SPIROPYRANS OF THE ISOQUINOLINE AND 3,4-DIHYDROISOQUINOLINE SERIES

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The products of condensation of 1,2-dimethylisoquinolinium and 1,2-dimethyl-3,4-dihydroisoquinolinium salts with salicylaldehyde derivatives may, depending on the nature of the substituents, exist in the merocyanine or spiropyran form. The spiropyrans of the dihydroisoquinoline series are considerably more stable than the isoquinoline analogs. In polar solvents the spiropyrans of both series exist in equilibrium with the corresponding merocyanine, and the position of the equilibrium depends on the Z function of the solvent and is shifted more strongly to favor the merocyanines in the case of isoquinoline derivatives. The merocyanines of both series have negative solvatochromism, but the solvent effect is greater by a factor of 1.5-2 for the dihydroisoquinoline derivatives.

The products of condensation of the quaternary salts of α- and γ-methyl derivatives of pyridine and quinoline with o-hydroxy aldehydes exist only in the merocyanine form and are incapable of intramolecular cyclization to give spiropyrans [1, 2]. On the other hand, acridine [2], phenanthridine [3], and 4,9-diazapyrene [4] derivatives readily undergo cyclization to give a spiran ring; this was explained by the magnitude of the positive charge and the energy of localization of the carbon atom participating in the cyclization [4].

In the calculations indicated in [4] the effect of steric factors on the relative stability of the merocyanines and spiropyrans, the role of which may be very large [1, 5], was disregarded. A comparison of the structures of six-membered nitrogen heterocycles shows that the presence of a hydrogen atom that should disrupt its coplanarity is characteristic for 6-phenanthridinium, 9-acridinium, and 5,10-diazapyrenium derivatives in the peri position relative to the merocyanine chain. At the same time, the effect of the peri hydrogen is not substantial for spiropyrans because of the orthogonality of the fragments of the molecule. In this respect, 1-substituted isoquinolinium derivatives should be similar to the indicated condensed systems, but quinolinium or pyridinium derivatives should not. One therefore might expect the formation of stable cyclic forms for isoquinolinium derivatives.

In the present paper we present the results of the synthesis and study of the properties of the products of condensation of 1,2-dimethylisoquinolinium derivatives with salicylaldehyde derivatives. The reactions of 1,2-dimethylisoquinolinium iodide with monosubstituted salicylaldehydes were carried out by heating the components in alcohol solution in the presence of catalytic amounts of piperidine. Neutralization of the resulting salts gave merocyanines (Ia-d), which, in contrast to the analogous quinaldine derivatives, can be cyclized to colorless spriopyrans (IIa-d). The structure of the latter was confirmed in the case of IIa and IIc by the PMR spectra. Strong electron-acceptor groups in the styryl ring hinder intramolecular cyclization. Compounds with substituents of this sort were obtained in the form of merocyanines (Ie-g) by carrying out the condensation with excess piperidine.

Dissolving of spiropyrans IIa-d in alcohol is accompanied by opening of the pyran ring, and brightly colored solutions are formed. When these solutions are vacuum evaporated, the methoxy derivatives are re-isolated in colorless forms (IIa, b).

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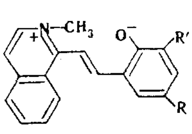
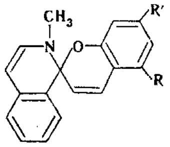


Ia-g



IIa-d

a $R=OCH_3$; b $R'=OCH_3$; c $R=Cl$; d $R=Br$; e $R=R'=Br$; f $R=NO_2$; g $R=NO_2$; $R'=Br$; unindicated R and $R'=H$

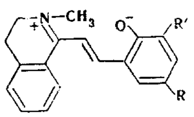
In contrast to them the chloro and bromo derivatives are isolated in the form of colored merocyanines (Ic, d). The two forms have identical elementary compositions.

It was found that intensification of the acceptor properties of the substituents in the chromene ring of the spiropyrans of the indoline series sharply reduces the stabilities of the cyclic forms [6]. Spiropyrans cannot be obtained from isoquinoline derivatives that are substituted by two bromine atoms or one nitro group. Only the merocyanine forms (Ie-g) were isolated for these compounds.

