Chemistry of Heterocyclic Compounds, Vol. 42, No. 8, 2006

STUDIES OF 4H-3,1-BENZOXAZINES. 14*. STRUCTURE AND SOME PROPERTIES OF 2-[2-HYDROXYPHENYL(NAPHTHYL)]-1,2-DIHYDRO-4H-3,1-BENZOXAZINES

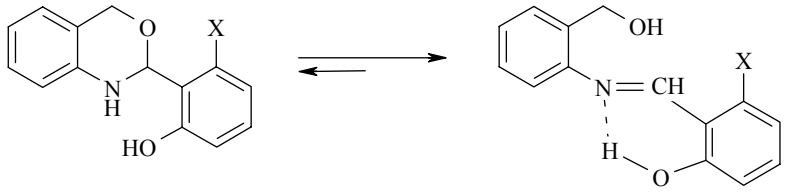
E. V. Gromachevskaya, T. P. Kosulina, and A. A. Borodavko

It has been shown that the condensation of tertiary aminophenylcarbinols with 2-hydroxybenz(naphth)aldehydes gives the corresponding 1,2-dihydrobenzoxazines and their structural Schiff base isomers. The reaction of 2-[2-hydroxyphenyl(naphthyl)]-1,2-dihydro-4H-3,1-benzoxazines with aliphatic aldehydes gives substituted 3,1-benzoxazino[1,2-c][1,3]benz(naphth)oxazines.

Keywords: 3,1-benzoxazino[1,2-*c*][1,3]benz(naphth)oxazines, 2-hydroxybenz(naphth)aldehydes, 1,2-dihydro-4H-3,1-benzoxazines, isomers, mass spectra.

The main method for preparing 1,2-dihydro-4H-3,1-benzoxazines is the condensation of *o*-aminobenzyl alcohols with carbonyl compounds under acid catalysis conditions [2, 3]. Their structure was established by the spectral methods [3, 4]. However, it has been shown that the heterocycle unsubstituted in the 4 position can exist in tautomeric equilibrium with an open (azomethine) form [3]. This tendency is most clearly seen in compounds in which the alternative unsaturated structure is stabilized by an intramolecular hydrogen bond [3, 5].

Extending our investigation in this area by treating the carbinols **1a-c** with the salicylaldehydes **2a-d** in acetic acid medium we have obtained a series of 2,4,4-trisubstituted 1,2-dihydro-4H-3,1-benzoxazines **3a-f** (Scheme 1) and we have studied their properties. A similar reaction of the carbinols **1a,b** with 3-hydroxy-2-naphthaldehyde gave yellow-orange crystals of the naphthylbenzoxazines **4a,b** (Table 1). The cyclic structure for compounds **3a-f** was confirmed by analysis of their IR, UV, and ^{1}H NMR spectra (Table 2).

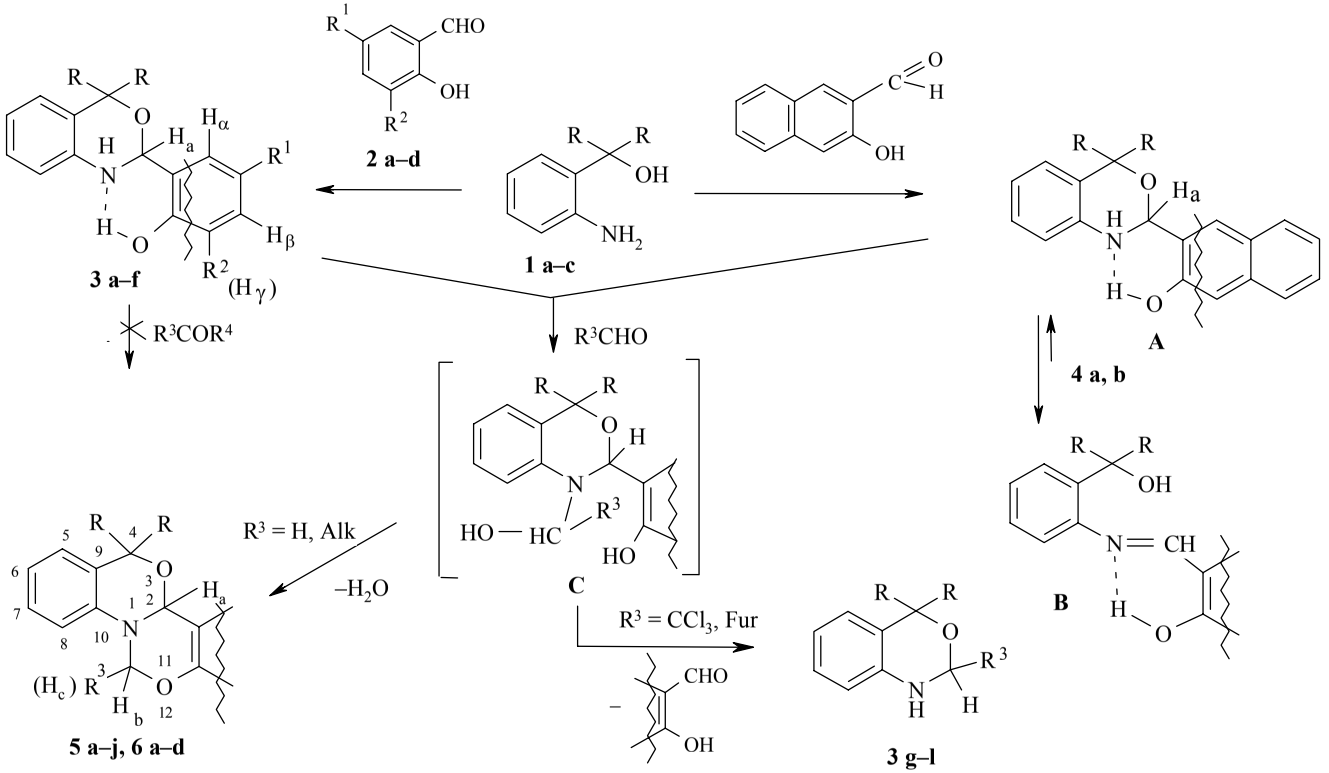


X = H, Br

* For Communication 13 see [1].

