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CONDENSED ISOQUINOLINES
28*. SYNTHESIS AND PROPERTIES OF 10a,15b-DIAZADIBENZO[*a,e*]-PLEIADEN-11-ONES

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The reaction of 7,12-dihydro-5H-isoquino[2,3-a]quinazolin-5-ones with o-xylidene dibromide leads to 11-oxo-4bH,5H,10H,11H,16H-10a-aza-15b-azoniadibenzo[a,e]pleiadene bromides, which are converted to 11-oxo-10H,11H,16H-10a-aza-15b-azoniadibenzo[a,e]pleiadene salts upon oxidation using nitrobenzene. The reaction of these salts with benzylamine leads to 6-{2-[(benzylimino)methyl]-phenyl}-7,12-dihydroisoquino[3,2-b][2]benzazepin-14(6H)-ones, which recyclize to 11-oxo-5H,10H,11H-10a-aza-15b-azoniadibenzo[a,e]pleiadene perchlorates upon the action of perchloric acid. The reactions of the 10a,15b-diazadibenzo[a,e]pleiadene salts obtained with $NaBH_4$ were studied and the structures of the reduction products were determined by spectral methods.

Keywords: 10a,15b-diazadibenzo[*a,e*]pleiadene, isoquino[2,3-*a*]quinazoline, quinazolino[3,2-*b*][2]-benzazepine, borohydride reduction, oxidation.

In previous work [2], we reported that the reaction of 7,12-dihydro-5H-isoquino[2,3-*a*]quinazolin-5-one (**1a**) with *o*-xylylene dibromide leads to derivative of a new heterocyclic system, 10a,15b-diazadibenzo-[*a,e*]pleiadene. This system is a unique combination of three condensed heterocycles, namely, isoquinoline, quinazoline, and benzazepine, each of which, considering the enormous amount of information on the biological activity of their derivatives (see, for example, some recent studies [3-5]), may be seen as holding promise for medicinal chemistry [6]. Furthermore, there is considerable evidence that polycondensed systems containing elements of these heterocycles are found in nature and possess biological activity [7-10]. These findings have led us to synthesize new derivatives of diazadibenzopleiadene system starting with substituted 7,12-dihydro-5H-isoquino[2,3-*a*]quinazoline-5-ones and to carry out a detailed study of the chemical transformations of these compounds. This was the subject of the present work.

We have found that, similar to **1a** [2], aryl-substituted isoquinoquinazolines react with *o*-xylylene dibromide to give different types of products depending on the reaction conditions. Thus, in the presence of strong bases, the alkylation of **1b-d** leads to spiro[5H-isoquino[2,3-*a*]quinazoline-(12H)-2'-indan]-5-ones **2b-d** in high yield.

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* For Communication see 27 [1].

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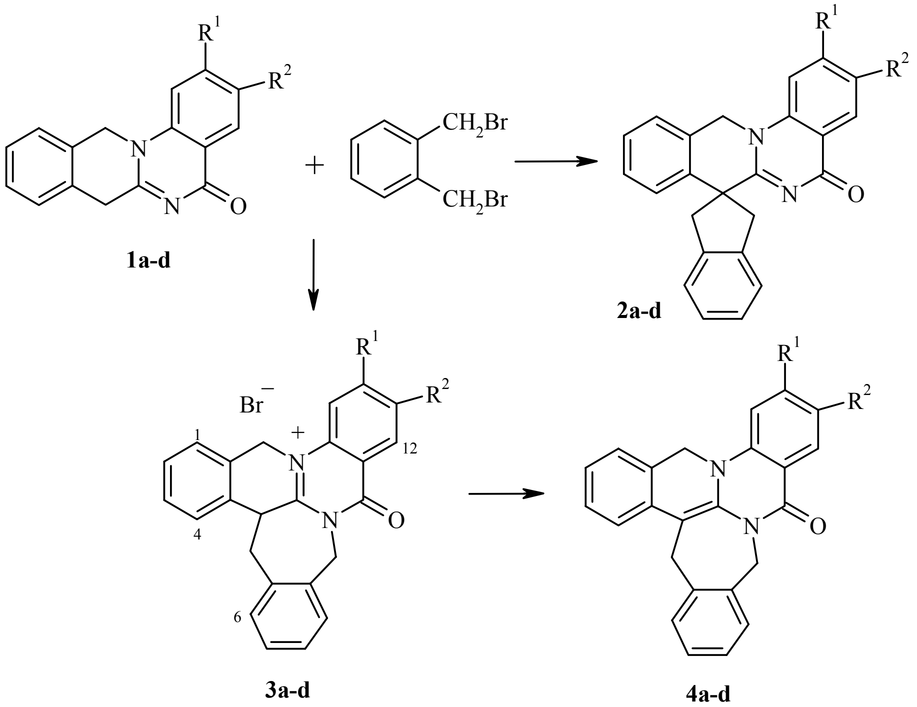

a $R^1 = R^2 = H$; **b** $R^1 = Cl$, $R^2 = H$; **c** $R^1 = H$, $R^2 = Me$; **d** $R^1 = H$, $R^2 = Br$

Carrying out the reaction by fusing a mixture of equivalent amounts of the starting compounds at 110-120°C leads to 11-oxo-5,10,11,16-tetrahydro-4bH-10a-aza-15b-azoniadibenzo[*a,e*]pleiadene bromides **3b-d** (Table 1). Reaction products **3** were obtained in good yield and the formation of by-products was minimal. Some difference was found in the time required for complete conversion of the starting materials: thin-layer chromatography indicated that complete conversion for **1c** (R^2 = Me) was achieved in 3.5 h, while the reaction was complete for **1b** (R^1 = Cl) after only 1 h. The action of Et_3N on salts **3b-d** leads to $C_{(4b)}$-deprotonation to give 5,10-dihydro-11,16-tetrahydro-10a,15b-diazadibenzo[*a,e*]pleiaden-11-ones **4b-d**. The reversibility of this transformation was established in our previous work [2] for aryl-nonsubstituted diazadibenzopleiadene **4a**. The data from the IR and ^{1}H NMR spectra of solutions of salts **3b-d** in CF_3CO_2D, bases **4b-d** in $CDCl_3$ (see Table 2), and spiro compounds **2b-d** in $CDCl_3$ are in good accord, on the whole, with the data for aryl-nonsubstituted **2a, 3a**, and **4a** [2].

