Pyrano[4,3-*d*]pyrimidinium salts
3.* Reactions of 1,3-dimethyl-2,4-dioxo-1*H*,3*H*-pyrano[4,3-*d*]pyrimidinium salts with azomethines

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Reactions of 1,3-dimethyl-2,4-dioxo-1*H*,3*H*-pyrano[4,3-*d*]pyrimidinium salts with azomethines have been studied. The reactions lead to 1,3-dimethyl-2,4-dioxo-1*H*,3*H*-pyrido-[4,3-*d*]pyrimidinium salts and aromatic aldehydes.

Key words: pyrano[4,3-*d*]pyrimidinium salts, azomethines, pyrido[4,3-*d*]pyrimidinium salts, aromatic aldehydes, recyclization.

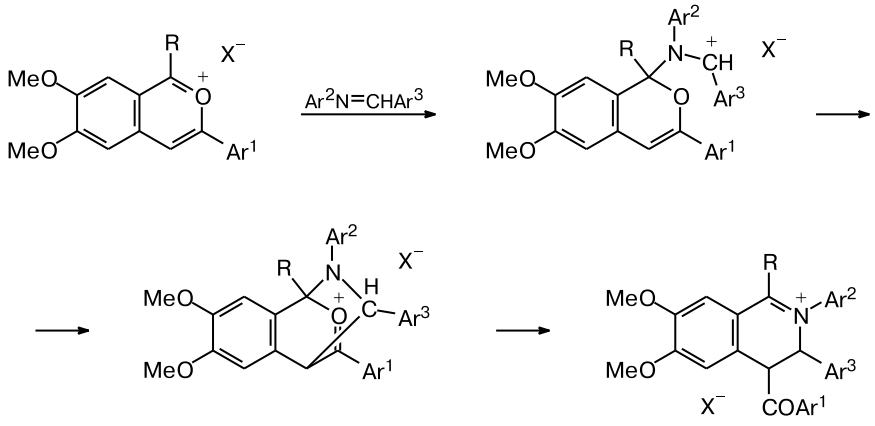
Among various transformations of fused pyrylium salts, reactions with azomethines are of importance. Benzo-[*c*]pyrylium perchlorates quantitatively and stereoselectively add Schiff bases, that leads to derivatives of 3,4-dihydroisoquinolinium salts[2,3] (Scheme 1). Apparently, the process follows a concerted [4+2]-cycloaddition mechanism, since annulation with the benzene ring imparts noticeable heterodiene character to the pyrylium ring.

In the present work, we study the reaction of 1,3-dimethyl-2,4-dioxo-1*H*,3*H*-pyrano[4,3-*d*]pyrimidinium salts with azomethines. The structure of these salts considerably differs from that of benzo[*c*]pyrylium salts, since the uracil fragment is not aromatic[4—6] and cannot significantly disturb aromaticity of the pyrylium fragment in the molecule. It turned out that a short-time heating pyrimidopyrylium salts **1** and **2** with Schiff bases in acetic acid leads to 1,3-dimethyl-2,4-dioxo-1*H*,3*H*-pyrido[4,3-*d*]-pyrimidinium salts **3** and **4** and corresponding aldehydes (Scheme 2). When the experiments were performed in DMF and MeCN at room temperature and upon heating, similar results were obtained.

The structures of the products indicate that the transformation under consideration is an exchange process known for the monocyclic pyrylium salts,[7] in the course of which the onium O atom of the pyrylium ring is substituted for the imine N atom of the azomethine, thus transforming to ammonium.

* For Part 2, see Ref. 1.

Scheme 1



R = H, Ph

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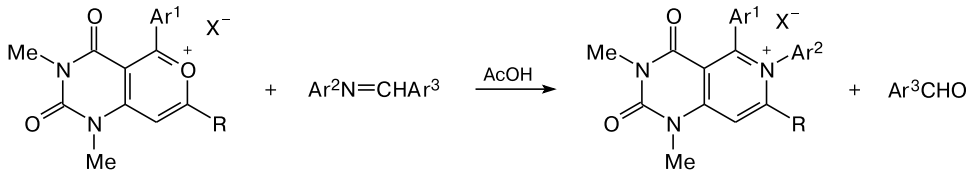
Scheme 2