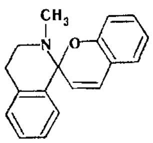
Thus some of the isoquinoline o-oxidostyryls proved to be capable of undergoing intramolecular cyclization to give spiropyrans. Even greater stability of the cyclic forms might be expected for the 1,2-dimethyl-3,4-dihydroisoquinolinium derivatives, in which the positive charge should be localized to a greater degree on the C_1 and N atoms than in the corresponding 1,2-dimethylisoquinolinium analogs, whereas the effect of steric factors is approximately identical. The literature does not contain data on the synthesis of compounds of this sort. Only the products of condensation of 1,2-dimethyl-3,4-dihydroisoquinolinium iodide with substituted benzaldehydes have been reported [7]. However, the considerable differences in the physical characteristics of the compounds described in [7] and the compounds obtained by us and the crude disparity between the calculated values and the results of analytical determinations constitute evidence that the reaction products were not isolated in pure form and probably were inaccurately characterized.

We carried out the reactions of 1,2-dimethyl-3,4-dihydroisoquinolinium iodide with o-hydroxybenzaldehydes by the method used in the preceding condensations. This salt reacted considerably more rapdily with aldehydes than the 1,2-dimethylisoquinolinium salt. Merocyanine hydriodides (IIIc, d, g), two of which were readily converted to spiropyrans (IVc, d) by the action of ammonia, were obtained in the presence of catalytic amounts of piperidine.

The condensation reactions with the remaining aldehydes were carried out with excess piperidine. In this case, we isolated immediately either colorless spiropyrans (IVa, b) or colored merocyanines (IIIe, f), which, in contrast to the corresponding merocyanines of the isoquinoline series, readily form spiropyrans. We were unable to obtain the corresponding spiropyran only in the case of the bromo nitro derivative (IIIg).



IIIe-g



IVa-f

a $R=OCH_3$; b $R'=OCH_3$; c $R=H$; d $R=Br$; e $R=R'=Br$; f $R=NO_2$; g $R=NO_2$, $R'=Br$; unindicated R and $R'=H$

The structures of the spiropyrans isolated were confirmed by the PMR spectra, in which multiplets of methylene groups in the 3 and 4 positions (2.5-3.5 ppm) and aromatic protons (~7 ppm) are present.

Thus intramolecular cyclization becomes impossible for oxidostyryl derivatives of the dihydroisoquinolinium ion in the case of a considerably stronger acceptor effect of substituents in the phenoxide ring ($\sigma_{o\text{-}Br}+\sigma_{p\text{-}NO_2}=0.99$) than for isoquinolinium derivatives ($\sigma_{o\text{-}Br}+\sigma_{p\text{-}Br}=0.44$). This difference and the increased activity of the 1,2-dimethyl-3,4-dihydroisoquinolinium ion in reactions with aldehydes are apparently due to the higher positive charge on the C_1 atom in the dihydroisoquinolinium derivatives. On the other hand, the higher stabilities of the spiropyrans of the dihydroisoquinoline series (IVa-f) may be due to the greater stability of the tetrahydroisoquinoline structure as compared with the dihydroisoquinoline structure and also the lower stabilities of dihydroisoquinoline merocyanines as compared with aromatic isoquinoline merocyanines.

The electronic spectra of all of the spiropyrans in hexane are characterized by the presence of three to four intense absorption bands at up to 340 nm (Table 1). Like spiropyrans IIa-d, colorless IVa-f are partially converted to the corresponding merocyanines to give colored solutions when they are dissolved in alcohol. The spectra of the investigated compounds in alcohol depend on the concentration of dissolved substance, and this may be partially due to protonation of the merocyanine forms by the solvent [8]. The intensity of the longwave absorption bands is associated with the concentration of the merocyanines, and this also characterizes the stability of the spiropyrans. The "apparent" molar extinctions (ε') obtained for alcohol solutions upon referral of the experimental optical densities to the total concentrations of the compounds are presented in Table 1. If compounds with identical substituents are compared in both series, the intensity of the longwave band observed for the dihydroisoquinoline derivative is lower by a factor of 1-1.5 than in the spectra of the isoquinoline derivatives.