In earlier work [11], we showed that 6-methyl-5-oxo-5,6,7,12-tetrahydroisoquino[2,3-*a*]quinazolin-13-ium perchlorate (**5**) is readily oxidized by nitrobenzene to give 6-methyl-5(6H)-oxoisoquino-[2,3-*a*]quinazolin-13-ium perchlorate (**6**), which undergoes reversible opening of the $C_{(12)}$–$N_{(13)}$ bond by the action of primary amines. In particular, this reaction with benzylamine leads to 2-{2-[(benzylimino)-methyl]benzyl}-3-methyl-4-(3H)-quinazolinone (**7**).

It would be logical to assume that analogous assignments would be found for diazadibenzopleiadenes **3a-d** in light of their obvious structural similarity. However, the benzazepine system produces significant change in the reactivity of the isoquinoquinazoline fragment. Thus, the oxidation of salts **3a-c**, achieved by heating the solutions of these compounds in nitrobenzene with subsequent treatment by perchloric acid, does not lead to the expected aromatization of the isoquinoline ring but rather to dehydrogenation of the $C_{(4b)}$–$C_{(5)}$ bond to give 11-oxo-10,10a,11,16-tetrahydro-10a-aza-15b-azoniadibenzo-[*a,e*]pleiadene perchlorates **8a-c**. Analysis of the spatial models showed that the molecules of salts **8** are nonplanar; the azepine ring has *distorted boat* conformation, leading to molecular asymmetry, nonequivalence of the protons of the $C_{(10)}H_2$ and $C_{(16)}H_2$ methylene groups, which are seen in the ^{1}H NMR spectra as AB spin systems with $^2J = 14$ and $^2J = 16$ Hz, respectively (Table 2).

TABLE 1. Physicochemical Characteristics of the Synthesized Compounds

Com-pound	Empirical formula	Found, % / Calculated, % C	H	Hal	N	mp, °C*	Yield, %
2b	$C_{24}H_{17}ClN_2O$	74.85 74.90	4.40 4.45	9.22 9.21	7.29 7.28	297-299	74
2c	$C_{25}H_{20}N_2O$	82.30 82.39	5.47 5.53		7.70 7.69	292-294	61
2d	$C_{24}H_{17}BrN_2O$	67.09 67.14	3.90 3.99	18.61 18.61	6.54 6.53	276-278	69
3b	$C_{24}H_{18}BrClN_2O$	61.81 61.89	3.86 3.90	17.17 17.16 7.62^{*2} 7.61	6.01 6.01	255-258	73
3c	$C_{25}H_{21}BrN_2O$	67.37 67.42	4.70 4.75	17.95 17.94	6.30 6.29	241-243	64
3d	$C_{24}H_{18}Br_2N_2O$	56.46 56.50	3.47 3.56	31.31 31.32	5.51 5.49	253-255	70
4b	$C_{24}H_{17}ClN_2O$	74.87 74.90	4.39 4.45	9.22 9.21	7.29 7.28	184-186	75
4c	$C_{25}H_{20}N_2O$	82.39 82.39	5.53 5.53	—	7.69 7.69	128-130	69
4d	$C_{24}H_{17}BrN_2O$	67.05 67.14	3.89 3.99	18.60 18.61	6.55 6.53	131-133	71
8a	$C_{24}H_{17}ClN_2O_5$	64.14 64.22	3.78 3.82	7.91 7.90	6.25 6.24	306-309	69
8b	$C_{24}H_{16}Cl_2N_2O_5$	59.60 59.64	3.28 3.34	14.69 14.67	5.82 5.80	>320 dec)	67
8c	$C_{25}H_{19}ClN_2O_5$	64.80 64.87	4.06 4.14	7.68 7.66	6.04 6.05	228–230	65
9a	$C_{24}H_{18}N_2O$	82.16 82.26	5.09 5.18	—	8.00 7.99	218-220	73
9b	$C_{24}H_{17}ClN_2O$	74.84 74.90	4.37 4.45	9.22 9.21	7.30 7.28	222-224	70
9c	$C_{25}H_{20}N_2O$	82.28 82.39	5.46 5.53	—	7.71 7.69	213-215	65
10a	$C_{31}H_{25}N_3O$	81.68 81.73	5.49 5.53	—	9.22 9.22	246-249	40
10b	$C_{31}H_{24}ClN_3O$	75.91 75.99	4.84 4.94	7.25 7.24	8.59 8.58	154-156	31
12	$C_{24}H_{17}ClN_2O_5$	64.16 64.22	3.77 3.82	7.91 7.90	6.25 6.24	276-278	87
13	$C_{24}H_{20}N_2O$	81.69 81.79	5.64 5.72	—	7.94 7.95	165-167	66^{*3}