1a,b, 2a,b **3a—d, 4a—d**

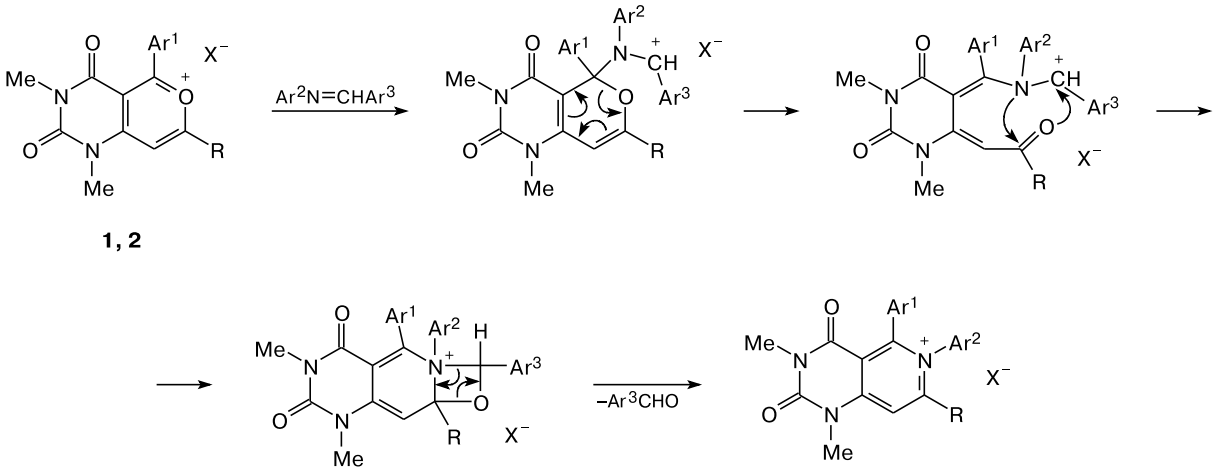
Compound	Ar^1	Ar^2	Ar^3	R	X^-
1a, **3a**	Ph	Ph	Ph	$4\text{-}BrC_6H_4$	Br^-
1a, **3b**	Ph	$4\text{-}MeOC_6H_4$	$4\text{-}MeOC_6H_4$	$4\text{-}BrC_6H_4$	Br^-
1b, **3c**	Ph	$4\text{-}BrC_6H_4$	$4\text{-}MeOC_6H_4$	Ph	Br^-
1b, **3d**	Ph	$4\text{-}FC_6H_4$	$3\text{-}NO_2C_6H_4$	Ph	Br^-
2a, **4a**	$4\text{-}BrC_6H_4$	Ph	Ph	H	ClO_4^-
2a, **4b**	$4\text{-}BrC_6H_4$	$4\text{-}MeOC_6H_4$	$4\text{-}MeOC_6H_4$	H	ClO_4^-
2b, **4c**	Ph	$4\text{-}BrC_6H_4$	$4\text{-}MeOC_6H_4$	H	ClO_4^-
2b, **4d**	Ph	$4\text{-}FC_6H_4$	$3\text{-}NO_2C_6H_4$	H	ClO_4^-

The structurally related *N*-arylpyrido[4,3-*d*]pyrimidinium salts have been obtained by us earlier resulting from the recyclization of pyrimidopyrylium salts upon the action of primary aromatic amines.[8] The ^{1}H NMR spectra of 5,6,7-triarylpyrido[4,3-*d*]pyrimidinium bromides **3** exhibit the signals for the protons of three aromatic substituents in the region δ 6.46—7.68 and the singlet at δ 7.54—7.68, which belongs to the proton C(8)H. The signals for the protons of the *N*-methyl groups in the form of two singlets are found at δ 3.27—3.31 and 3.60—3.77. The ^{1}H NMR spectra of 5,6-diarylpyrido[4,3-*d*]pyrimidinium perchlorates **4** contain signals for the protons of two aromatic substituents in the region δ 6.95—7.57 and two doublets at δ 9.21—9.25 and 8.19—8.24, which are related to the protons C(7)H and C(8)H, respectively. The protons of two methyl groups on the uracil N atoms are found as the singlets at δ 3.17—3.19 and 3.71—3.74. In the IR spectra of pyrimidopyridinium salts **3** and **4**, there are observed the absorption maxima for the carbonyl groups in the region 1615—1690 cm^{-1} (characteristic of the amide carbonyl group absorption[9]), and in the case of perchlorates **4**, there are also absorption bands at 1084—1096 cm^{-1} related to the perchlorate ion.