Kuban State Technological University, Krasnodar 350072, Russia; e-mail: kosylina@rambler.ru.
Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 8, pp. 1230-1241, August, 2006. Original article submitted April 22, 2004; revision submitted September 28, 2005.

Scheme 1



1 a R = Ph, **b** R = Et, **c** R = Me; **2 a** R^1 = H, **b** R^1 = NO_2, **c,d** R^1 = Br, **a-c** R^2 = H, **d** R^2 = NO_2; **3 a-d,g,j-l** R = Ph, **e,h** R = Et, **f,i** R = Me, **a** R^1 = H, **b**,**e**,**f** R^1 = NO_2, **c,d** R^1 = Br, **a-c,e,f** R^2 = H, **d** R^2 = NO_2, **g-i** R^3 = 5-methylfuryl-2, **j** R^3 = furyl-2, **k** R^3 = 5-nitrofuryl-2, **l** R^3 = CCl_3; **4 a** R = Ph, **b** R = Et; **5 a-g** R = Ph, **h,i** R = Et, **j** R = Me, **a**,**e**,**g** R^1 = H, **b-d**,**f**,**h-j** R^1 = NO_2, **a-j** R^2 = H, **a,c,h,j** R^3 = H, **b** R^3 = *n*-Pr, **d** R^3 = *n*-C_6H_{13}, **e,f,i** R^3 = Me, **g** R^3 = *i*-Bu; **6 a,c,d** R = Ph, **b** R = Et, **a,b** R^3 = H, **c** R^3 = Me, **d** R^3 = *n*-C_6H_{13}

TABLE 1. Physicochemical Characteristics of Compounds **3a-i, 5a-j, 6a-d**

Compound	Empirical formula	Found, % / Calculated, %			mp, °C	R_f (benzene)	Yield, %
		C	H	N			
3a	$C_{26}H_{21}NO_2$	82.53 / 82.32	5.31 / 5.54	3.92 / 3.69	160-170	0.35	75
3b	$C_{26}H_{20}N_2O_4$	73.85 / 73.58	4.55 / 4.72	6.35 / 6.60	155-158	0.30	72
3c	$C_{26}H_{20}BrNO_2$	68.33 / 68.27	4.42 / 4.38	3.10 / 3.06	146-148	0.80	65
3d	$C_{26}H_{19}BrN_2O_4$	62.21 / 62.15	3.72 / 3.78	5.49 / 5.58	191-193	0.65	65
3e	$C_{18}H_{20}N_2O_4$	65.52 / 65.58	6.42 / 6.09	8.92 / 8.54	123-125	0.30	65
3f	$C_{16}H_{16}N_2O_4$	64.08 / 64.00	5.42 / 5.33	9.28 / 9.33	130-132	0.35	60
3g	$C_{25}H_{11}NO_2$	81.78 / 81.74	5.59 / 5.72	3.68 / 3.81	163-165	0.75	60
3h	$C_{17}H_{21}NO_2$	75.32 / 75.28	7.61 / 7.75	5.05 / 5.17	45-47	0.6	55
3i	$C_{15}H_{17}NO_2$	74.18 / 74.07	6.83 / 6.99	5.59 / 5.76	109-110	0.45	52
5a	$C_{27}H_{21}NO_2$	82.42 / 82.86	5.62 / 5.37	3.20 / 3.58	215	0.59	70
5b	$C_{30}H_{26}N_2O_4$	75.74 / 75.31	5.31 / 5.44	5.52 / 5.86	170-172	0.70	55
5c	$C_{27}H_{20}N_2O_4$	74.55 / 74.31	4.31 / 4.58	6.15 / 6.42	228-230	0.60	65
5d	$C_{33}H_{32}N_2O_4$	76.48 / 74.15	6.34 / 6.15	5.12 / 5.38	200-201	0.75	45
5e	$C_{28}H_{23}NO_2$	82.51 / 82.96	5.83 / 5.68	3.21 / 3.46	200-205	0.73	60
5f	$C_{28}H_{22}N_2O_4$	74.42 / 74.67	4.65 / 4.89	6.53 / 6.22	218-220	0.40	60
5g	$C_{31}H_{29}NO_2$	83.57 / 83.22	6.72 / 6.48	3.28 / 3.13	172-173	0.57	60
5h	$C_{19}H_{20}N_2O_4$	67.42 / 67.06	5.62 / 5.88	8.48 / 8.23	123-124	0.70	65
5i	$C_{20}H_{22}N_2O_4$	67.45 / 67.79	6.03 / 6.21	7.64 / 7.90	140-142	0.55	68
5j	$C_{17}H_{16}N_2O_4$	65.32 / 65.38	5.16 / 5.12	8.91 / 8.97	135-137	0.65	70
6a	$C_{31}H_{23}NO_2$	84.72 / 84.35	5.44 / 5.21	3.41 / 3.17	250-252	0.48	72
6b	$C_{23}H_{23}NO_2$	80.21 / 80.80	6.82 / 6.66	4.11 / 4.06	102-105	0.52	70
6c	$C_{32}H_{25}NO_2$	84.58 / 84.39	5.22 / 5.49	3.35 / 3.07	236-237	0.68 (benzene + ether)	65
6d	$C_{37}H_{35}NO_2$	84.82 / 84.57	6.31 / 6.67	2.43 / 2.67	198-201	0.58	35

The IR spectra of these compounds show absorbance stretching bands for the N–H bonds at 3320-3350 cm^{-1} and broad OH absorption stretching bands in the region 3000-3600 cm^{-1} which point to the presence of an intramolecular hydrogen bond [6]. In addition, the IR spectra of compounds **4a,b** show both the OH and NH group absorption bands at 3600-3030 cm^{-1} and also stretching bands for the azomethine fragment at 1630-1610 cm^{-1}.