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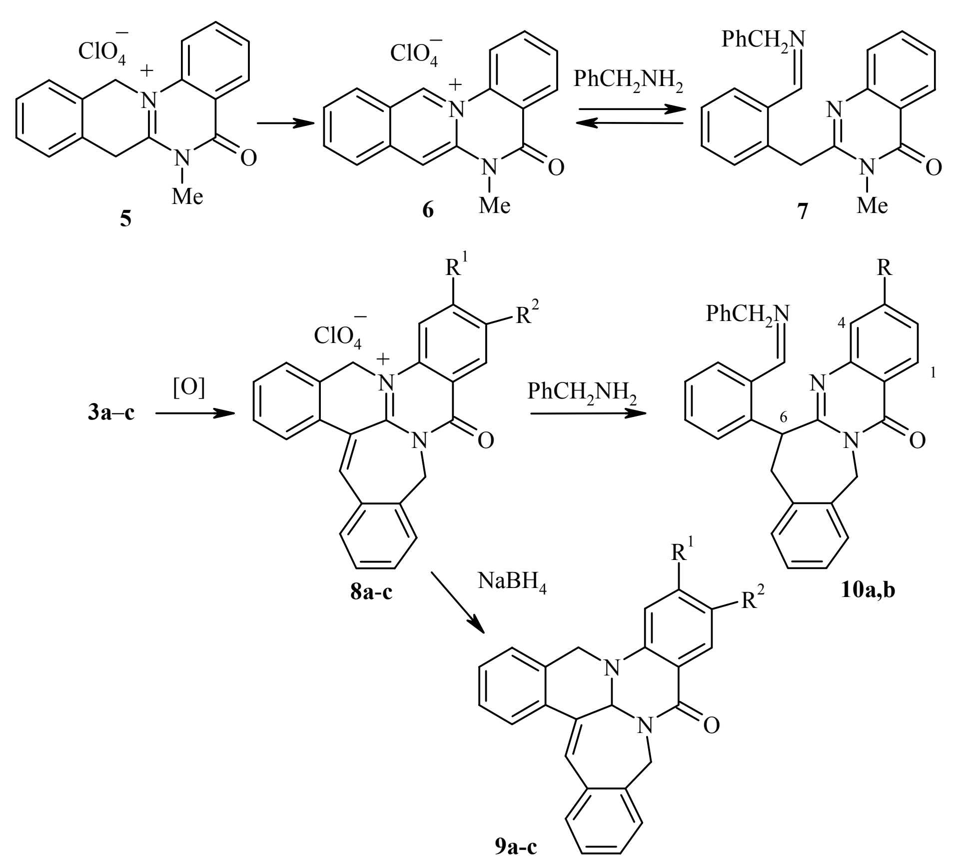
* Recrystallization solvents: DMF for **2b-d, 4b-d,** and **9a-c**, 2-propanol for **10a**, **10b**, acetic acid for **3b-d, 8a-c**, and **12**, and 1:2 2-propanol–DMF for **13**.

^{*2} Analysis data for Cl.

^{*3} Yield in method A.

The assignment of the signals for the methylene group protons was carried out through NOE experiments (Table 2, Fig.1). The signal for the methine proton at $C_{(5)}$ is in the aromatic proton region, which makes its observation difficult.

The behavior of salts **8** in the presence of nucleophiles proved unexpected. The characteristic 1,4-addition for 2-enimines [12] does not occur in this case. Thus, the reduction of salts **8a-c** by excess $NaBH_4$ leads to 10,11,15c,16-tetrahydro-10a,15b-diazadibenzo[*a,e*]pleiaden-11-ones **9a-c**, as indicated by the one-proton signal at 6.19-6.29 ppm observed along with two AB spin systems of the benzylamine methylene group protons at $C_{(10)}$ and $C_{(16)}$ with $\Delta\delta$ ~0.5 ppm. The signal for H-5 is found in the aromatic proton region due to the anisotropic effect of the two adjacent benzene rings and its position in the spectrum of **9b** (7.50 ppm) was determined from the ^{1}H NMR 2D spectra and the NOE experiments (Table 2, Fig. 1).



8–10 a $R^1 = R^2 = H$; **b** $R^1 = Cl$, $R^2 = H$; **8**, **9 c** $R^1 = H$, $R^2 = Me$

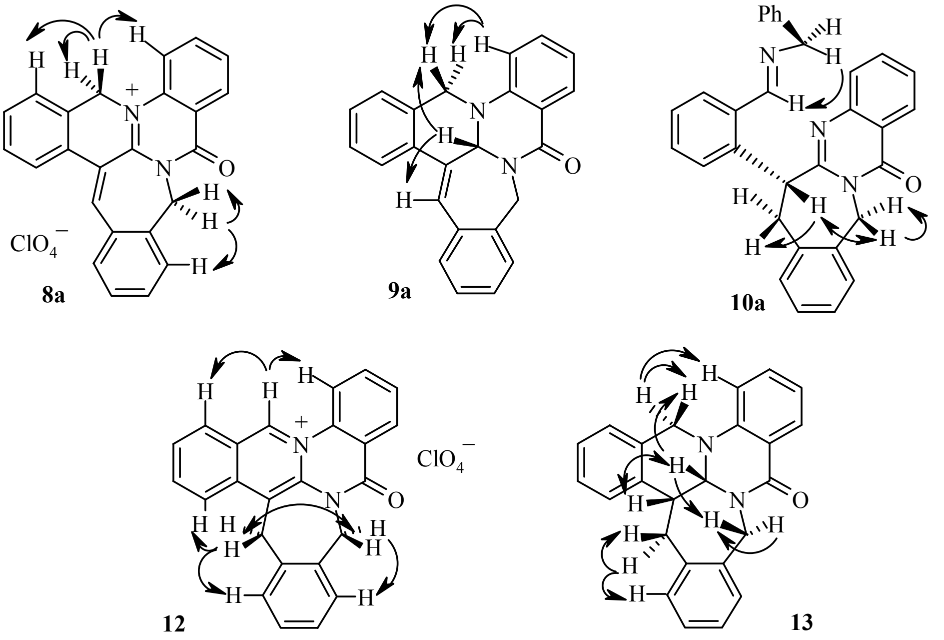


Fig. 1. Observed NOE for compounds **8a, 9a, 12,** and **13**.