Taking into account that water is present in the reaction mixture in only trace amounts, we did not consider a possibility of recyclization of the pyrylium ring upon the action of arylamine, which can be formed during hydrolysis of the Schiff base, by a simple nucleophile substitution.[8]

It is possible that pyrylium ring of cations **1** and **2** is transformed to pyridinium one according to the mechanism described earlier[7] for similar reaction in the series of

Scheme 3



1, 2 **3, 4**

Table 1. Yields, melting points, and elemental analysis data for compounds **3a—d** and **4a—d**

Compound	Yield (%)	M.p./°C	Found / Calculated (%)			Molecular formula
			C	H	Hal	
3a	77	>350	55.80 55.98	3.52 3.65	27.39[a] 27.59	$C_{27}H_{21}Br_2N_3O_2$
3b	50	279—284	55.07 55.19	3.88 3.80	26.05[a] 26.23	$C_{28}H_{23}Br_2N_3O_3$
3c	90	290—295	56.24 55.98	3.57 3.65	27.34[a] 27.59	$C_{27}H_{21}Br_2N_3O_2$
3d	78	282—286	62.35 62.56	3.93 4.08	18.76[b] 19.07	$C_{27}H_{21}BrFN_3O_2$
4a	89	309—312	48.41 48.25	3.16 3.28	22.12[c] 22.07	$C_{21}H_{17}BrClN_3O_6$
4b	89	239—242	47.63 47.80	3.53 3.46	20.69[c] 20.87	$C_{22}H_{19}BrClN_3O_7$
4c	86	297—299	48.38 48.25	3.20 3.28	21.96[c] 22.07	$C_{21}H_{17}BrClN_3O_6$
4d	85	289—292	54.47 54.62	3.66 3.71	11.91[d] 11.79	$C_{21}H_{17}ClFN_3O_6$

[a] Hal = Br.
[b] Hal = Br + F.
[c] Hal = Br + Cl.
[d] Hal = Cl + F.

Table 2. IR and ^{1}H NMR spectra of compounds **3a—d** (in $CDCl_3$) and **4a—d** (in DMSO-d_6)

Compound	IR, ν/cm^{-1}	^{1}H NMR, δ (*J*/Hz)
3a	1627, 1690 (C=O)	3.27 (s, 3 H, N(3)Me); 3.73 (s, 3 H, N(1)Me); 6.96—7.11 (m, 5 H, Ar); 7.12—7.24 (m, 5 H, Ar); 7.28 (d, 2 H, 7-Ar, *J* = 8.77); 7.36 (d, 2 H, 7-Ar, *J* = 8.77); 7.54 (s, 1 H, C(8)H)
3b	1624, 1685 (C=O)	3.31 (s, 3 H, N(3)Me); 3.60 (s, 3 H, N(1)Me); 3.80 (s, 3 H, OMe); 6.46 (d, 2 H, Ar, *J* = 8.76); 7.19—7.29 (m, 3 H, Ar); 7.34—7.45 (m, 6 H, Ar); 7.55 (d, 2 H, Ar, *J* = 8.42); 7.64 (s, 1 H, C(8)H)
3c	1628, 1688 (C=O)	3.27 (s, 3 H, N(3)Me); 3.76 (s, 3 H, N(1)Me); 7.05 (d, 2 H, Ar, *J* = 8.85); 7.15—7.35 (m, 6 H, Ar); 7.43—7.51 (m, 4 H, Ar); 7.59—7.68 (d + s, 3 H, Ar, C(8)H, *J* = 6.64)
3d	1615, 1680 (C=O)	3.28 (s, 3 H, N(3)Me); 3.77 (s, 3 H, N(1)Me); 6.56—6.68 (m, 2 H, Ar); 7.15—7.34 (m, 6 H, Ar); 7.46—7.53 (m, 2 H, Ar); 7.58—7.68 (m, 5 H, Ar, C(8)H)
4a	1632, 1686 (C=O); 1084 (Cl—O)	3.17 (s, 3 H, N(3)Me); 3.72 (s, 3 H, N(1)Me); 7.19 (d, 2 H, H(3′), H(5′), 5-Ar, *J* = 8.09); 7.36—7.57 (br.s + d, 7 H, 6-Ar, H(2′), H(6′), 5-Ar, *J* = 8.42); 8.21 (d, 1 H, C(8)H, *J* = 7.41); 9.25 (d, 1 H, C(7)H, *J* = 7.07)
4b	1630, 1683 (C=O); 1096 (Cl—O)	3.19 (s, 3 H, N(3)Me); 3.74 (s, 6 H, N(1)Me, OMe); 6.95 (d, 2 H, H(3″), H(5″), 6-Ar, *J* = 9.09); 7.23 (d, 2 H, H(3′), H(5′), 5-Ar, *J* = 8.42); 7.39 (d, 2 H, H(2″), H(6″), 6-Ar, *J* = 9.09); 7.54 (d, 2 H, H(2′), H(6′), 5-Ar, *J* = 8.42); 8.20 (d, 1 H, C(8)H, *J* = 7.41); 9.21 (d, 1 H, C(7)H, *J* = 7.41)
4c	1625, 1685 (C=O); 1090 (Cl—O)	3.19 (s, 3 H, N(3)Me); 3.74 (s, 3 H, N(1)Me); 7.22—7.36 (m, 5 H, 5-Ar); 7.43 (d, 2 H, H(3″), H(5″), 6-Ar, *J* = 8.53); 7.63 (d, 2 H, H(2″), H(6″), 6-Ar, *J* = 8.85); 8.24 (d, 1 H, C(8)H, *J* = 7.26); 9.23 (d, 1 H, C(7)H, *J* = 7.26)
4d	1615, 1680 (C=O); 1090 (Cl—O)	3.16 (s, 3 H, N(3)Me); 3.71 (s, 3 H, N(1)Me); 7.17—7.31 (m, 7 H, Ar); 7.46—7.54 (m, 2 H, Ar); 8.19 (d, 1 H, C(8)H, *J* = 7.41); 9.21 (d, 1 H, C(7)H, *J* = 7.33)