TABLE 2. Spectroscopic Characteristics of Compounds **3a-i, 5a-j, 6a-d**

Com-pound	IR spectrum, ν, cm^{-1} (vaseline oil)	^1H NMR spectrum ($CDCl_3$)*, δ, ppm (*J*, Hz)
1	2	3
3a	3330 (NH); 3200-3070 (OH)	4.40 (1H, br. s, NH); 5.60 (1H, s, H-a); 6.90 (8H, m, H_{arom}); 7.27 (10H, m, $(C_6H_5)_2$); 8.40 (1H, br. s, OH)
3b	3350 (NH); 3300-3100 (OH); 1520, 1325 (NO_2)	4.45 (1H, br. s, NH); 5.60 (1H, s, H-a); 6.80 (5H, m, C_6H_4 + H_γ); 7.32 (10H, m, $(C_6H_5)_2$); 7.95 (1H, s, H-α); 8.15 (1H, d, $^3J_{\beta\gamma}$=8.0, H-β); 9.50 (1H, br. s, OH)
3c	3600-3200 (OH), 3320 (NH)	5.70 (1H, s, H-a); 6.30 (1H, s, NH); 6.90 (16H, m, H_{arom}); 7.75 (1H, s, H-a); 9.70 (1H, s, OH)
3d	3600-3300 (OH), 3320 (NH); 1520, 1350 (NO_2)	5.80 (1H, s, H-a); 6.20 (1H, br. s, NH); 6.55 (1H, dd, H-7), 6.62 (1H, d, H-8), 6.75 (1H, d, H-5), 7.00 (1H, dd, H-6), $^3J_{8,7}$= 7.7; $^3J_{7,6}$= 6.5; $^3J_{5,6}$= 7.7; 7.30 (10H, m, $(C_6H_5)_2$); 8.15 and 8.17 (2H, ss, H-α + H-β); 10.55 (1H, br. s, OH)
3e	3340 (NH);] 3250-3300 (OH); 1510, 1330 (NO_2)	0.55 and 1.25 (6H, two t, $(CH_3)_2$), 1.60, 1.80, 2.15 and 2.25 (4H, four q, $(CH_2)_2$), $^3J_{CH_2CH_3}$= 7.0; 4.52 (1H, br. s, NH); 5.45 (1H, s, H-a); 7.10 (5H, m, (C_6H_4) + H-γ); 8.15 (1H, d, $^3J_{\beta\gamma}$= 7.7; H-β); 8.25 (1H, s, H-α); 9.20 (1H, br. s, OH)
3f	3400-3100 (OH); 3300 (NH); 1530, 1310 (NO_2)	1.55 and 1.62 (6H, two s, $(CH_3)_2$); 5.80 (1H, br. s, NH); 5.90 (1H, s, H-a); 6.80 (5H, m, (C_6H_4) + H-γ); 8.00 (1H, d, $^3J_{\beta\gamma}$= 7.5, H-β); 8.35 (1H, s, H-α); 10.85 (1H, br. s, OH)
3g	3450 (NH)	2.25 (3H, s, CH_3); 4.35 (1H, d, NH), 5.45 (1H, d, H-a), $^3J_{H\alpha NH}$ = 5.0; 5.85 (1H, d, H_{4fur}), 6.30 (1H, d, H_{3fur}), $^3J_{3,4}$= 3.0; 6.85 (4H, m, C_6H_4); 7.25 (10H, m, $(C_6H_5)_2$)
3h	3400 (NH)	0.6 and 1.0 (6H, two t, $(CH_3)_2$), 1.60, 1.80, 1.92 and 2.15 (4H, four q, $(CH_2)_2$), $^3J_{CH_2CH_3}$= 7.5; 2.35 (3H, s, CH_3); 5.50 (1H, s, H-a); 5.85 (1H, br. s, NH); 6.00 (1H, d, H_{4fur}), 6.35 (1H, d, H_{3fur}) $^3J_{3,4}$= 3.0; 6.80 (4H, m, C_6H_4)
3i	3360 (NH)	1.50 and 1.60 (6H, two s, $(CH_3)_2$); 2.35 (3H, s, CH_3); 5.55 (1H, s, H-a); 5.90 (1H, br. s, NH); 6.00 (1H, d, H_{4fur}), 6.35 (1H, d, H_{3fur}), $^3J_{3,4}$= 3.0; 6.80 (4H, m, C_6H_4)
5a	—	5.15 and 5.25 (2H, two d, $^2J_{bc}$= 8.0, H_b+H_c); 5.35 (1H, s, H_a); 7.20 (18H, m, H_{arom})
5b	1510, 1330 (NO_2)	0.90 (3H, t, $^3J_{CH_2CH_3}$= 6.5, CH_3); 1.51 (4H, m, $(CH_2)_2$); 5.40 (1H, s, H_a); 5.72 (1H, t, $^3J_{CHCH_2}$= 5.0, H_b); 7.10 (15H, m, C_6H_4+$(C_6H_5)_2$+H_γ), 8.05 (1H, s, H_α); 8.20 (1H, d, $^3J_{\beta\gamma}$= 7.8, H_β)
5c	1520, 1340 (NO_2)	5.35 and 5.45 (2H, two d, $^2J_{bc}$= 7.5, H_b+H_c); 5.55 (1H, s, H_a); 7.25 (15H, m, C_6H_4+$(C_6H_5)_2$+H_γ); 7.90 (1H, s, H_α); 8.20 (1H, d, $^3J_{\beta\gamma}$= 8.0, H_β)
5d	1520, 1330 (NO_2)	0.85 (3H, t, $^3J_{CH_2CH_3}$= 7.0, CH_3); 1.65 (10H, m, $(CH_2)_5$); 5.30 (1H, s, H_a); 5.95 (1H, t, $^3J_{CHCH_2}$= 5.5, H_b); 7.25 (15H, m, C_6H_4+$(C_6H_5)_2$+H_γ); 7.85 (1H, s, H_α); 8.20 (1H, d, $^3J_{\beta\gamma}$= 7.5, H_β)
5e	—	1.62 (3H, d, CH_3), 5.35 (1H, q, H_b), $^3J_{CHCH_3}$= 6.0; 5.50 (1H, s, H_a); 7.25 (18H, m, H_{arom})
5f	1510, 1350 (NO_2)	1.57 (3H, d, CH_3), 5.45 (1H, q, H_b), $^3J_{CHCH_3}$= 6.0; 5.75 (1H, s, H_a); 7.15 (15H, m, C_6H_4+$(C_6H_5)_2$+H_γ); 7.9 (1H, s, H_α); 8.2 (1H, d, $^3J_{\beta\gamma}$= 7.6, H_β)
5g	—	1.10 (6H, d, $^3J_{CHCH_3}$= 6.9, $(CH_3)_2$); 1.57 (2H, m, CH_2); 2.55 (1H, m, CH); 5.40 (1H, s, H_a); 5.71 (1H, t, $^3J_{CHCH_2}$= 5.0, H_b); 7.05 (18H, m, H_{arom})
5h	1510, 1330 (NO_2)	0.55 and 1.20 (6H, two t, $(CH_3)_2$), 1.65, 1.82, 2.15 and 2.35 (4H, four q, $(CH_2)_2$), $^3J_{CH_2CH_3}$= 7.0; 5.05 (2H, s, H_b+H_c); 5.45 (1H, s, H_a); 7.20 (5H, m, C_6H_4+H_γ); 8.15 (1H, d, $^3J_{\beta\gamma}$= 7.8, H_β); 8.25 (1H, s, H_α)
5i	1520, 1330 (NO_2)	0.58 and 1.18 (6H, two t, $(CH_3)_2$), 1.55 (3H, d, CH_3), 1.65, 1.85, 2.15 and 2.28 (4H, four q, $(CH_2)_2$), $^3J_{CH_2CH_3}$ = 7.0, 5.30 (1H, q, $^3J_{CHCH_3}$ = 5.5, H_b); 5.45 (1H, s, H_a); 7.15 (5H, m, C_6H_4+H_γ); 8.15 (1H, d, $^3J_{\beta\gamma}$ = 7.8, H_β); 8.20 (1H, s, H_α)