TABLE 2. Spectral Characterisatics of the Derivatives 10a,15b-diazadibenzo[*a*,*e*]pleiaden-11-ones*

Com-pound	IR spectrum ν, cm^{-1} (C=O, C=N)	^{1}H NMR spectrum, δ, ppm (*J*, Hz)					
		Solvent	HAr	2H, H-10	2H, H-16	2H, H-5	Other signals
1	2	3	4	5	6	7	8
3b	1710, 1610	CF_3CO_2D	8.53 (1H, d, ^oJ = 8.0, H-12); 7.91 (1H, d, ^oJ = 8.0, H-13); 8.31 (1H, s, H-15); 7.61 (4H, m, H-1–H-4); 7.45 (1H, d, ^oJ = 8.0, H-9); 7.38 (1H, t, ^oJ = 8.0, H-7); 7.31 (1H, t, ^oJ = 8.0, H-8); 7.15 (1H, d, ^oJ = 8.0, H-6)	6.34 (d, ^2J = 17.0, H_B-10*^{2})	6.05 (d, ^2J = 16.0, H_B-16*^{2})	3.88 (dd, ^3J = 4.5), 3.56 (dd, ^3J = 12.5), ^2J = 18.0	6.02-5.65 (3H, m, H_B-10, H_B-16, H-4b)
3c	1708, 1620	CF_3CO_2D	8.43 (1H, s, H-12); 8.19 (1H, d, ^oJ = 8.6, H-15); 8.08 (1H, d, ^oJ = 8.6, H-14); 7.61 (4H, m, H-1–H-4); 7.47 (1H, d, ^oJ = 8.0, H-9); 7.38 (1H, t, ^oJ = 8.0, H-7); 7.31 (1H, t, ^oJ = 8.0, H-8); 7.15 (1H, d, ^oJ = 8.0, H-6)	6.41 (d, ^2J = 17.0, H_B-10*^{2})	6.10 (d, ^2J = 16.0, H_B-16*^{2})	3.90 (dd, ^3J = 4.5), 3.55 (dd, ^3J = 12.5), ^2J = 18.0	6.01-5.63 (3H, m, H_B-10, H_B-16, H-4b), 2.66 (3H, s, CH_3)
3d	1715, 1620	CF_3CO_2D	8.73 (1H, d, ^mJ = 2.0, H-12); 8.34 (1H, dd, ^mJ = 2.0, ^oJ = 8.0, H-14); 8.13 (1H, d, ^oJ = 8.0, H-15); 7.61 (8H, m, H-1–H-4, H-6–H-9)	6.38 (d, ^2J = 17.0, H_B-10*^{2})	6.08 (d, ^2J = 16.0, H_B-16*^{2})	3.90 (dd, ^3J = 4.5), 3.56 (dd, ^3J = 12.5), ^2J = 18.0	6.00-5.65 (3H, m, H_B-10, H_B-16, H-4b)
4b	1650	$CDCl_3$	7.88 (1H, d, ^oJ = 8.0, H-12); 7.52 (1H, m, H-9); 7.38 (2H, m, H-7,8); 7.31–7.17 (5H, m, H-1–H-4,6); 7.00 (1H, d, ^mJ = 2.0, H-15); 6.87 (1H, dd, ^mJ =2.0, ^oJ = 8.0, H-13)	5.28 (s)	4.65 (s)	4.15 (s)	—
4c	1652	$CDCl_3$	7.80 (1H, s, H-12); 7.54 (1H, m, H-9); 7.35 (2H, m, H-7,8); 7.30-7.11 (5H, m, H-1–H-4,6); 6.95 (2H, d, ^oJ = 8.0, H-14,15)	5.30 (s)	4.66 (s)	4.16 (s)	2.27 (3H, s, CH_3)
4d	1660	$CDCl_3$	8.03 (1H, d, ^mJ = 2.0, H-12); 7.70–7.17 (8H, m, H-1–H-4, H-6–H-9); 6.88 (2H, m, H-14,15)	5.29 (s)	4.65 (s)	4.15 (s)	—
8a	1715, 1612	CF_3CO_2D	8.63 (1H, d, ^oJ = 8.0, H-12); 8.24 (3H, m, H-13,14,15); 8.00-7.62 (9H, m, H-1–H-9)	6.42, 4.73 (two d, ^2J = 14.0)	6.19, 5.41 (two d, ^2J = 16.0)	—*^{3}	—
		DMSO-d$_6$	8.42 (2H, d, ^oJ = 8.0, H-12,15); 8.37 (1H, s, H-5); 8.23 (1H, t, ^oJ = 8.0, H-14); 7.90 (3H, m, H-4,6,13); 7.78 (1H, d, ^oJ = 8.0, H-1); 7.68 (5H, m, H-2–H-3, H-7–H-9)	6.08, 4.62 (two d, ^2J = 14.0)	6.37, 5.20 (two d, ^2J = 16.0)	—	—
			8.42 (30%, H-15); 7.78 (23%, H-1)	—	5.20 (41%, H_B)	—	—
			7.68 (30%, H-9)	4.62 (40%, H_B)	—		
8b	1720, 1605	CF_3CO_2D	8.55 (1H, d, ^oJ = 8.0, H-12); 8.25 (2H, m, H-13,15); 7.90-7.62 (9H, m, H-1–H-9)	6.39, 4.70 (two d, ^2J = 14.0)	6.07, 5.38 (two d, ^2J = 16.0)	—*^{3}	—
8c	1710, 1615	CF_3CO_2D	8.42 (1H, s, H-12); 8.23-7.60 (11H, m, H-1–H-9, H-14,15)	6.41, 4.73 (two d, ^2J = 14.0)	6.15, 5.38 (two d, ^2J = 16.0)	—*^{3}	2.65 (3H, s, CH_3)

TABLE 2. (continued)

