REACTION OF SOME PYRYLIUM SALTS WITH HYDRAZINE

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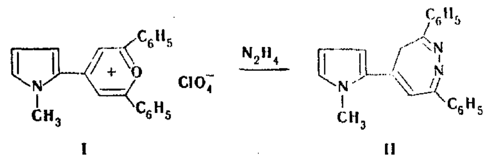
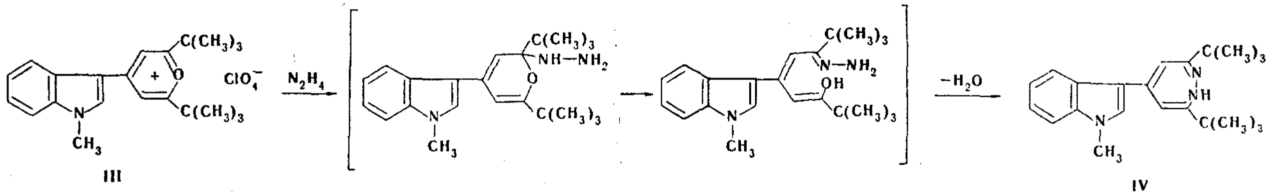
2,6-Diphenyl- and 2,6-di-tert-butylpyrylium salts react with excess hydrazine to give 1,2-diazepine derivatives. Under the same conditions, 4-(1-methyl-3-indolyl)flavylium perchlorate forms 3-phenyl-5-(1-methyl-3-indolyl)pyrazole.

The synthesis of 1,2-diazepines by the reaction of pyrylium salts with hydrazine [1-3], which until now has been known only for 2,4,6-triarylpyrylium salts, is attracting attention in view of the fact that compounds of this class are difficult to obtain and have not received sufficient study [4]. We attempted to ascertain the limits of application of this reaction. It was found that the reaction is also applicable to the preparation of 1,2-diazepines of the pyrrole series. For example, 2,6-diphenyl-4-(1-methyl-2-pyrrolyl) pyrylium perchlorate (I) reacts with hydrazine to give 1,2-diazepine derivative II:



The fact that extensive variation of the functional groups in the phenyl substituents of 2,4,6-triarylpyrylium salts does not change the direction of the reaction and that 1,2-diazepines [2, 3] are formed in high yields in all cases makes it possible to assume that the direction of the reaction depends on purely steric factors: bulky aryl substituents in the α-positions of the pyrylium ring hinder nucleophilic attack of the activated C=C bond in the initially formed monohydrazone and closing of the pyrazoline ring. In order to verify this assumption, we treated 2,6-di-tert-butyl-4-(1-methyl-3-indolyl)pyrylium perchlorate (III) with hydrazine and isolated a compound to which the 3,7-di-tert-butyl-5-(1-methyl-3-indolyl)-1H-1,2-diazepine structure (IV) can be assigned on the basis of the UV and IR spectra.



The mass spectrometric investigation confirms the IV structure. The mass spectrum contains a molecular ion peak with mass 335 and intense peaks of fragment ions with masses 278, 252, 196, 195, and 168, from which the order of disintegration can be determined (the mass spectrum does not contain the peak of the fragment ion formed due to ejection of a nitrogen molecule, a peak that is observed in all cases in the mass spectra of 4H-1,2-diazepines) [2]. The formation of fragment ions with masses 278 and 252 is confirmed by the metastable transitions (the apparent masses are 230.7 and 189.5, respectively). The

