108.32	128.84	117.38	125.30 (q, *J* = 290)		133.63 (*i*) 138.52 (*o*) 129.06 (*m*) 127.10 (*p*)		20.50 (CH_3)
3c		63.66 (q, *J* = 29)								125.40 (q, *J* = 290)		128.47 (*i*) 128.67 (*o*) 113.83 (*m*) 159.45 (*p*)		55.23 (CH_3O)
4a	81.36 (q, *J* = 31)	160.46	68.87	153.15	119.54	139.50	112.57	136.08	117.40	124.15 (q, *J* = 296)		133.83 (*i*) 128.31 (*o*) 129.41 (*m*) 130.97 (*p*)		

TABLE 3 (continued)

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
4b	81.33 (q, *J* = 31)	160.55	68.86	153.09	119.48	139.46	112.49	136.00	117.39	124.17 (q, *J* = 296)		130.84 (*i*) 128.20 (*o*) 129.90 (*m*) 140.80 (*p*)		20.67 (CH_3)
4c	81.14 (q, *J* = 30)	160.39	69.22	152.87	119.46	138.75	111.87	135.48	116.87	124.01 (q, *J* = 296)		125.11 (*i*) 129.69 (*o*) 114.38 (*m*) 160.61 (*p*)		55.23 (CH_3O)
6a	143.00	63.52 (q, *J* = 27)	69.16	148.37	119.92	133.53	107.94	130.22	118.04	124.77 (q, *J* = 285)		139.62 (*i*) 126.86 (*o*) 128.17 (*m*) 128.43 (*p*)	137.20 (*i*) 120.52 (*o*) 129.04 (*m*) 132.11 (*p*)	20.28 (CH_3)
6b	142.95	63.33 (q, *J* = 27.2)	69.30	148.27	119.91	133.39	107.87	130.23	118.05	124.83 (q, *J* = 285)		136.67 (*i*) 126.76 (*o*) 128.72 (*m*) 137.87 (*p*)	137.27 (*i*) 120.44 (*o*) 129.02 (*m*) 132.05 (*p*)	20.44 (CH_3) 20.26 (CH_3')
9a	148.50	154.46 (q, *J* = 34)	81.10	149.36	123.16	143.78	123.16	133.05	112.90	154.46 (q, *J* = 34)				
9b	148.03	163.44	79.70	150.11	121.90	142.97	122.70	132.59	113.78		95.26			

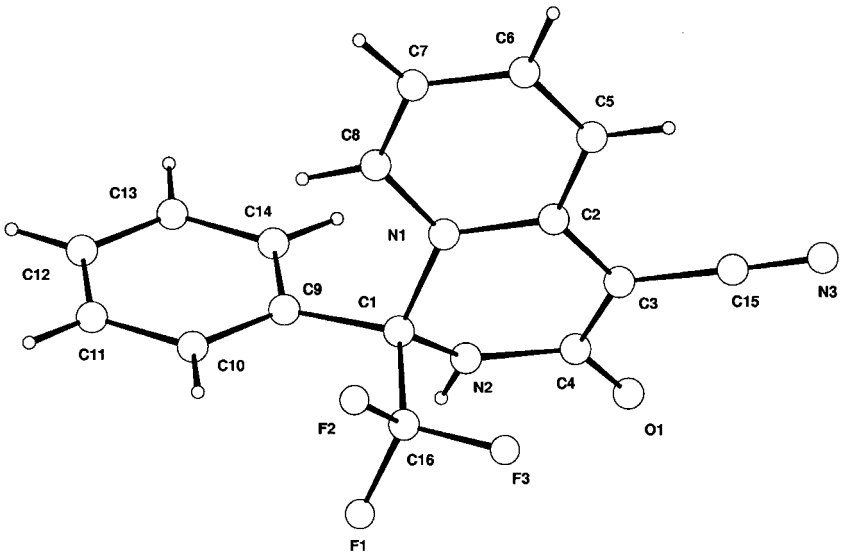


Fig. 1. Overall form of the **4a** molecule with numbering of atoms.

is practically orthogonal to the bicyclic system, the appropriate dihedral angle being 84.4°. In the crystal the **4a** molecules are joined in centrosymmetric dimers (Fig. 2) through hydrogen bonds $O_{(1)}\cdots H_{(2)}–N_{(2)}$ ($O_{(1)}\cdots N_{(2)}$ 2.866(2), $O_{(1)}\cdots H_{(2)}$ 2.04(2) Å, $O_{(1)}H_{(2)}N_{(2)}$ 176.7(14)°), which confirms the results of the IR spectral investigations presented above.