TABLE 2 (continued)

1	2	3
5j	1520, 1340 (NO_2)	1.50 and 1.65 (6H, two s, $(CH_3)_2$); 5.25 and 5.35 (2H, two s, H_b+H_c); 5.50 (1H, s, H_a); 7.10 (5H, m, C_6H_4+H_γ); 8.10 (1H, d, $^3J_{\beta\gamma}$ = 7.7, H_β); 8.35 (1H, s, H_α)
6a	3030, 1610, 1590; 1080, 1040	5.10 (1H, d, H_b), 5.42 (1H, d, H_c), $^2J_{bc}$ = 8.0; 5.65 (1H, s, H_a); 7.35 (20H, m, H_{arom})
6b	3030, 1610, 1580; 1070, 1030	0.42 (3H, t, $CH_{3(a)}$), 1.25 (3H, t, $CH_{3(e)}$), $^3J_{CH_2CH_3}$= 7.1; 2.08 (4H, m, $(CH_2)_2$); 4.95 (1H, d, H_b), 5.20 (1H, d, H_c), $^2J_{bc}$ = 7.0; 5.90 (1H, s, H_a); 7.50 (10H, m, H_{arom})
6c	3030, 1610, 1580; 1080, 1060	1.68 (3H, m, CH_3); 5.80 (1H, s, H_a); 6.35 (1H, q, $^3J_{CHCH_3}$= 6.0, H_b); 7.10 (20H, m, H_{arom})
6d	30.30, 1590, 1580, 1050, 1100	0.80 (3H, t, $^3J_{CH_2CH_3}$= 6.0, CH_3); 1.22 (10H, m, $(CH_2)_5$); 5.85 (1H, t, $^3J_{CHCH_2}$ = 7.0, H_b); 7.05 (1H, s, H_a); 7.45 (20H, m, H_{arom})

* ^{1}H NMR spectrum of compounds **5c,d** recorded in DMSO-d_6.

The UV spectra of compound **3a** show the presence of two absorption maxima at 242 and 277 nm which are typical of a benzoxazine structure [2]. However, the UV spectra of compounds **4a,b** show both the short wavelength maximum absorptions at 231 and 263 nm (structure **A**) and also two long wavelength maxima at 317 and 450 nm which are evidently typical of a longer chain π-π* and *p*-π* conjugated azomethine system (**B**) which points to the presence of these compounds as a tautomeric equilibrium of the cyclic (**A**) and linear (**B**) forms in the alcohol solvents [6].

The ^{1}H NMR spectra of compounds **3a-f** show broad singlets for the phenolic groups at 8.4-10.8, NH protons at 4.4-6.3, and the H_a proton singlets at 5.4-5.9 ppm and this confirms the cyclic structure of the benzoxazines. At the same time, the ^{1}H NMR spectra of compounds **4a,b** show signals for both the protons of the cyclic form **A** (H_a at 4.2-4.8, phenolic OH at 8.81-9.25, and NH protons at 8.08-8.35 ppm) and also for the linear (azomethine) form **B** (CH=N at 8.55, OH_{phen} 9.68-9.80, and OH_{alc} 6.32-6.42 ppm). Comparison of the integrated intensities of these signals shows that the ratio of forms **A** to **B** is 1:4.