In anhydrous acetone the spiropyrans (IIa-d, IVa-f) form colorless solutions, which become colored when water is added. Moreover, the intensity of the color increases after a certain time because of the slow establishment of a spiropyran–merocyanine equilibrium. The time required to establish this equilibrium is approximately three times longer for the dihydroisoquinoline spiropyrans than for the isoquinoline spirans (36 and 12 h, respectively, at room temperature). When the water concentration is increased, the intensity of the color initially increases and then decreases. The intensification of the color in more polar media is due to an increase in the relative concentration of the merocyanine structure, and the subsequent decrease may be associated with protonation of the merocyanines.

The maximum intensity of the coloration in aqueous acetone solutions of spiropyrans of the dihydroisoquinolines series is reached at a considerably higher water concentration than in the case of the isoquinoline analogs. These factors also constitute evidence for the higher stability of the spiropyrans of the dihydroisoquinoline series.

In order to evaluate the effect of the polarity of the solvent on the merocyanine forms of both series we investigated the solvatochromism of these compounds in aqueous acetone solutions and treated the results by means of the Kosower method [9] (Table 1). All of the merocyanines have clearly expressed negative solvatochromism, and a linear relationship between the energy of the transition of the longwave absorption band (E_T) and the Z value of the solvent is observed for them. The magnitude of the free term (b), which characterizes the ease of electron excitation of the system in the absence of a solvent, as expected, increases on passing from donor substituents to acceptor substituents in conjugation with the phenoxide oxygen atom. Compounds with a p-methoxy group are the most sensitive to the solvent effect in both series. The effects of the polarity of the solvent on compounds with other substituents are approximately identical within each series but are stronger by a factor of 1.5-2 for the isoquinolinium derivatives than for the corresponding dihydroisoquinoline analogs. On the basis of this, it can be concluded that polar solvents stabilize the isoquinoline merocyanines considerably more markedly, and this is one of the reasons for the easier conversion of the corresponding spiropyrans to open forms as compared with the dihydro derivatives.

EXPERIMENTAL

The absorption spectra of thin layers (1, 2, and 5 cm) of solutions of the compounds in hexane, alcohol, and chloroform were recorded with an SF-8 spectrophotometer; the spectra of aqueous acetone mixtures (c 10^{-5}-10^{-4} M, l 2 or 5 cm) were recorded with an SF-10 spectrophotometer. The PMR spectra of CCl_4 solutions of the spiropyrans were recorded with an RYa-2306 spectrometer (60 MHz) with hexamethyldisiloxane as the internal standard.

1-Methyl-3,4-dihydroisoquinoline. This compound, with bp 106-110° (10 mm) and n_D^{20} 1.570, was obtained in 60-65% yield by cyclization of N-acetyl-β-phenylethylamine in polyphosphoric acid (1 : 10 by weight) at 200° for 3.5 h [10].

1-Methylisoquinoline. This compound was obtained in 90% yield by dehydrogenation of 1-methyl-3,4-dihydroisoquinoline [11].

The quaternary salts of both bases were obtained by the action of methyl iodide in benzene. 1,2-Dimethylisoquinolinium iodide had mp 205-207° [12]. 1,2-Dimethyl-3,4-dihydroisoquinolinium iodide had mp 196-197° (mp 191-193° [13] and 200-202° [14]).

2-Methyl-6'-methoxyspiro(1,2-dihydroisoquinoline-1,2'-[2H]chromene) (IIa). A 0.38-g (2.5 mmole) sample of 5-methoxysalicylaldehyde and 0.03 g (0.35 mmole) of piperidine were added to a suspension of 0.72 g (2.5 mmole) of 1,2-dimethylisoquinolinium iodide in 2 ml of alcohol, after which the mixture was refluxed for 15-20 min and vacuum evaporated. Chloroform (30-40 ml) was added to the dark-brown viscous residue, and 0.74 g (70%) of orange crystals of 1-(2-hydroxy-5-methoxystyryl)-2-methylisoquinolinium

TABLE 1. Spectral Characteristics of Spiropyrans (II and IV) and Merocyanines (I and III)