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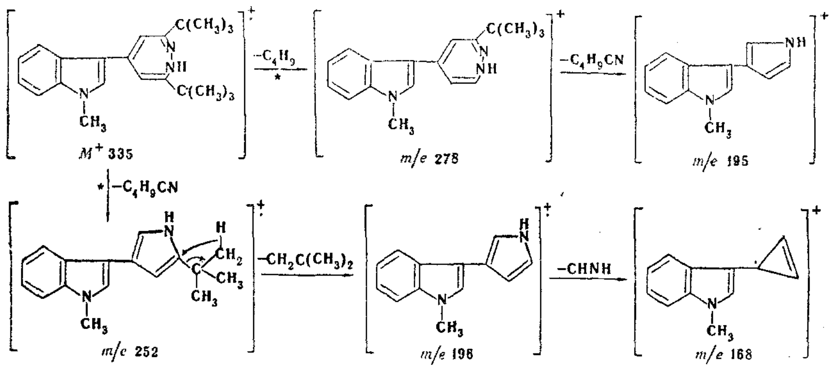
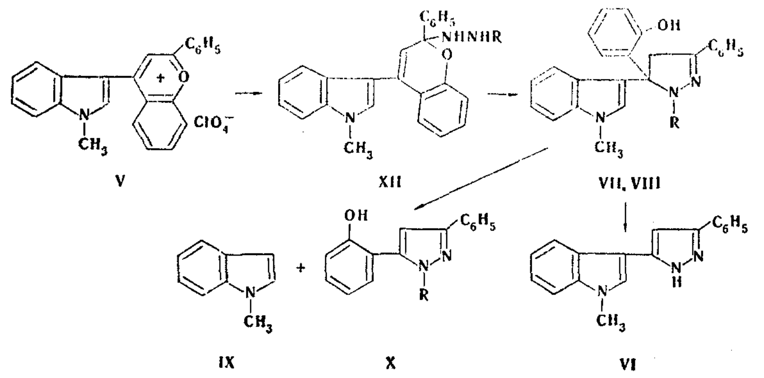
disintegration of the molecular ion also leads to a fragment ion with mass 293 (the relative intensity is 58%), which is confirmed by the metastable transition: $335^+ \rightarrow 293^+ + 42$ (the apparent mass is 256.5). Detachment of C_3H_6 from one of the tert-butyl substituents of the molecular ion with migration of a methyl group to the cycloheptatriene ring apparently occurs during electron impact. Also appearing in the mass spectrum is the peak of an indole ion with mass 131, the formation of which can be explained by detachment of a pyrrole residue from the ion with mass 196 and migration from it of a hydrogen to the β position of the indole molecule.



As should have been expected, 4-(1-methyl-3-indolyl)flavylium perchlorate (V) does not form a 1,2-diazepine under these conditions for the same reasons for which salts containing an oxygen atom directly connected to an aromatic ring do not form pyridine bases [5]. This reaction leads to 3-phenyl-5-(1-methyl-3-indolyl)pyrazole (VI), which is formed as a result of detachment of a phenol residue from the pyrazoline (VII) in the presence of a base (the same product is formed during the action of alcoholic alkali on VII). This detachment does not occur during the reaction of salt V with phenylhydrazine. In this case, we isolated 1,3-diphenyl-5-(1-methyl-3-indolyl)-5-(o-hydroxyphenyl)-Δ^2-pyrazoline (VIII), which is cleaved to form 1,3-diphenyl-5-(o-hydroxyphenyl)pyrazole (XI) on refluxing in acetic acid. Refluxing of pyrazoline VII in acetic acid leads to a similar pyrazole derivative (X). 1-Methylindole (IX) was detected in the reaction mixture by chromatography in a thin layer of aluminum oxide.



VII, X, XII R = H; VIII, XI R = C_6H_5

EXPERIMENTAL

3,7-Diphenyl-5-(1-methyl-2-pyrrolyl)-4H-1,2-diazepine (II). A suspension of 4.1 g (0.01 mole) of 2,6-diphenyl-4-(1-methyl-2-pyrrolyl)pyrylium perchlorate in 40 ml of methanol was refluxed with 2 g (0.04 mole) of hydrazine hydrate for 30 min, and the mixture was then cooled and poured into water. The aqueous mixture was extracted with chloroform, and the extract was washed with water, dried with sodium sulfate, and distilled to dryness. The residue was crystallized from benzene to give 1.2 g (38%) of a product with mp 224°. Found: C 81.4; H 6.1; N 12.7%. $C_{22}H_{19}N_3$. Calculated: C 81.2; H 5.8; N 12.9%. IR spectrum (KBr pellet), cm^{-1}: 1595, 1470, 1380, 1335, 1210, 780, and 700. UV spectrum (in alcohol): λ_{max} 205 and 270 nm, log ε 4.64 and 4.35.

3,7-Di-tert-butyl-5-(1-methyl-3-indolyl)-1H-1,2-diazepine (IV). This compound [1.5 g (88%)] with mp 226° (from methanol) was similarly obtained from 2.1 g (5 mmole) of 2,6-di-tert-butyl-4-(1-methyl-3-indolyl)pyrylium perchlorate and 1 g (0.02 mole) of hydrazine hydrate. Found: C 79.1; H 8.8; N 12.3%. $C_{22}H_{29}N_3$. Calculated: C 78.8; H 8.7; N 12.5%. IR spectrum (KBr pellet), cm^{-1}: 3450, 2980, 1600, 1530, 1475, 1430, 1365, 1255, 745. UV spectrum (in alcohol): λ_{max} 205, 229, and 333 nm, log ε 4.64, 4.39, and 4.26. Molecular weight 335 (mass spectrum).