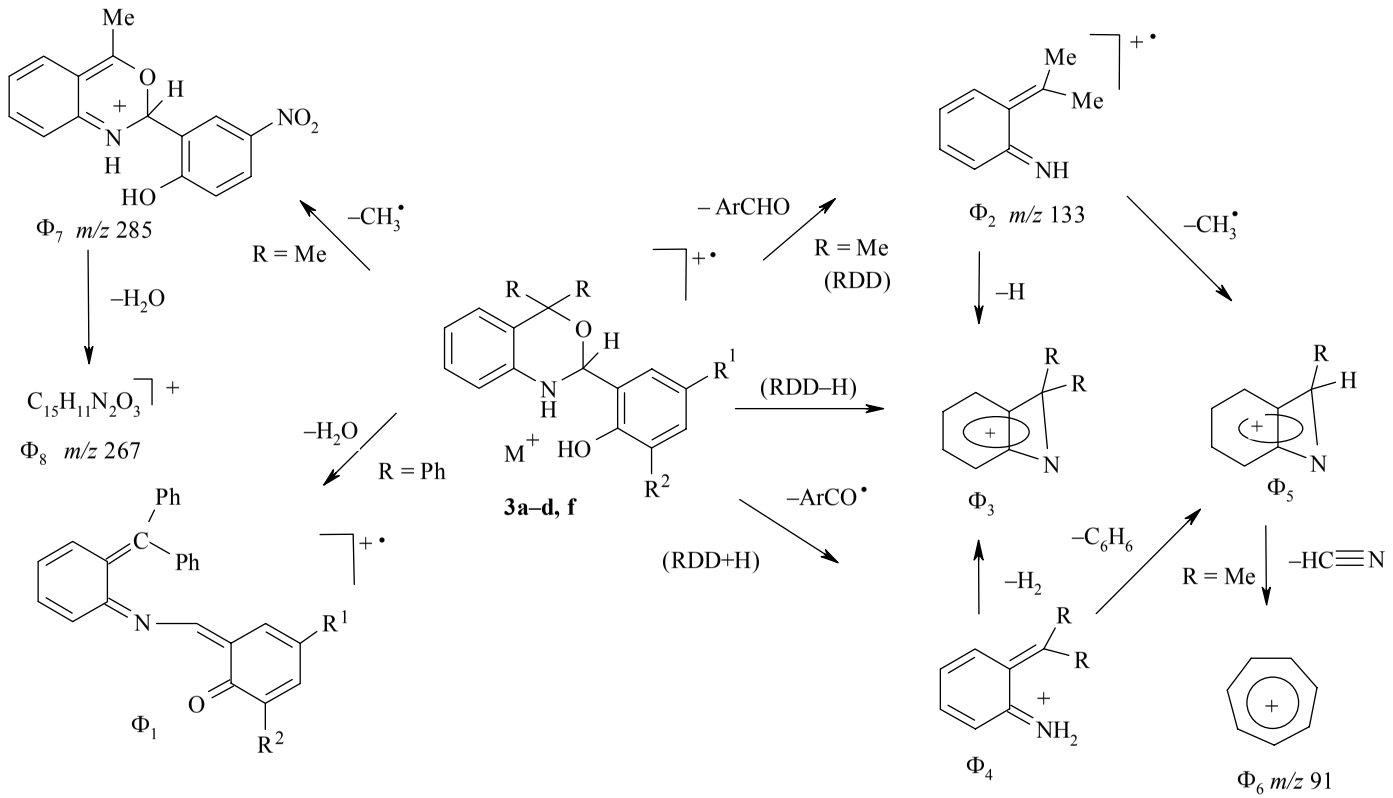
Analysis of the mass spectra of compounds **3a-d,f** and **4a,b** (Table 3) shows the presence of the sample molecular ion peaks $[M]^+$. The fragmentation of M^+ for the dihydrobenzoxazines **3a-d,f** (Scheme 2) is characterized by the fission of a 2-hydroxybenzaldehyde [retrodiene decomposition (RDD)] or of an aromatic aldehyde radical (RDD + H) to give ions Φ_2 and Φ_4 which, in turn, lose an atom or molecule of hydrogen Φ_3 (RDD – H process). The ions Φ_2-Φ_4 are typical of the mass spectroscopic decomposition of M^+ in 2,4-substituted 1,2-dihydro-4H-3,1-benzoxazines [4].

An additional fragmentation event for the molecular ion in these compounds is the loss of water to form the ion Φ_1 which is specific to the decomposition of saturated alcohols [7] and can point to the presence of the hydroxyl group in the structures studied. Hence on the basis of the spectroscopic analytical data (see Tables 2 and 3) we have shown that the products **3a-f** are substituted dihydrobenzoxazines and compounds **4a,b** are a mixture of the structural isomers **A** and **B** (see Scheme 1) with the latter predominating.

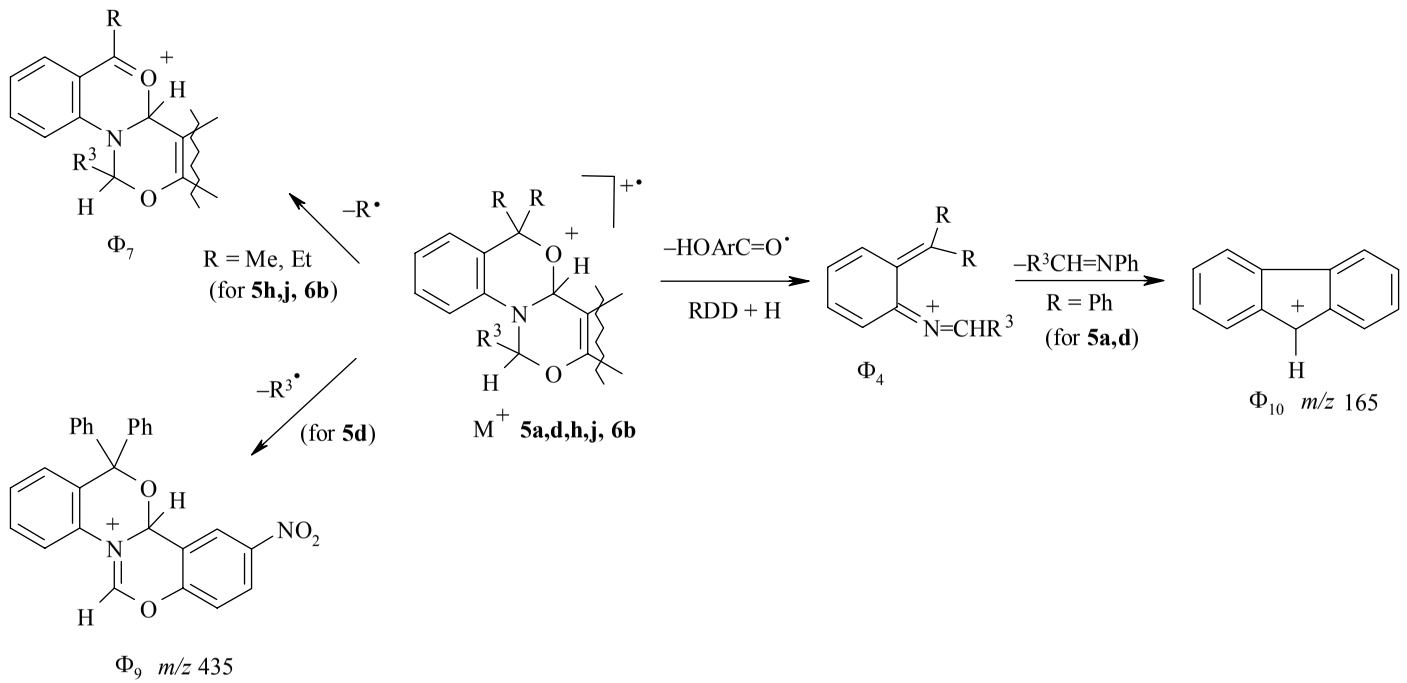
The dihydrobenzoxazines **3a-d** and **4a,b** (form **A**) have two potential reaction centers able to interact with carbonyl compounds, i.e. the amino NH and phenol groups. The reactivity of such systems in similar reactions has been studied before for dihydroquinazolinones [8] which have a hydroxyl group in the β-position of an aryl substituent placed at position 2 of the heterocycle. Such a reaction for dihydrobenzoxazines has been little studied and only isolated examples have been reported [5, 9].