Compound	R	R′	In hexane[a]	In alcohol		Parameters in $E_t = aZ + b$		
			λ_{max}, nm (lg ε or lg ε′)[b]	λ_{max}, nm(lg ε or lg ε′)[b]	$c \cdot 10^5$ M	Z, $\frac{kcal}{mole}$	a	b, $\frac{kcal}{mole}$
I_e	Br	Br	275*, 325*, 390, 605 (4,11; 3,76; 4,10; 4,32)	235, 252*, 315*, 350, 510 (4,71; 4,44; 3,88; 4,06; 4,10)	1,36 (to 260 nm) and 2,72	65,7—78,4 (65,7)	0,47	48,6
I_f	NO_2	H	320*, 360*, 410, 550 (4,09; 4,18; 4,30; 4,37)	235, 293, 350*, 400, 460 (4,57; 3,98; 3,97; 4,22; 4,18)	2,94	65,7—76,6 (65,7)	0,48	54,6
I_g	NO_2	Br	315*, 345, 415, 535 (3,99; 4,05; 4,20; 4,11)	235, 295, 350*, 400, 450* (4,51; 3,85; 3,92; 4,18; 4,08)	3,09	—	—	—
IIa	OCH_3	H	243, 274*, 290, 305—310* (4,43; 3,93; 3,99; 3,94)	233, 303, 362, 400*, 560 (4,74; 4,08; 4,10; 4,06; 3,51)	0,87 (to 240 nm) and 4,36	73,6—79,8 (78,4)	0,67	40
IIb	H	OCH_3	227, 279, 310* (4,58; 4,29; 4,08)	227, 260*, 380, 545 (4,77; 4,23; 4,24; 3,84)	0,88 (to 270 nm and 4,40	69,3—78,6 (77,5)	0,47	45,5
IIc	Cl	H	225, 245*, 270*, 290 (4,80; 4,35; 3,83; 3,95)	235, 286*, 350, 370*, 510 (4,50, 3,76; 3,83; 3,79; 3,62)	2,9 (to 240 nm and 5,8	69,3—78,6 (76,6)	0,50	47,8
I_d	Br	H	225, 242*, 273*, 290 (4,65; 4,61; 4,09; 4,20)	235, 283*, 352, 510 (4,44; 3,97; 4,01; 3,83)	1,37 (to 240 nm) and 2,73	69,3—77,6 (76,6)	0,45	48,3
III g	NO_2	Br	245, 300, 355, 402, 538 (4,11; 4,05; 4,25; 4,15; 4,42)	239, 295*, 340, 396, 474 (4,36; 4,32; 4,78; 4,20; 4,19)	1,30	65,7—80,7 (65,7)	0,28	55,5
IVa	OCH_3	H	235, 265*, 535 (4,35; 3,67; 3,48)	236, 265*, 333, 432, 574 (4,49; 3,76; 3,62; 2,61; 2,06)	2,73 (to 270 nm) and 13,6	83,2—94,4 (92,4)	0,37	43,3
IVb	H	OCH_3	229, 265, 275, 319 (4,49; 3,78; 3,70; 3,26)	227, 265, 275, 318, 365, 554 (4,49; 3,82; 3,79; 3,37; 3,11; 2,76)	2,8 (to 280 nm) and 14,3	80,7—94,3 (92,4)	0,30	46,9
IVc	H	H	220, 260*, 310 (4,54; 3,83; 3,47)	222, 260*, 270*, 310, 380, 525 (4,50; 3,77; 3,68; 3,56; 2,69; 2,42)	3,04 (to 320 nm), and 30,4	83,2—94,4 (92,4)	0,27	50,1
IVd	Br	H	231, 265*, 322 (4,45; 3,69; 3,38)	234, 265*, 320, 405*, 530 (4,56; 3,80; 3,49; 2,36; 2,78)	2,5 (to 270 nm), and 25,0	80,7—92,3 (90,3)	0,23	50,9
IVe	Br	Br	236, 265*, 330 (4,61; 3,92; 3,40)	237, 265*, 335, 525 (4,43; 3,78; 3,71; 3,64)	2,75	69,3—90,3 (87,9)	0,26	50,1
IVf	NO_2	H	231, 266, 322 (4,33; 4,18; 3,98)	232, 272, 330, 480 (4,29; 4,06; 3,96; 3,56)	1,9 (to 340 nm) and 9,8	35,7—80,7 (83,2)	0,32	54,1

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[a] The spectra of Ie-g and IIIg in $2.51 \cdot 10^{-5}$, $2.57 \cdot 10^{-5}$, $3.94 \cdot 10^{-5}$, and $3.3 \cdot 10^{-5}$ M concentrations, respectively, were recorded.