2-Hydrazino-2-phenyl-4-(1-methyl-3-indolyl)-Δ^3-chromene (XII). Excess hydrazine hydrate was added dropwise with stirring and ice cooling to a suspension of 1 g of 4-(1-methyl-3-indolyl)flavylium perchlorate (V) [6] in 20 ml of ether. As the hydrazine hydrate was added, the perchlorate dissolved. The reaction mixture was washed several times with water, dried with sodium sulfate, concentrated to half the original volume, and allowed to stand overnight. The crystalline yellow precipitate was removed by filtration and washed thoroughly with ether to give 0.8 g (95%) of a product with mp 130-132°. Found: C 79.0; H 6.0; N 11.5%. $C_{24}H_{21}N_3O$. Calculated: C 78.5; H 5.7; N 11.4%. IR spectrum (mineral oil), cm^{-1}: 3400, 1600, 1520, and 1350.

3-Phenyl-5-(o-hydroxyphenyl)-5-(1-methyl-3-indolyl)-Δ^2-pyrazoline (VII). A solution of 0.6 g of pyran derivative XII in 20 ml of methanol was refluxed for 30 min and cooled to give 0.6 g (100%) of yellow crystals of pyrazoline VII with mp 225° (from methanol). Found: C 78.7; H 5.6; N 11.8%. $C_{24}H_{20}N_3O$. Calculated: C 78.5; H 5.7; N 11.4%. IR spectrum (mineral oil), cm^{-1}: 3280, 1590, 1540, 1350, 1330, 1250, 1230, and 1115.

1,3-Diphenyl-5-(o-hydroxyphenyl)-5-(1-methyl-3-indolyl)-Δ^2-pyrazoline (VIII). This compound [0.6 g (92%)] with mp 211° (from methanol-chloroform) was similarly obtained from 0.66 g (1.5 mmole) of 4-(1-methyl-3-indolyl)flavylium perchlorate (V) and excess phenylhydrazine. Found: C 80.8; H 5.7; N 9.5%. $C_{30}H_{25}N_3O$. Calculated: C 81.3; H 5.6; N 9.5%. IR spectrum (KBr pellet), cm^{-1}: 3450, 1600, 1495, 1380, 1240, 1140, 760, 700. UV spectrum (in alcohol): λ_{max} 212, 252, and 270 nm, log ε 4.64, 4.59, and 4.60.

3-Phenyl-5-(1-methyl-3-indolyl)pyrazole (VI). This compound [0.6 g (95%)] with mp 238° (from chloroform) was similarly obtained from 1 g (2.3 mmole) of 4-(1-methyl-3-indolyl)flavylium perchlorate (V) and excess hydrazine hydrate. Found: C 78.6; H 5.8; N 15.2%. $C_{18}H_{15}N_3$. Calculated: C 79.1; H 5.5; N 15.4%. IR spectrum (KBr pellet), cm^{-1}: 3450, 1583, 1545, 1485, 1350, 1250, 745, 695. UV spectrum (in alcohol): λ_{max} 205, 222, and 279 nm, log ε 4.61, 4.58, and 4.17.

3-Phenyl-5-(o-hydroxyphenyl)pyrazole (X). A solution of 0.3 g of pyrazoline VII in 10 ml of acetic acid was refluxed for 1 h, after which the mixture was diluted with a small amount of water until it became turbid. The resulting precipitate was removed by filtration and crystallized several times from aqueous acetic acid to give 0.15 g (79%) of a product with mp 136°. Found: C 76.5; H 5.1; N 11.8%. $C_{15}H_{12}N_2O$. Calculated: C 76.3; H 5.1; N 11.9%. IR spectrum (KBr pellet), cm^{-1}: 3420, 3280, 3070, 1620, 1590, 1495, 1258, 1185, 1040, 978, 765, 700. UV spectrum (in alcohol): λ_{max} 208 and 255 nm, log ε 4.52 and 4.52.

1,3-Diphenyl-5-(o-hydroxyphenyl)pyrazole (XI). A solution of 0.44 g (1 mmole) of pyrazoline VIII in 20 ml of acetic acid was refluxed for 1 h, after which it was cooled and poured into water. The product was extracted with benzene, and the extract was dried with sodium sulfate and concentrated to give 0.3 g (97%) of a product with mp 178° (from benzene). Found: C 80.2; H 5.2; N 9.4%. $C_{21}H_{16}N_2O$. Calculated: C 80.8; H 5.1; N 9.0%. IR spectrum (KBr pellet), cm^{-1}: 3250-3450 (broad band), 1595, 1500, 1460, 1361, 760, 697. UV spectrum (in alcohol): λ_{max} 212 and 270 nm, log ε 4.64 and 4.60.

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