We have studied the reactions of compounds **3a,b,e,f** and **4a,b** with aliphatic, aromatic, and furan aldehydes.

Scheme 2


Me
O
H
+
N
H
NO2
HO
Φ7 m/z 285
–CH3•
R = Me
–H2O
C15H11N2O3 +
Φ8 m/z 267
–H2O
R = Ph
Ph
C
Ph
N
R1
O
R2
Φ1
+•
R
R
O
H
N
H
M+
HO
R1
R2
3a–d, f
– ArCHO
R = Me
(RDD)
(RDD–H)
–ArCO•
(RDD+H)
Me
Me
NH
Φ2 m/z 133
–CH3•
–H
R
R
N
Φ3
R
H
N
Φ5
–H2
–C6H6
R = Me
–HC≡N
R
R
NH2
Φ4
Φ6 m/z 91

Scheme 3


R
O
H
N
R3
H
O
Φ7
R = Me, Et
(for 5h,j, 6b)
–R•
–R3•
(for 5d)
Ph Ph
O
H
N
NO2
H
O
Φ9 m/z 435
R R
O
H
N
R3
H
O
+•
M+ 5a,d,h,j, 6b
–HOArC=O•
RDD + H
R
R
N=CHR3
Φ4
–R3CH=NPh
R = Ph
(for 5a,d)
H
Φ10 m/z 165

It was found that the dihydrobenzoxazines **3a,b,e,f** and **4a,b** react with aliphatic aldehydes in acetic acid [2] to give 45-70% yields of the corresponding tetra(penta)cyclic structures 3,1-benzoxazino[1,2-*c*][1,3]-benzoxazines **5a-j** and 3,1-benzoxazino[1,2-*c*][1,3]naphthoxazines **6a-d**. The preparation of the latter is possible in the case of a shift of the **A** to **B** tautomeric equilibrium to the side of the cyclic form **A** which takes part in the reaction (see Scheme 1 and Tables 1 and 2).

The yields and ease of carrying out the reactions reported depend on the size of the radical of the attacking aliphatic aldehyde. With formaldehyde the reaction occurs at room temperature. The reaction of compound **3b** and the mixture of isomers **4a** with heptanal occurs at a higher temperature (34-36°C) for 3 h to give the products **5d** and **6d** in 45 and 35% yields respectively (Table 1). Monitoring of the reaction was carried out by TLC.

The ^{1}H NMR spectra of compounds **5a,c** and **6a,b** show H_b and H_c geminal proton signals as two doublets and in compounds **5f,i, 6c** and **5d,g, 6d** the H_a signal appears as quadruplets and triplets respectively (Table 2) thus confirming the structure of the heterocycle. In the ^{1}H NMR spectra of compounds **5h,j** the doublet splitting of the H_b and H_c protons is absent but the tetracyclic structure of these compounds is confirmed by mass spectroscopic data with the fragmentation of the molecular ions $[M]^+$ following the overall scheme (Table 3 and Scheme 3). Initial mass spectroscopic decomposition of M^+ in compounds **5a,d,h,j, 6b** occurs with fission of 2-hydroxybenz(naphth)oyl (RDD + H process [4]) and aliphatic R and R^3 radicals to give the cations Φ_4, Φ_7, and Φ_9 respectively.