monocyclic pyrylium salts. The reaction starts from the nucleophilic attack by the azomethine atom N on one of the positions neighboring to the onium atom O, which leads to the ring opening. The intermediate is transformed to the four-membered complex by intramolecular [2+2]-cycloaddition. The latter eliminates an aldehyde molecule to be transformed to *N*-arylpyridinium ion **3**, **4** (Scheme 3).

In conclusion, it was shown that 1,3-dimethyl-2,4-dioxopyrano[4,3-*d*]pyrimidinium derivatives by the reaction with azomethines, like monocyclic pyrylium salts, are transformed to pyridinium salts. In contrast to benzo[*c*]pyrylium salts, the salts studied by us do not give cycloaddition reaction with Schiff bases under analogous conditions.

Experimental

IR spectra were recorded on a Specord IR-71 and Varian FT-IR 1000 spectrophotometers in Nujol. ^{1}H NMR spectra were recorded on a Bruker Avance DPX-250 spectrometer. TLC was performed on aluminium oxide (Reaktiv Ltd.) with $CHCl_3$ as an eluent. Compounds **1** and **2** were synthesized according to the procedures described earlier,[1] azomethines, according to the published procedures.[10,11] In the ^{1}H NMR spectra, assignment of the signals for the protons of the methyl groups of the uracil ring was made based on comparative analysis of the spectra obtained by us earlier for the fused uracil derivatives.[1,8,12,13]

1,3-Dimethyl-2,4-dioxo-1*H*,3*H*-pyrido[4,3-*d*]pyrimidinium salts 3, 4 (general procedure). A suspension of 1,3-dimethyl-2,4-dioxo-1*H*,3*H*-pyrano[4,3-*d*]pyrimidinium salts **1**, **2** (0.5 mmol) and azomethine (0.55 mmol) in AcOH (2 mL) was heated for 10 min, the solution was cooled, a precipitate formed was filtered off, washed with AcOH and Et_2O. If the precipitate of salts **3**, **4** was not formed, the solution was concentrated to dryness, rubbed with diethyl ether, filtered off, and washed with Et_2O. The salt was recrystallized from AcOH and dried at 100 °C.

The formation of aromatic aldehyde Ar^3CHO (see Scheme 3) was fixed by chromatography of the residue obtained after concentration of the filtrates of salts **3** and **4**. A pure sample of the corresponding aldehyde was used for the cospotting.

The yields, melting points, and elemental analysis data for compounds **3** and **4** are given in Table 1, their spectral characteristics, in Table 2.

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