[b] The shoulders and inflection points are indicated by asterisks.

[c] The range of Z values over which the solvatochromism were investigated is indicated, and the Z value in parentheses is the value at which the intensity of the longwave band is a maximum.

iodide (hydriodide of Ia), with mp 204-206° (from butanol), was removed by filtration. Found: I 30.3; N 3.6%. $C_{19}H_{18}INO_2$. Calculated: I 30.3; N 3.3%. A 0.36-g (0.86 mmole) sample of hydrodide Ia was dissolved by heating in 10-12 ml of water, and the solution was cooled and treated with ammonium hydroxide to pH 9-10. The mixture was then filtered to give 0.2 g (80%) of red Ia, which was dissolved by heating in 20 ml of benzene. The benzene solution was filtered, the filtrate was vacuum evaporated to 3-5 ml, 25-30 ml of hexane was added, and the mixture was vacuum evaporated to dryness to give 0.1 g of IIa as slightly colored crystals. Crystallization from hexane gave colorless needles with mp 122-123° (dec.). PMR spectrum, δ, ppm: 2.95 (N$-$CH$_3$, s), 3.62 (O$-$CH$_3$, s), 5.53 (4-H, d, $J_{3,4}$ 7.5 Hz), 6.12 (3-H, d, $J_{3,4}$ 7.5 Hz), 5.70 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.73 (4'-H, d, $J_{3',4'}$ 10 Hz), and 6.51 (5', 7', 8'-H$_3$, s). Found: C 78.1; H 6.1; N 4.8%. $C_{19}H_{17}NO_2$. Calculated: C 78.3; H 5.8; N 4.8%.

2-Methyl-8'-methoxyspiro(1,2-dihydroisoquinoline-1,2-'-[3H]chromene) (IIb). Condensation with 3-methoxysalicylaldehyde was carried out as in the preceding experiment, after which a tenfold amount of water was added to the dark-brown solution, the mixture was evaporated to one-third of its original volume, and the concentrate was cooled and treated with ammonium hydroxide to pH 9-10. The precipitated red Ib was removed by filtration and treated as in the case of IIa to give colorless crystals of spirochromene IIb, with mp 116-118° [from hexane (1 : 100)], in 60% yield. Found: C 78.5; H 6.2; N 5.1%. $C_{19}H_{17}NO_2$. Calculated: C 78.3; H 5.8; N 4.8%.

Compounds IIc, d were similarly obtained in 60-65% yields and crystallized from hexane (1 : 150). Compound IIc had mp 154-156° (dec.). PMR spectrum, δ, ppm: 2.97 (N-CH$_3$, s), 5.58 (4-H, d, $J_{3,4}$ 7.5 Hz), 6.16 (3-H, d, $J_{3,4}$ 7.5 Hz), 5.78 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.83 (4'-H, d, $J_{3',4'}$ 10 Hz), and 6.48 (8'-H, d, $J_{7',8'}$ 9.5 Hz). Found: Cl 11.9; N 4.6%. $C_{18}H_{14}ClNO$. Calculated: Cl 12.0; N 4.7%. Compound IId had mp 142-144° (dec.). Found: Br 23.3; N 4.2%. $C_{18}H_{14}BrNO$. Calculated: Br 23.5; N 4.1%. Compound Id was obtained as crimson crystals with mp 189-192°. Found: Br 23.2%. $C_{18}H_{14}BrNO$. Calculated: Br 23.5%.

2-Methyl-1-(2-oxido-3,5-dibromostyryl)isoquinolinium (Ie). A 0.7-g (2.5 mmole) sample of 3,5-dibromosalicylaldehyde and 0.45 ml (5 mmole) of piperidine were added to a suspension of 0.72 g (2.5 mmole) of 1,2-dimethylisoquinolinium iodide in 4 ml of alcohol, after which the mixture was refluxed for 15-20 min. It was then cooled, and the brown-red precipitate of Ie was removed by filtration and washed with benzene to give 0.8 g (76%) of product. Two crystallizations from 50% ethanol gave 0.5 g of dark-brown crystals with mp 200-202°, which were soluble in hot benzene (to give a blue solution). Found: Br 38.1; N 3.3%. $C_{18}H_{13}Br_2NO$. Calculated: Br 38.2; N 3.3%.