TABLE 3. Mass Spectra of Compounds **3a-d,f, 4a,b, 5a,d,h,j, 6b**

Com-pound*	*m/z* (I_{rel}, %)*[2]
3a	379 (12), 361 (23), 258 (30), 256 (100), 255 (16), 254 (22), 180 (95), 165 (30), 152 (22), 121 (30), 105 (26), 77 (38)
3b	424 (25), 406 (15), 258 (23), 256 (100), 255 (19), 254 (20), 180 (45), 165 (18), 105 (19), 77 (30)
3c	457 (20), 439 (90), 272 (6), 258 (50), 256 (100), 255 (31), 254 (38), 180 (35), 165 (15), 152 (10), 105 (12), 77 (18)
3d	502 (10), 484 (8), 258 (10), 256 (100), 254 (15), 180 (22), 165 (5), 105 (8), 77 (5)
3f	300 (28), 285 (18), 282 (5), 267 (9), 144 (30), 134 (60), 133 (100), 132 (65), 118 (28), 106 (10), 91 (31), 77 (16)
4a	429 (28), 411 (95), 272 (18), 258 (51), 256 (100), 255 (81), 254 (38), 180 (60), 172 (13), 165 (42), 105 (30), 77 (71)
4b	333 (29), 315 (5), 304 (35), 286 (13), 162 (36), 160 (100), 159 (40), 144 (61), 132 (20), 115 (40), 91 (15), 77 (20)
5a	391 (25), 313 (10), 270 (100), 194 (5), 180 (9), 165 (22), 152 (8), 132 (3), 121 (8), 105 (4), 91 (10), 77 (12)
5d	520 (52), 435 (80), 354 (100), 270 (19), 254 (3), 206 (4), 180 (3), 165 (22), 91 (3), 77 (4)
5h	340 (18), 311 (100), 265 (6), 174 (12), 144 (10), 132 (15), 130 (15), 118 (6), 91 (8), 77 (10)
5j	312 (15), 297 (12), 146 (100), 131 (20), 130 (30), 118 (10), 117 (13), 106 (6), 91 (18), 77 (16)
6b	345 (15), 316 (48), 174 (100), 144 (39), 132 (21), 130 (40), 118 (27), 115 (33), 91 (19), 77 (35)

* Compound **3g** M^+ = 367; compound **3h** M^+ = 271.

*[2] M^+ peaks and ion intensities are given. For compounds **3c,d** the *m/z* values are calculated for the lighter halogen isotope.

According to the mechanism of interaction of aminoalcohols with aldehydes [10, 11] the first stage in the formation of the 3,1-benzoxazino[1,2-*c*][1,3]benz(naphth)oxazines **5a-j, 6a-d** is likely a nucleophilic addition of the amino group of the dihydrobenz(naphth)oxazines **3a-d**, **4a,b** to the carbonyl carbon to form the intermediate **C** (see Scheme 1). Further reaction can then occur by two routes which are determined by the structure both of the benzoxazines and the aldehyde. Formation of an additional six-membered heterocycle and thus the structure **5a-j**, **6a-d** is characteristic only of aliphatic aldehydes. On changing to more bulky or aromatic aldehydes (chloral, furfural, nitrofurfural, or methylfurfural) exchange in the starting substrate of a 2-hydroxyphenyl(naphthyl) or 2-hydroxy-5-nitrophenyl radical for the attacking aldehyde occurs. The parameters for the dihydrobenzoxazines **3j-l** formed agree with those given in [4]. The data for the dihydrobenzoxazines **3a-i** are recorded for the first time by us and are given in the Experimental and in Tables 1 and 2.

The dihydrobenzoxazines **3a-d** do not react with ketones (acetone, methylethyl ketone), probably as a result of steric hindrance.

EXPERIMENTAL

IR spectra were taken on Specord-71 and Infralum FT-02 instruments using vaseline oil or in CCl_4 and ^1H NMR spectra on Tesla BS-467 (60 MHz), Varian VXR-400 (400 MHz), or Bruker DRX 500 (500 MHz) instruments using TMS as internal standard. Mass spectra were obtained on a Varian MAT CH-6 instrument with direct introduction of the sample into the ionization chamber at a temperature of 50-180°C and ionization energy of 70 eV. Electronic spectra were recorded on a Specord UV-vis spectrometer using ethanol. TLC was carried out on Silufol UV-254 plates using the system benzene–ether (4:1) and were revealed using iodine vapor.

***o*-Aminophenylcarbinols 1a-c** were prepared by reaction of methyl anthranilate with the corresponding alkylmagnesium halide [2]. Carbinol **1b**. Yield 76%; mp 59-60°C. Found, %: C 73.9; H 9.20; N 7.6. $C_{11}H_{17}NO$. Calculated, %: C 74.2; H 9.5; N 7.8.

Dihydrobenzoxazines 3a-f were prepared by method [2] in acetic acid at room temperature.

Mixture of 2-(2-Hydroxynaphthyl)-4,4-diphenyl-1,2-dihydro-4H-3,1-benzoxazine (4a, A) and *o*-(3-Hydroxy-2-naphthylideneaminophenyl)diphenylmethanol (4a, B). 3-Hydroxy-2-naphthaldehyde (1.1 g, 6.4 mmol) was added to a vigorously stirred solution of the carbinol **1a** (1.76 g, 6.4 mmol) in acetic acid (5-7 ml) and the mixture was heated for 2 h on a water bath at 40-50°C. The product was cooled and the precipitate formed was filtered off and washed with a small amount of acetic acid and water. Yield 72%, mp 160-164°C. IR spectrum (thin layer), ν, cm^{-1}: 3600, 3540, 3200, 3030, 1610, 1590. UV spectrum (EtOH), λ_{max}, nm (log ε): 231 (4.65), 263 (4.6), 317 (3.99), 450 (4.01). ^1H NMR spectrum (DMSO-d_6), δ, ppm: **A** 8.81 (1H, s, OH_{Ph}); 8.08 (1H, s, NH); 6.5-7.8 (20H, m, H_{arom}); 4.2 (1H, s, H_a). **B** 9.68 (1H, s, OH_{Ph}); 8.55 (1H, s, CH=N); 6.5-7.8 (20H, m, H_{arom}) and 6.42 (1H, s, OH_{alc}). Found, %: C 84.72; H 5.44; N 3.41. $C_{31}H_{23}NO_2$. Calculated, %: C 84.35; H 5.21; N 3.17. M^+ 429.

Mixture of 4,4-Diethyl-2-(2-hydroxynaphthyl)-1,2-dihydro-4H-3,1-benzoxazine (4b, A) and *o*-(3-Hydroxy-2-naphthylideneaminophenyl)diethylmethanol (4b, B) was obtained similarly. Yield 70%; mp 98-103°C. IR spectrum (thin layer), ν, cm^{-1}: 3400, 3290, 3100, 3030, 1630, 1590, 1580. ^1H NMR spectrum (DMSO-d_6), δ, ppm: **A** 9.25 (1H, s, OH_{Ph}); 8.35 (1H, s, NH); 6.7-7.8 (10H, m, H_{arom}); 4.8 (1H, s, H_a); 2.25 (4H, m, $2CH_2$) and 0.95 (6H, t, $2CH_3$). **B** 9.80 (1H, s, OH_{Ph}); 8.55 (1H, s, CH=N); 6.7-7.8 (10H, m, H_{arom}); 6.32 (1H, s, OH_{alc}); 1.75 (4H, m, $2CH_2$); 0.75 (6H, t, $2CH_3$). Found, %: C 80.21; H 6.82; N 4.11. $C_{23}H_{23}NO_2$. Calculated, %: C 80.80; H 6.66; N 4.06. M^+ 333.