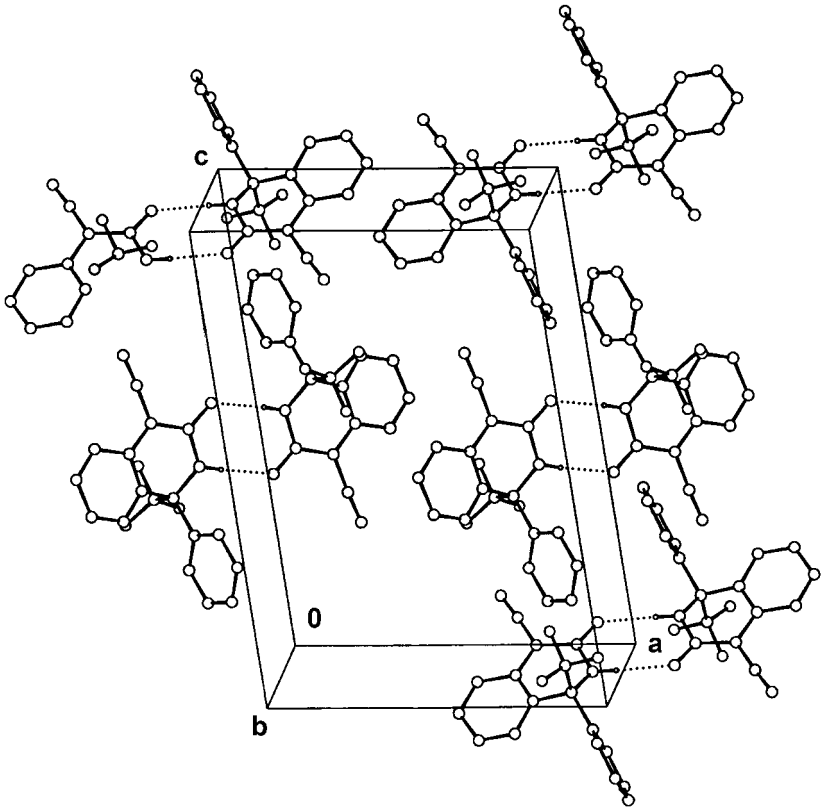
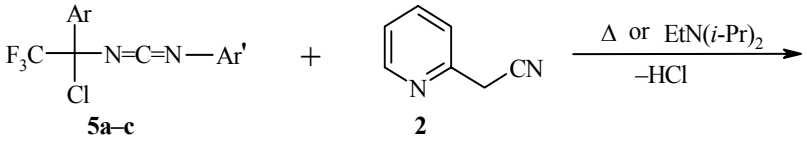


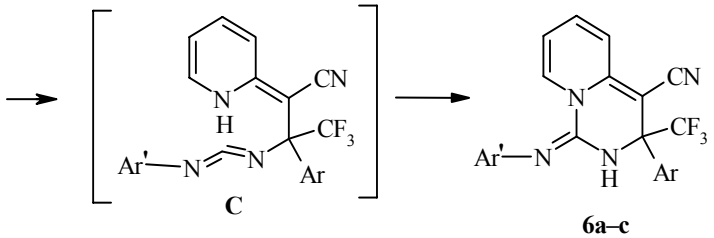
Fig. 2. Crystal packing of compound **4a**
(intermolecular hydrogen bonds $N_{(2)}H_{(2)}\cdots O_{(1)}$ are shown by dotted lines).

TABLE 4. Bond Lengths (*d*) and Valence Angles (ω) in the Molecule of Compound **4a**