2-Methyl-1-(2-oxido-5-nitrostyryl)isoquinolinium (If). This compound was obtained in 70% and was crystallized from 25% aqueous pyridine (1 : 150) to give orange crystals with mp 230-231°; the product was insoluble in benzene. Found: N 9.0%. $C_{18}H_{14}N_2O_3$. Calculated: N 9.2%.

2-Methyl-1-(2-oxido-3-bromo-5-nitrostyryl)isoquinolinium (Ig). This compound was similarly obtained in 75% yield. It was purified by precipitation from a solution in a tenfold amount of dimethylformamide (DMF) by dilution (by a factor of 1.5) with water. The product was washed with benzene to give brown crystals with mp 270°. Found: Br 20.8; N 7.4%. $C_{18}H_{13}BrN_2O_3$. Calculated: Br 20.8; N 7.3%.

2-Methyl-6'-methoxyspiro(1,2,3,4-tetrahydroisoquinoline-1,2'-[2H]chromene) (IVa). A 0.33-ml (2.5 mmole) sample of 5-methoxysalicylaldehyde and 0.45 ml (5 mmole) of piperidine were added to a suspension of 0.72 g (2.5 mmole) of 1,2-dimethyl-3,4-dihydroisoquinolinium iodide in 2 ml of isopropyl alcohol. The reaction solution warmed up and turned dark-lilac, and 0.7 g (84%) of light-colored IVa precipitated after 5-7 min. Recrystallization gave colorless needles with mp 125-126° (dec.), from hexane (1 : 20)]. Found: C 77.5; H 6.8; N 4.4%. $C_{19}H_{19}NO_2$. Calculated: C 77.8; H 6.5; N 4.8%.

2-Methyl-8'-methoxyspiro(1,2,3,4-tetrahydroisoquinoline-1,2'-[2H]chromene (IVb). This compound was obtained as in the preceding experiment in 80% yield (condensation in ethanol). Recrystallization gave colorless crystals with mp 114-115° [dec., from hexane (1 : 15)]. PMR spectrum, δ, ppm: 2.35 (N-CH$_3$, s) 3.66 (O-CH$_3$, s), 5.30 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.62 (4'-H, d, $J_{3',4'}$ 10 Hz), and 6.54 (5', 6', 7'-H$_3$, s). Found: C 77.3; H 7.0; N 4.6%. $C_{19}H_{19}NO_2$. Calculated: C 77.8; H 6.6; N 4.8%.

2-Methylspiro(1,2,3,4-tetrahydroisoquinoline-1,2'-[2H]chromene) (IVc). A 0.3-ml (2.5 mmole) sample of salicylaldehyde and 0.03 g (0.35 mmole) of piperidine were added to a suspension of 0.72 g (2.5 mmole) of 1,2-dimethyl-3,4-dihydroisoquinolinium iodide in 3 ml of ethanol. The solution turned dark-brown, and 0.8 g (81%) of hydrodide IIIc precipitated after 5-7 min. Recrystallization gave yellow crystals with mp 238-240° [from alcohol (1 : 15)]. Found: I 32.3%. $C_{18}H_{18}INO$. Calculated: I 32.2%.

Cold water (20 ml) and ammonia were added to 0.5 g of hydriodide IIIc until the pH was 9-10. The resulting precipitate was removed by filtration and dissolved in 10 ml of benzene, and the solution was filtered. The filtrate was vacuum evaporated to dryness, and the residue was crystallized twice from petroleum ether (1 : 5) to give 0.15 g (44.5%) of colorless crystals (IVc) with mp 89-91° (dec.). PMR spectrum, δ, ppm: 2.38 (N-CH_3, s), 5.32 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.68 (4'-H, d, $J_{3',4'}$ 10 Hz). Found: C 82.1; H 6.5; N 5.3%. $C_{18}H_{17}NO$. Calculated: 82.0; H 7.1; N 5.0%.