1	2	3	4	5	6	7	8
12	1680, 1615	DMSO-d$_6$	8.83 (1H, d, ^{o}J = 8.0, H-15); 8.74 (1H, d, ^{o}J = 8.0, H-4); 8.62 (1H, d, ^{o}J = 8.0, H-1); 8.46-7.88 (5H, m, H-3,9, H-12–H-14); 7.69-7.32 (4H, m, H-2, H-6–H-8)	5.62 (s)	10.95 (1H, s)	5.14 (s)	—
			8.83 (24%, H-15); 8.62 (18%, H-1);	—	—	—	—
			7.88 (30%, H-9)	—	—	5.14 (4%)	—
			8.74 (20%, H-4); 7.55 (16%, H-6)	5.62 (4%)	—	—	—
9a	1650	DMSO-d$_6$	7.96 (1H, d, ^{o}J = 8.0, H-12); 7.58 (1H, d, ^{o}J = 8.0, H-6); 7.52 (1H, m, H-4); 7.42 (3H, m, H-1,2,5); 7.32-7.21 (5H, m, H-3, H-7–H-9, H-14); 6.92 (1H, d, ^{o}J = 8.0, H-15); 6.74 (1H, t, ^{o}J = 8.0, H-13)	5.10, 4.59 (two d, ^{2}J = 15.5)	5.04, 4.55 (two d, ^{2}J = 17.0)	—*3	6.22 (1H, d, ^{3}J = 2.0, H-15C)
			—	—	5.04 (32%, H$_A$)	—	—
			7.42 (22%, H-5)	4.59 (30%, H$_B$)	—		
9b	1650	DMSO-d$_6$	7.98 (1H, d, ^{o}J = 8.0, H-12); 7.58 (1H, d, ^{o}J = 8.0, H-6); 7.53 (1H, m, H-4); 7.44 (2H, m, H-2,5); 7.40 (1H, m, H-1); 7.34-7.24 (5H, m, H-3, H-7-H-9, H-14); 7.05 (1H, d, ^{o}J = 2.0, H-15); 6.77 (1H, dd, ^{m}J = 2.0, ^{o}J = 8.0, H-13)	5.08, 4.57 (two d, ^{2}J = 15.5)	5.11, 4.55 (two d, ^{2}J = 17.0)	—*3	6.25 (1H, d, ^{3}J = 2.0, H-15c)
9c	1648	DMSO-d$_6$	7.95 (1H, d, ^{o}J = 2.5, H-12); 7.51 (1H, m, H-6); 7.40 (4H, m, H-1,2,4,5); 7.27 (4H, m, H-7–H-9, H-3); 7.09 (1H, d, ^{o}J = 8.0, H-14); 6.81 (1H, d, ^{o}J = 8.0, H-15)	5.10, 4.58 (two d, ^{2}J = 15.5)	4.98, 4.52 (two d, ^{2}J = 17.0)	—*3	6.16 (1H, d, ^{3}J = 2.0, H-15c), 2.11 (3H, s, CH$_3$)
13	1650	C$_6$D$_6$	8.46 (1H, dd, ^{m}J = 1.2, ^{o}J = 8.0, H-12); 7.45 (1H, td, ^{m}J = 1.2, ^{o}J = 8.0, H-14); 7.36 (1H, d, ^{o}J = 8.0, H-9); 7.32-6.65 (8H, m, HAr); 6.44 (1H, d, ^{o}J = 8.5, H-15)	5.81, 3.76 (two d, ^{2}J = 16.5)	4.27, 3.62 (two d, ^{2}J = 15.1)	3.82 (dd, ^{3}J = 10.0), 2.48 (d, ^{2}J =17.1)	4.54 (1H, d, ^{3}J = 3.9, H-15c), 3.28 (1H, dd, ^{3}J = 3.9, ^{3}J = 10.0, H-4b)
			6.85 (16%, H-6)	—	—	3.82 (26%, H$_A$)	
			—	—	—	—	4.54 (10%, H-15c)
			6.44 (12%, H-15)	—	3.62 (27%, H$_B$)	—	—
			—	3.76 (8%, H$_B$)	3.62 (4%, H$_B$)	—	3.28 (9%, H-4b)
			—	3.76 (28%, H$_B$)	—	—	—

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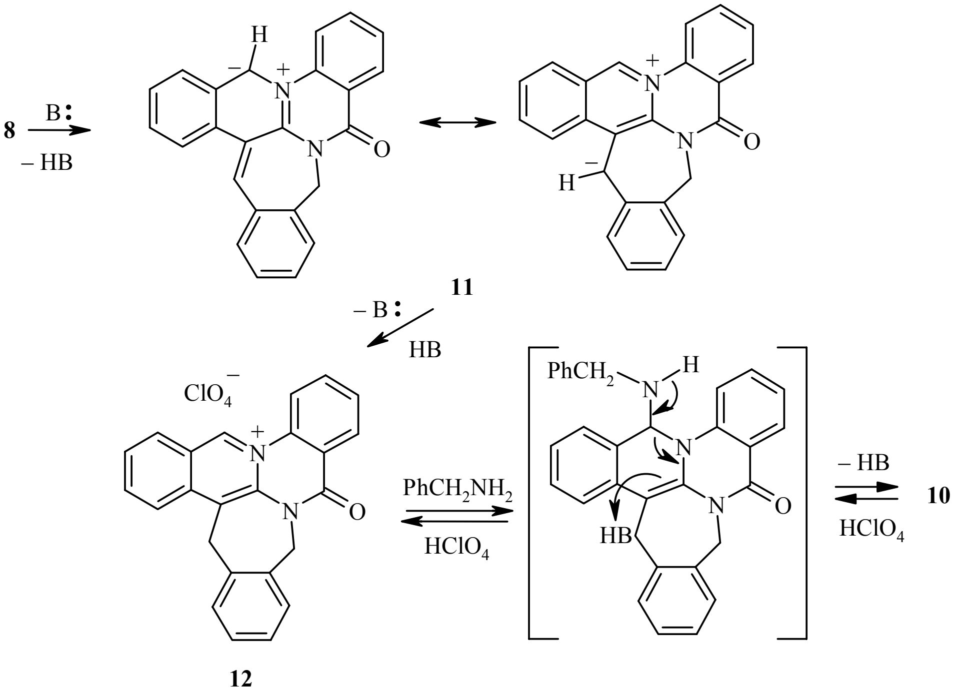
* NOE experiment results : {6.37}; {6.08} (**8a**); {10.95}; {5.62}; {5.14} (**12**); {6.92}; {6.22} (**9a**) obtained DMSO-d$_6$; {2.48}; {3.28}; {4.27}; {4.54}; {5.81} (**13**) obtained C$_6$D$_6$.