Bond	*d*, Å	Angle	ω, deg
$O_{(1)}$–$C_{(4)}$	1.234(2)	$C_{(1)}$–$N_{(1)}$–$C_{(2)}$	119.57(13)
$N_{(1)}$–$C_{(1)}$	1.498(2)	$C_{(2)}$–$N_{(1)}$–$C_{(8)}$	121.12(14)
$N_{(1)}$–$C_{(2)}$	1.379(2)	$C_{(1)}$–$N_{(2)}$–$C_{(4)}$	124.13(13)
$N_{(1)}$–$C_{(8)}$	1.379(2)	$N_{(1)}$–$C_{(1)}$–$N_{(2)}$	108.98(13)
$N_{(2)}$–$C_{(1)}$	1.437(2)	$N_{(1)}$–$C_{(2)}$–$C_{(3)}$	119.67(14)
$N_{(2)}$–$C_{(4)}$	1.372(2)	$N_{(1)}$–$C_{(2)}$–$C_{(5)}$	116.77(15)
$C_{(2)}$–$C_{(3)}$	1.396(2)	$C_{(2)}$–$C_{(3)}$–$C_{(4)}$	121.00(14)
$C_{(2)}$–$C_{(5)}$	1.422(2)	$N_{(2)}$–$C_{(4)}$–$C_{(3)}$	115.49(14)
$C_{(3)}$–$C_{(4)}$	1.436(2)	$C_{(2)}$–$C_{(5)}$–$C_{(6)}$	121.47(16)
$C_{(5)}$–$C_{(6)}$	1.354(3)	$C_{(5)}$–$C_{(6)}$–$C_{(7)}$	119.66(16)
$C_{(6)}$–$C_{(7)}$	1.408(3)	$C_{(6)}$–$C_{(7)}$–$C_{(8)}$	119.32(16)
$C_{(7)}$–$C_{(8)}$	1.343(3)	$N_{(1)}$–$C_{(8)}$–$C_{(7)}$	121.36(16)

The imino analogs of 1-chloroalkyl isocyanates **1a-c**, the 1-chloroalkylcarbodiimides **5a-c**, are systems with a less electrophilic heterocumulene group and an α-carbon atom with more marked electrophilic properties. This shows up significantly in the character of their interaction with 2-cyanomethylpyridine **2**.





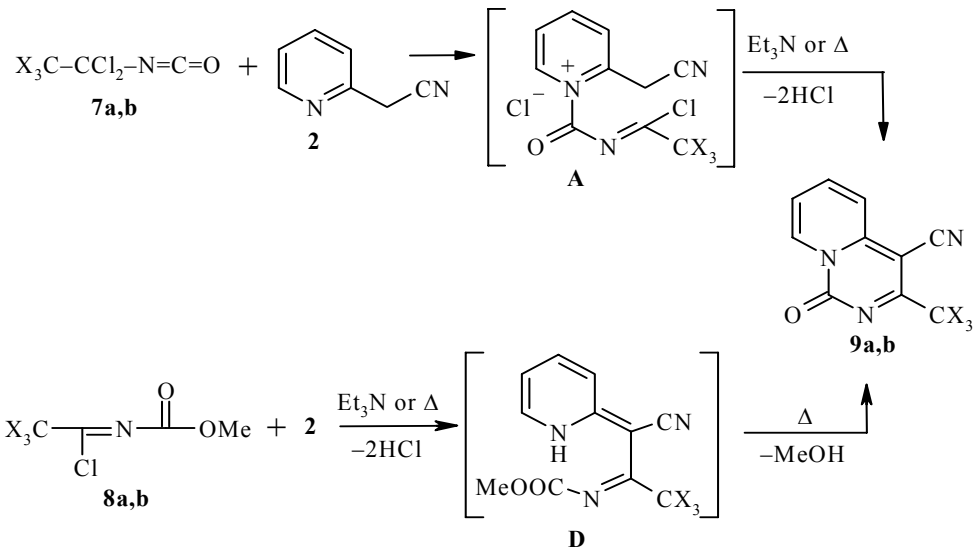
a Ar = Ph, Ar' = 4-MeC_6H_4; **b** Ar = Ar' = 4-MeC_6H_4; **c** Ar = 4-$MeOC_6H_4$, Ar' = 4-MeC_6H_4

It was established that 10 h heating of reactants **5a-c** and **2** in boiling benzene did not give analogs of compound **4** but analogs of compound **3**, *viz*. the 1-imino-1H-pyrido[1,2-*c*]pyrimidines **6a-c** (see Table 1). It is most probable that in this case products of C-alkylation **C** are formed first, which are then cyclized intramolecularly into **6a-c**. The presence in the ^{1}H NMR spectra of compound **6a** (see Table 2) of doublet signals for the 8-H protons at 7.67-7.70, and in the ^{13}C NMR spectra (see Table 3) of compounds **6a,b** of quartets for the $C_{(3)}$ atoms at 63 ppm ($J_{C–F}$ = 27 Hz) reliably confirm the structure proposed.