2-(5-Methylfur-2-yl)-4,4-diphenyl-1,2-dihydro-4H-3,1-benzoxazine (3g). A. A solution of 5-methylfurfural (0.09 g, 0.84 mmol) in acetic acid (2-3 ml) was added in small portions with vigorous stirring

to a solution of the benzoxazine **3a** (0.32 g, 0.84 mmol) in acetic acid (5 ml) at room temperature and stirred for 30-40 min. The precipitated crystals were filtered off, recrystallized from alcohol, and dried. Yield 0.18 g (60%).

B. A solution of 5-methylfurfural (0.09 g, 0.84 mmol) in acetic acid (3 ml) was added in small portions to a solution of the dihydrobenzoxazine **4a** (a mixture of **A** and **B** isomers) (0.38 g, 0.84 mmol) in acetic acid (5 ml). The mixture was heated on a water bath at 40-45°C for 2-3 h until the yellow color had disappeared. It was then cooled, recrystallized from alcohol, and dried. Yield 0.14 g (45%).

4,4-Diethyl(methyl)-2-(5-methylfur-2-yl)-1,2-dihydro-4H-3,1-benzoxazines 3h,i (see Table 1) were prepared similarly from the dihydrobenzoxazines **3e,f** using method A.

Dihydrobenzoxazines 3j-l were prepared by methods A and B.

4,4-Diphenyl-3,1-benzoxazino[1,2-*c*][1,3]benzoxazine (5a). A mixture of the dihydrobenzoxazine **3a** (0.95 g, 2.5 mmol) and formalin (0.2 ml, containing 2.5 mmole formaldehyde) in acetic acid (10 ml) was stirred at room temperature for 40 min. The original precipitate of the dihydrobenzoxazine **3a** disappeared and was replaced by a new precipitate which was filtered off, washed with aqueous alcohol (3:1), dried, and recrystallized from toluene. Yield 0.69g (70%).

Compounds 5b-j and 6a-c were prepared similarly using the dihydrobenzoxazines **3a,b,e,f, 4a,b** and the corresponding aldehyde.

11-Hexyl-15-nitro-4,4-diphenyl-3,1-benzoxazino[1,2-*c*][1,3]benzoxazine (5d). A mixture of the dihydrobenzoxazine **3b** (1.06 g, 2.5 mmol) and heptanal (0.28 g, 2.5 mmol) in acetic acid (10 ml) was stirred for 3 h at 35-40°C. The precipitate formed was filtered off, washed with aqueous alcohol (3:1), dried, and recrystallized from toluene. Yield 0.58 g (45%).

11-Hexyl-4,4-diphenyl-3,1-benzoxazino[1,2-*c*][1,3]naphthoxazine (6d) was prepared similarly from **4a** and heptanal.

REFERENCES

1. E. V. Gromachevskaya, G. D. Krapivin, V. E. Zavodnik, and V. G. Kul'nevich, *Khim. Geterotsikl. Soedin.*, 1391 (1997) [*Chem. Heterocycl. Comp.,* **33**, 1209 (1997*)*].
2. E. V. Gromachevskaya, V. G. Kul'nevich, T. P. Kosulina, and V. S. Pustovarov, *Khim. Geterotsikl. Soedin.*, 842 (1988). [*Chem. Heterocycl. Comp.,* **24**, 692 (1988*)*].
3. E. V. Gromachevskaya, F. V. Kvitkovskii, T. P. Kosulina, and V. G. Kul'nevich, *Khim. Geterotsikl. Soedin.*, 163 (2003). [*Chem. Heterocycl. Comp., **39**, 137 (2003)*].
4. E. V. Gromachevskaya, T. P. Kosulina, V. G. Kul'nevich, Yu. Yu. Samitov, A. I. Khayarov, and V. T. Dubonosov, *Khim. Geterotsikl. Soedin.*, 101 (1990). [*Chem. Heterocycl. Comp.,* **26**, 86 (1990)].
5. F. Fulop, L. Lazar, and C. Bernath, *Magy. Kem. Folyoirat*, No. 5, 212 (1989).
6. L. A. Kazitsina and N. B. Kupletskaya, *Uses of UV, IR, NMR and Mass Spectroscopy in Organic Chemistry* [in Russian], Moscow, Vyssh. shkola, (1979), p. 236.
7. H. Budzikiewicz, C. Djerassi, and D. H. Williams, *Interpretation of the Mass Spectra of Organic Compounds* [Russian translation], Mir, Moscow (1966), p. 304.
8. O. A. Luk'yanov and P. B. Gordeev, *Izv. Akad. Nauk SSSR, Ser. Khim.,* 2523 (1988).
9. L. Lazar, F. Fulor, G. Bernath, A. Kalmaw, and G. Argay, *J. Heterocycl. Chem.*, **28**, 1213 (1991).
10. E. V. Gromachevskaya, I. S. Arustamova, R. B. Valeev, B. A. Bazhenov, A. G. Sakhabutdinov, and V. G. Kul'nevich, *Khim. Geterotsikl. Soedin.*, 1687 (1985). [*Chem. Heterocycl. Comp.,* **21**, 1391 (1985)].
11. E. V. Gromachevskaya, I. A. Arustamova, A. G. Sakhabutdinov, and V. G. Kul'nevich, *Khim. Geterotsikl. Soedin.*, 1670 (1988). [*Chem. Heterocycl. Comp.,* **24**, 1381 (1988)].