*[2] Overlap of signals, see column 8.

*[3] Overlap of signals, see column 4.

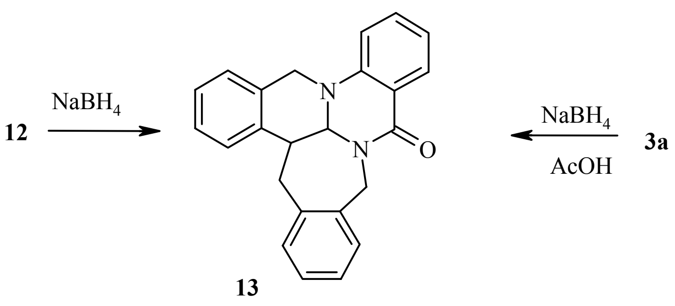
The reaction of salts **8a**,**b** with benzylamine leads to compounds with ^{1}H NMR spectra displaying A_2, AB, and ABX spin systems for seven aliphatic protons in the aliphatic protons absorbtion region and a downfield signal at 8.48 ppm. Taking account of the spectral behavior of imine **7** [11], these findings are in accord with the structure of products such as 6-{2-[(benzylimino)methyl]phenyl}-7,12-dihydroisoquino-[3,2-*b*][2]benzazepin-14(6H)-ones **10a** and **10b**. This hypothesis is also supported by the NOE experiments for **10a** (see Experimental and Fig. 1) and the UV spectra. Thus, the great similarity of the electronic spectrum of **10a** to the spectrum of 6,11-dihydro-13H-isoquino-[3,2-*b*]quinazolin-6-one [13] confirms the existence of a 2,3-cycloalkylated 4(3H)-quinazolone.



The formation of imines **10a** and **10b** may be seen as initial deprotonation at $C_{(16)}$ by the action of the base (benzylamine), which leads to an intermediate betaine **11**. Further protonation gives the 11-oxo-5,10,10a,11-tetrahydro-10a-aza-15b-azoniadibenzo[*a,e*]pleiadene cation (**12**), which is a structural analog of cation **6**. Similar to **6**, the addition of a primary amine at $C_{(16)}$ is accompanied by opening of the $N_{(15a)}$–$C_{(16)}$ bond. Similar to imine **7**, imine **10a** is converted by treatment with perchloric acid to 11-oxo-10,11-dihydro-10a-aza-15b-azoniadibenzo[*a,e*]pleiadene perchlorate (**12**), whose formation was expected in the oxidation of salt **3a**. This reaction is reversible and imine **10a** is reobtained upon the reaction of salt **12** with benzylamine. The ^{1}H NMR spectrum of **12** shows signals characteristic for the aromatic system of isoquino[2,3-*a*]quinazoline. The assignment of these signals was supported by the NOE experiments (Table 2, Fig. 1). The total similarity of the UV spectra of salts **6** and **12**, indicating that these salts are isoelectronic, is final proof for the structure of salt **12**. We also found evidence for the proposed transformation scheme **8** → **11** → **12** → **10**. In a comparative analysis of the UV spectra of **8a, 12,** and a mixture of **8a** + Et_3N in methanol (Fig. 2), we found that the absorption curve for the mixture is extremely similar in form to the curves for **6** and **12**.

Perchlorate **12** readily reacts with $NaBH_4$ in methanol to give 4b,5,10,10a,11,15b,15c,16-octahydro-10a,15b-diazadibenzo[*a,e*]pleiaden-11-one (**13**).

The same compound was obtained in the reduction of bromide **3a** by a 10-fold excess of $NaBH_4$ in acetic acid–methanol. The use of acetic acid in the latter case proved necessary since the free base, dibenzopleiadene **4a**, which is readily formed in basic medium (in the absence of acetic acid), proved inert toward the action of $NaBH_4$ under these conditions.



The reaction is stereoselective as indicated by the single set of NMR signals of the raw reaction product. Only the *erythro* isomer is formed in this reaction of the two theoretically possible diastereomeric products (with *cis* and *trans* arrangement of the hydrogen atoms in the $C_{(4b)}$–$C_{(15c)}$ fragment). This finding is supported by the ^{1}H NMR spectral data for **13** in benzene-d_6. The one-proton doublet at 4.54 ppm with $J = 3.9$ Hz, characteristic for a vicinal *cis* proton coupling was assigned to H-15c. The final conclusion concerning the *cis* structure of the reduction product was made using the results of a series of NOE experiments (Table 2, Fig. 1). Using a modified Karplus equation, the H–$C_{(15c)}$–$C_{(4b)}$–H, H–$C_{(15c)}$–$C_{(5)}$–H_B, and H–$C_{(15c)}$–$C_{(5)}$–H_A dihedral angles were found to be 48, 87, and 153°, respectively. Analysis of a molecular model showed that the values of φ correspond to a *distorted half-chair* conformation of the tetrahydroisoquinoline ring atom ($N_{(15b)}$ is located in the plane of the isoquinoquinazoline fragment, while atom $C_{(15c)}$ is located above this plane) and a *distorted boat* conformation for the azepine ring ($C_{(4b)}$ and $C_{(15c)}$ are located above the plane, while atoms $N_{(10a)}$ is located below the plane of the other atoms in the bicyclic system).