2-Methyl-6'-bromospiro(1,2,3,4-tetrahydroisoquinoline-1,2'-[2H]chromene) (IVd). Condensation with 5-bromosalicylaldehyde was carried out as in the preceding experiment, but the starting materials were refluxed in alcohol for 30 min. The yellow crystals of hydriodide IIId (60%) were removed by filtration. Ammonia was added to 0.45 g of hydriodide IIId in 100 ml of water to pH 9-10, and the resulting light-lilac-colored precipitate (50%) was recrystallized twice from petroleum ether (1 : 5) to give a product with mp 93-96° (dec.). PMR spectrum, δ, ppm: 2.33 (N-CH_3, s), 5.36 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.61 (4'-H, d, $J_{3',4'}$ 10 Hz), 6.51 (8'-H, d, $J_{7',8'}$ 9.5 Hz), and 7.07 (5,6,7,8,5',7'-H_6 broad signal). Found: Br 23.3; N 4.3%. $C_{18}H_{16}BrNO$. Calculated: Br 23.4; N 4.1%.

2-Methyl-6',8'-dibromospiro(1,2,3,4-tetrahydroisoquinoline-1,2'-[2H]-chromene) (IVe) and 2-Methyl-1-(2-oxido-3,5-dibromostyryl)-3,4-dihydroisoquinolinium (IIIe). Condensation with 3,5-dibromosalicylaldehyde was carried out as in the case of IVa. Water (20 ml) was added to the resulting suspension, and the dark-brown crystals of IIIe were removed by filtration and crystallized from 25% aqueous isopropyl alcohol to give crimson crystals of IIIe with mp 167-168° in 60% yield. Found: Br 38.2%. $C_{18}H_{15}Br_2NO$. Calculated: Br 38.0%. A 0.6-g sample of IIIe was dissolved in 5-7 ml of benzene, the solution was filtered, and the filtrate was vacuum evaporated to dryness. The residue was crystallized from petroleum ether (1 : 10) to give 0.4 g of colorless crystals of IVe with mp 97-98° (dec.). PMR spectrum, δ, ppm: 2.31 (N-CH_3, s), 5.45 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.63 (4'-H, d, $J_{3',4'}$ 10 Hz), 7.46 (7'-H, d, $J_{5',7'}$ 2.5 Hz), and 7.01 (5,6,7,8,5'-H_5). Found: Br 37.9%. $C_{18}H_{15}Br_2NO$. Calculated: Br 38.0%.

2-Methyl-6'-nitrospiro(1,2,3,4-tetrahydroisoquinoline-1,2'-[2H]chromene) (IVf) and 2-Methyl-1-(2-oxido-5-nitrostyryl)-3,4-dihydroisoquinolinium (IIIf). Condensation with 5-nitrosalicylaldehyde was carried out as in the case of IVa. A tenfold excess of water was added to the red solution, and the precipitated red crystals were removed by filtration to give IIIf in 60% yield. Crystallization from 30% aqueous isopropyl alcohol gave crimson crystals with mp 195-197°. A 0.4-g sample of IIIf was dissolved in 20 ml of boiling benzene, the solution was filtered, and the filtrate was evaporated to dryness. The residue was crystallized from petroleum ether (1 : 7) to give 0.2 g of light-yellow crystals of IVf with mp 135-137° (dec.). PMR spectrum, δ, ppm: 2.40 (N-CH_3, s), 5.50 (3'-H, d, $J_{3',4'}$ 10 Hz), 6.77 (4'-H, d, $J_{3',4'}$ 10 Hz), 6.68 (8'-H, d, $J_{7',8'}$ 9.5 Hz), 7.09 (5,6,7,8-H_4, s), 7.95 (7'-H, q, $J_{7',8'}$ 9.5 Hz, $J_{5',7'}$ 2.5 Hz), and 7.92 (5'-H, d, $J_{5',7'}$ 2.5 Hz). Found: N 8.9%. $C_{18}H_{16}N_2O_3$. Calculated: N 9.1%.

2-Methyl-1-(2-oxido-3-bromo-5-nitrostyryl)-3,4-dihydroisoquinolinium (IIIg). Condensation with 3-bromo-5-nitrosalicylaldehyde was carried out as in the case of IVd. The brown-red solution was cooled, a threefold excess of water and ammonia were added to pH 9-10, and 0.54 g (80%) of light-red crystals were removed by filtration. The product was crystallized from 25% aqueous pyridine (1 : 40) to give 0.25 g of orange crystals with mp 217-218°. Found: Br 20.7; N 7.4%. $C_{18}H_{15}BrN_2O_3$. Calculated: Br 21.5; N 7.2%.

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