On investigating the reaction of carbodiimides **5** with 2-cyanomethylpyridine **2** in the presence of an organic base a positive result was obtained only on using N-ethyl-N,N-diisopropylamine as base. It was shown for carbodiimide **5a** as an example, that on using this base **5a** reacts with pyridine **2** by the scheme given above with the formation of compound **6a** in 40% yield.

With the aim of synthesizing unhydrogenated analogs of pyrido[1,2-*c*]pyrimidines **3** and **4** the interaction of 2-cyanomethylpyridine **2** with 1,1-dichloroalkyl isocyanates **7a,b** and N-(1-chloro-2,2,2-trihaloethylidene)-O-methylurethanes **8a,b** was investigated under various experimental conditions. The results

obtained indicate that irrespective of the character of reactants **7** and **8** and also of the reaction conditions, one type of compound is formed, 3-trihalomethyl-1H-pyrido[1,2-*c*]pyrimidin-1-ones **9a,b** (see Tables 1-3). It is logical to propose that thanks to the more electrophilic properties of the heterocumulene group of isocyanates **7a,b,** compared with isocyanates **1a-c,** the more stable pyridinium salts of type **A** are formed initially which, under the action of base or temperature, are dehydrochlorinated into the cyclic system **9**. N-(1-Chloroethylidene)urethanes **8a,b** react with nitrile **2** by a C-iminoalkylation scheme with the formation first of intermediates **D**, the intramolecular condensation of which also leads to heterocycle **9**.



a X = F ; **b** X = Cl

In the IR spectra of pyrido[1,2-*c*]pyrimidines **9a,b** there were absorption bands for the C=O group at 1709-1714 cm^{-1}. The presence in the ^1H NMR spectra of a doublet for 8-H at 9.27-9.35 ppm is in agreement with literature data [6], and in the ^{13}C NMR spectra the signal of the $C_{(1)}$ atom (C=O group) at 148 ppm corresponds to that for the hydrogenated analogs **3a-c**.

EXPERIMENTAL

The IR spectra were recorded on a UR-20 instrument in KBr disks (for compounds **3a** and **4a** also in CH_2Cl_2 solution). The ^1H and ^{19}F NMR spectra of solutions in $(CD_3)_2SO$–CCl_4, 2:1 and the ^{13}C NMR spectra of solutions in $(CD_3)_2SO$ were obtained on a Varian-Gemini spectrometer (300, 188, 75 MHz respectively), internal standards were TMS (^1H, ^{13}C) and CCl_3F (^{19}F).

The initial 1-chloroalkyl isocyanates **1a-c** were obtained by the procedure of [10], 1-chloroalkylcarbodiimides **5a-c** of [11], 1,1-dichloroalkyl isocyanates **7a,b** according to [12,13], and N-(1-chloroethylidene)urethanes **8a,b** according to [14].

3-Aryl-4-cyano-3-trifluoromethyl-2,3-dihydro-1H-pyrido[1,2-*c*]pyrimidin-1-ones (3a-c). A solution of isocyanate **1a-c** (3 mmol) in benzene (15 ml) was added dropwise with stirring to a solution of 2-cyanomethylpyridine **2** (0.354 g, 3 mmol) in benzene (5 ml), and then after 30 min triethylamine (0.31 g, 3.1 mmol) was added. The reaction mixture was stirred for 1 h, left for 24 h, and then filtered. The solid was washed with water, and dried. The filtrate was evaporated, hexane (1 ml) and 2-propanol (10 ml) were added to the oily residue, and the mixture heated to boiling. The precipitate formed on cooling was filtered off, combined with the first portion of solid, and crystallized.

1-Aryl-4-cyano-1-trifluoromethyl-2,3-dihydro-1H-pyrido[1,2-*c*]pyrimidin-3-ones (4a-c). A mixture of isocyanate **1a-c** (3 mmol) and 2-cyanomethylpyridine **2** (0.354 g, 3 mmol) in benzene (20 ml) was boiled for 20 h. The solvent was evaporated, ethanol (6 ml) was added to the residue, the mixture was heated to boiling, and cooled. The resulting solid was filtered off, and dried.