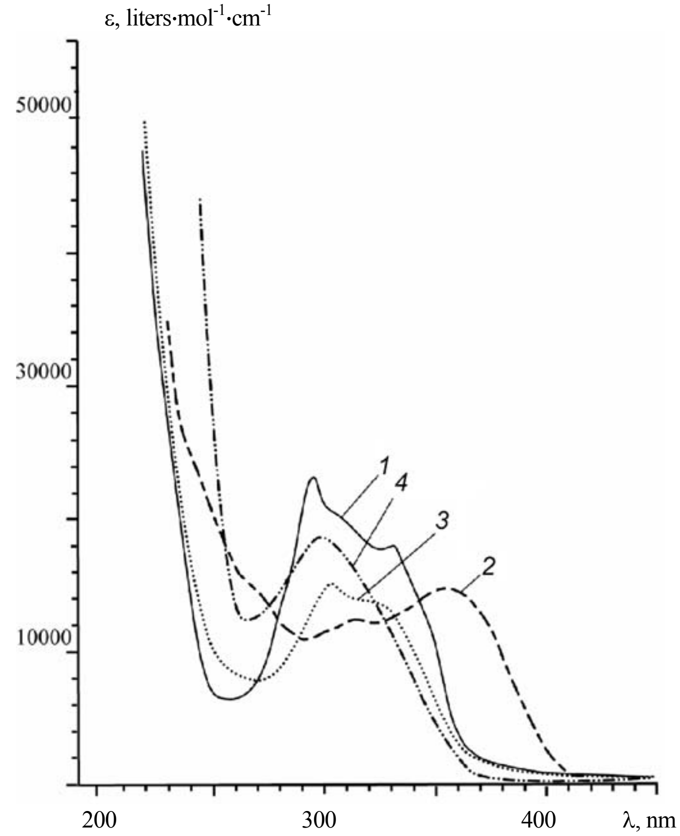


Fig. 2. UV spectra of **6** (*1*), **8a** (*2*), **12** (*3*), and a mixture of **8a** and Et$_3$N (*4*) in methanol.

EXPERIMENTAL

The UV spectra for tablets in KBr were taken on an SP3-300 Pye Unicam spectrometer. The ^{1}H NMR spectra were taken on a Varian Mercury 400 spectrometer at 400 MHz, while the ^{13}C NMR and COSY HH spectra were taken on a Bruker-250 spectrometer at 63 and 250 MHz, respectively with TMS as the internal standard. The UV spectra were taken on a Specord M400 spectrophotometer in methanol. The mass spectra were recorded on a Nermag R10 mass spectrometer by the FAB method in DMSO (**9a**) and by the CI method (NH_3) in acetonitrile (**9b**). The melting points were taken on a Boetius block.

Spiro[R-5H-isoquino[2,3-*a*]quinazoline-7(12H)-2'-indan]-5-ones 2b-d were obtained by a procedure described by Milanowski [3] of the corresponding isoquinoquinazoline **1b-d** (0.5 mmol), 2-PrONa (0.1 g, 1.1 mmol), and *o*-xylylene dibromide (0.13 g, 0.5 mmol).

Ketone 2b. IR spectrum, ν, cm^{-1}: 1635 br. (C=O). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm (*J*, Hz): 8.33 (1H, $^oJ = 8.0$, H-4); 7.69 (1H, d, $^mJ = 2.0$, H-1); 7.46 (1H, dd, $^mJ = 2.0$, $^oJ = 8.0$, H-3); 7.38-7.20 (8H, m, HAr); 5.31 (2H, s, H-12); 4.28 (2H, d, $^2J = 16.0$, H_A-1',3'); 3.33 (2H, d, $^2J = 16.0$, H_B-1',3').

Ketone 2c. IR spectrum, ν, cm^{-1}: 1635 br. (C=O). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm (*J*, Hz): 8.19 (1H, s, H-4); 7.61 (2H, m, H-1,2); 7.40-7.20 (8H, m, HAr, 5.34 (2H, s, H-12); 4.29 (2H, d, $^2J = 16.0$, H_A-1',3'); 3.31 (2H, d, $^2J = 16.0$, H_B-1',3').

Ketone 2d. IR spectrum, ν, cm^{-1}: 1632 br. (C=O). ^{1}H NMR spectrum ($CDCl_3$), δ, ppm (*J*, Hz): 8.51 (1H, d, $^mJ = 2.0$, H-4); 7.88 (1H, dd, $^mJ = 2.0$, $^oJ = 8.0$, H-2); 7.57 (1H, d, $^oJ = 8.0$, H-1); 7.40-7.20 (8H, m, HAr); 5.33 (2H, s, H-12); 4.28 (2H, d, $^2J = 16.0$, H_A-1',3'); 3.32 (2H, d, $^2J = H_B$-1',3').

11-Oxo-5,10,11,16-tetrahydro-4bH-10a-aza-15b-azoniadibenzo[*a,e*]pleiadenes Bromides 3b-d were obtained according to the procedure described by Milanowski [3] of the corresponding isoquinoquinazoline **1b-1d** (0.5 mmol) and *o*-xylylene dibromide (0.13 g, 0.5 mmol). Heating times: 1 h for **1b**, 3.5 h for **1c**, and 1.5 h for **1d**.

5,10,11,16-Tetrahydro-10a,15b-diazadibenzo[*a,e*]pleiaden-11-ones 4b-d were obtained by a procedure described by Milanowski [3] using Et_3N.

11-Oxo-10,10a,11,16-tetrahydro-10a-aza-15b-azoniadibenzo[*a,e*]pleiadenes Perchlorates 8a-c. Salt **3a-c** (5 mmol) was dissolved with heating in nitrobenzene (3 ml). The solution of, aqueous perchloric acid (1 ml) was added and the mixture was heated at reflux for 10 min. After cooling, 2-propanol (20 ml) was added. A yellow precipitate formed after 5 h. The precipitate was filtered off, washed with 2-propanol, and recrystallized from acetic acid.

10,11,15c,16-Tetrahydro-10a,15b-diazadibenzo[*a,e*]pleiaden-11-ones 9a-c. $NaBH_4$ (0.95 g, 25 mmol) was added in small portions to a suspension of the corresponding dibenzopleiadene perchlorate **8a-c** (5 mmol) in methanol (10 ml). After the vigorous reaction, the mixture was heated at reflux for 15 min. The solvent was evaporated off and the residue was treated with 15 ml 10% aq. NaOH. The solid colorless product was filtered off, washed with water and, then, ethanol, and recrystallized from DMF.

Ketone 9a. Mass spectrum (FAB, MeCN), *m/z* ($I_{rel.}$, %): 351 $[M+1]^+$ (60), 232 $[M-118]^+$ (100), 202 $[M-148]^+$ (15).

Ketone 9b. ^{13}C NMR spectrum in $CDCl_3$, δ, ppm: 160.57 (C-11); 147.73 (C-15a); 138.67 (C-11a); 138.07 (C-9a); 133.65 (C-4a); 133.56 (C-5a); 133.25 (C-16a); 115.53 (C-4b); 133.19-112.95 (C-1–C-9, C-12–C-15); 74.85 (C-15c); 50.15 (C-10); 47.65 (C-16). Mass spectrum (CI, DMSO), *m/z*, ($I_{rel.}$, %): 385 $[M+(NH_3)_2H]^+$ (100), 235 $[M-149]^+$ (24).

6-{2-[(Benzylimino)methyl]phenyl}-7,12-dihydroquinazolino[3,2-*b*][2]benzazepin-14(6H)-ones 10a,b. Dibenzopleiadene perchlorate **8a** or **8b** (5 mmol) was dissolved with heating in benzylamine (3 ml). Then, water (3 ml) was added to the cooled solution and the mixture was heated at reflux for 5 min. After cooling, the oil was separated by decanting. The oil was triturated while added ethanol (4 ml) in small portions until a colorless precipitate formed. The precipitate was filtered off and washed with ethanol.

Ketone 10a. IR spectrum, ν, cm^{-1}: 1665 (C=O); 1640 (C=N). UV spectrum in methanol, λ_{max}, nm ($\varepsilon \cdot 10^{-3}$): 253 (19.0); 280 (9.0, inflection), 310 (6.0), 322 (5.0). ^{1}H NMR spectrum (CDCl$_3$), δ, ppm (*J*, Hz): 8.48 (1H, s, CH=N); 8.13 (1H, d, ^{o}J = 8.0, H-1); 7.85-6.80 (16H, m, ArH); 6.28 (1H, dd, ^3J = 4.4, ^3J = 11.2, H-6); 5.68 (1H, d, ^2J = 15.0, H$_A$-12); 5.07 (1H, d, ^2J = 15.0, H$_B$-12); 4.70 (1H, d, ^2J = 13.5, C$\underline{H}_A$H$_B$Ph); 4.49 (1H, d, ^2J = 13.5, CH$_A$C$\underline{H}_B$Ph); 3.70-3.59 (2H, m, H-7). NOE (CDCl$_3$), δ, ppm: {4.49} → 8.48 (η = 17%, CH=N); {5.07} → 5.68 (η = 29%, H$_A$-12); 6.28 (η = 28%, H-6); {6.28} → 5.07 (η = 27%, H$_B$-12); 3.65 (η = 15%, H$_A$-7).

Ketone 10b. IR spectrum, ν, cm^{-1}: 1660 (C=O), 1630 (C=N). ^{1}H NMR spectrum (CDCl$_3$), δ, ppm (*J*, Hz): 8.61 (1H, s, CH=N); 8.01 (1H, d, ^{o}J = 8.1, H-1); 7.78-6.93 (15H, m, HAr); 6.10 (1H, dd, ^3J = 4.4, ^3J = 11.2, H-6); 5.70 (1H, d, ^2J = 15.0, H$_A$-12); 5.24 (1H, d, ^2J = 15.0, H$_B$-12); 4.83 (1H, d, ^2J = 13.5, C$\underline{H}_A$H$_B$Ph); 4.49 (1H, d, ^2J = 13.5, CH$_A\underline{H}_B$Ph); 3.70-3.55 (2H, m, H-7).

11-Oxo-5,10,10a,11-tetrahydro-10a-aza-15b-azoniadibenzo[*a,e*]pleiadene Perchlorate (12). Perchloric acid (1 ml) was added to a solution of quinazolino[2]benzazepine **10a** (0.91 g, 2 mmol) in 2-propanol (4 ml). The yellow precipitate, which formed after 1 h, was filtered off, washed with acetone, and recrystallized from acetic acid. UV spectrum in methanol, λ_{max}, nm ($\varepsilon \cdot 10^{-3}$): 295 (15.5), 330 (13.0).

4b,5,10,10a,11,15b,15c,16-Octahydro-10a,15b-diazadibenzo[*a,e*]pleiaden-11-one (13). A. NaBH$_4$ (0.11 g, 3 mmol) was added in small portions to a suspension of salt **12** (0.87 g, 2.5 mmol) in methanol (5 ml). After the vigorous reaction, the mixture was heated at reflux for 30 min. The solvent was evaporated off. The residue was treated with 10% aq. NaOH (5 ml). The solid, colorless crude product was filtered off, washed with water and, then, ethanol, and recrystallized from DMF.

B. NaBH$_4$ (0.95 g, 2.5 mmol) was added in small portions to a suspension of pleiadene salt **3a** (1.55 g, 5 mmol) in a mixture of acetic acid (2 ml) and methanol (25 ml). After the vigorous reaction, the mixture was heated at reflux for 15 min. After cooling, an additional NaBH$_4$ (0.95 g, 2.5 mmol) was added and a solution of acetic acid (1 ml) in methanol (5 ml) was added dropwise. The mixture was heated at reflux for 1 h. The solvent was evaporated off at reduced pressure. The residue was treated with 10% aq. NaOH (20 ml). The solid crude product was filtered off and washed with water and, then, ethanol.

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