3-Aryl-1-arylimino-4-cyano-3-trifluoromethyl-2,3-dihydro-1H-pyrido[1,2-*c*]pyrimidines (6a-c). A. A mixture of 2-cyanomethylpyridine **2** (0.354 g, 3 mmol) and carbodiimide **5a-c** (3 mmol) in benzene (20 ml) was boiled for 10 h. The solvent was evaporated, and the residue purified by crystallization.

B. A solution of carbodiimide **5a** (0.974 g, 3 mmol) in benzene (15 ml) was added dropwise with stirring to a solution of 2-cyanomethylpyridine **2** (0.354 g, 3 mmol) in benzene (5 ml), and after 30 min N-ethyl-N,N-diisopropylamine (0.4 g, 3.1 mmol) was added. The reaction mixture was stirred for 1 h, left for 96 h, and then filtered. The filtrate was evaporated, ethanol (4 ml) was added to the oily residue, and the mixture heated to boiling. The precipitate formed on cooling was filtered off.

4-Cyano-3-trihalomethyl-1H-pyrido[1,2-*c*]pyrimidin-1-ones (9a,b). A. A solution of isocyanate **7a,b** (2.5 mmol) in benzene (5 ml) was added dropwise with stirring to a solution of 2-cyanomethylpyridine **2** (0.295 g, 2.5 mmol) in benzene (5 ml). After 30 min a solution of triethylamine (0.505 g, 5 mmol) in benzene (5 ml) was added dropwise, the mixture stirred for 3 h, and left for a day. The resulting solid was filtered off, washed with water, dried, and crystallized.

B. A mixture of 2-cyanomethylpyridine **2** (0.295 g, 2.5 mmol) and isocyanate **7a** (2.5 mmol) in benzene (15 ml) was boiled for 15 h. The solvent was evaporated, and the residue crystallized.

C. A mixture of urethane **8a,b** (3 mmol) and triethylamine (0.303 g, 3 mmol) in toluene (10 ml) was added with stirring to a solution of 2-cyanomethylpyridine **2** (0.354 g, 3 mmol) in toluene (5 ml). After 3 h the precipitate of triethylamine hydrochloride was filtered off, the filtrate was left at room temperature for 3-4 days (in the case of urethane **8b**) or boiled for 3 h (in the case of urethane **8a**). The solvent was then evaporated, and the residue purified by crystallization.

D. A mixture of 2-cyanomethylpyridine **2** (0.354 g, 3 mmol) and urethane **8a** (3 mmol) in benzene (15 ml) was boiled for 12 h. The solvent was evaporated, and the residue crystallized.

The X-Ray Structural Investigation of a Monocrystal of Compound 4a of linear dimensions 0.25 × 0.31 × 0.53 mm was carried out at room temperature on an Enraf-Nonius CAD-4 automatic four-circle diffractometer (CuKα radiation, relative scanning rate $2\theta/\omega = 1.2$, $\theta_{max} = 70°$, sphere segment $0 \le h \le 14$, $0 \le k \le 7$, $-21 \le l \le 21$). In all 2951 reflections were selected of which 2560 are symmetrically independent ($R_{int} = 0.01$). The crystals of **4a** are monoclinic, $a = 12.120(10)$, $b = 6.320(6)$, $c = 17.692(11)$ Å, $\beta = 94.84(6)°$, $V = 1350.5$ Å^3, M = 317.27, $Z = 4$, $d_{calc} = 1.56$ g/cm^3, $\mu = 10.8$ cm^{-1}, $F(000) = 650.3$, space group $P2_1/c$. The structure was solved by the direct method and refined by the least-squares method in a full-matrix anisotropic approach using the set of programs CRYSTALS [15]. In the refinement 2325 reflections with $I > 3(I)$ were used (248 parameters being refined, number of reflections per parameter 9.4). All the hydrogen atoms were made apparent from an electron density difference synthesis and were refined isotropically. Calculation of the absorption in the crystal was carried out by the azimuthal scanning method of [16]. In the refinement the weighting scheme of Chebyshev [17] was used with the parameters: 2.46, -0.74, 0.67, -1.16, and -0.10. The final values for the reliability factors were $R = 0.044$ and $R_W = 0.044$, GOF = 0.953. The residual electron density from the Fourier difference series were 0.26 and -0.30 e/Å^3. A full set of the crystallographic data is deposited in the Cambridge Structural Data Bank (No. CCDC 178183).

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