STRUCTURE AND AMBIPHILIC REACTIVITY OF INDOLIZINES.

6.* SCOPE OF THE ISOMERIZATIONAL RECYCLIZATION OF INDOLIZINES

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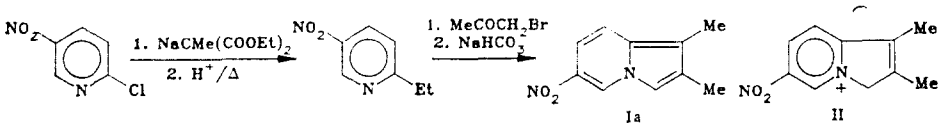
The behavior of substituted 6- and 8-nitroindolizines in the isomerizational recyclization reaction has been examined. A novel method of synthesis of 2-acyl-5- and 7-nitroindoles has been developed, by recyclization of 3-acyl-6- and 8-nitroindolizines. The scope of the isomerizational recyclization of indolizines for the synthesis of indoles has been established.

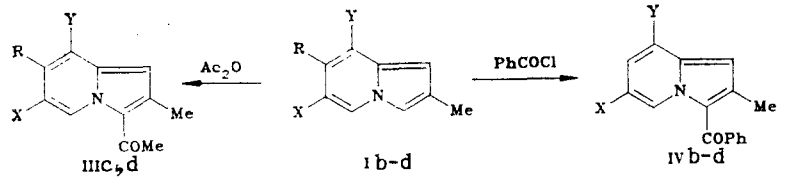
An important special case of the Kost–Sagitullin rearrangement [2] is the isomerizational recyclization, observed by these workers and by Gromov [3], of 2-methyl(phenyl)-6- and 8-nitroindolizines to give the 3-methyl(phenyl)-5- and 7-nitroindoles. According to literature data [3-6], the presence of a nitro group in the 6- or 8-position is obligatory for the rearrangement to occur, but some substituents in the 2-, 3-, or 7-positions prevent recyclization to the nitroindole. Generally speaking, the scope of the recyclization of indolizines to indoles remains undefined.

We have examined the influence of substituents in various positions of the indolizine bicycle on the recyclization of 6- and 8-nitroindolizines. Investigations have been carried out with 2,7-dimethyl-, 2,5-dimethyl-, and 2,5,7-trimethyl-8(6)-nitroindolizines, obtained by us previously [7], together with 3-acyl-6- and 8-nitroindolizines. The Chichibabin method has been used (without isolation of the intermediate bromoacetonylates) to obtain also 1,2-dimethyl-6-nitroindolizine (Ia), which is incapable of undergoing the "normal" recyclization to the indole. The required 2-ethyl-5-nitropyridine was obtained from the chloronitropyridine.



Obtained similarly was 2-methyl-6-nitroindolizine (Ib) [8]. In both cases, the solvent used in the first step (nucleophilic substitution) was DMF (cf. [9]). In the PMR spectrum of (Ia) in CCl_4 or $CDCl_3$, the resonance signals for both the two methyl groups and the three aromatic protons coincided. An informative PMR spectrum was obtained in CF_3COOH, since in the spectrum of the 3H-indolizinium cation (II) formed in acid solution all the resonance signals are separated.

The 3-acyl-6- and 8-nitroindolizines were obtained by acylating the appropriate nitroindolizines. No 1-substitution products were obtained, in contrast to the acylation of 2-methylindolizine [1] or the nitration of the nitroindolizine (Ib) [6].



IIIc,d Ib-d IVb-d

Ib,c IIIc, IVb X=NO_2, Id IIId IVd X=H; Ib,c IIIc IVb Y=H, Id IIId, IVd Y=NO_2; Ib,d IIId, IVb,d R=H, Ic IIIc R=Me

*For Communication 5, see [1].

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TABLE 1. Properties of Acylnitroindolizines (IIIc, d) and (IVb, d)

Compound	mp, °C (heptane)	R_f (benzene)	IR spectrum, cm^{-1}	Yield, %*
IIIc	174...175	0,06	1635, 1612	70
IIId	172...173	0,10	1640, 1625	56
IVb	216...218	0,21	1632, 1612	84 (27)
IVd	148...149	0,21	1640, 1600	64 (52)

*In the case of (IVb) and (IVd), the yield is given for nitroindolizine reacting (yield on starting material given in brackets).

TABLE 2. UV Spectra of Nitroindolizines (I), (III), (IV) and Nitroindoles (V-VII)

Compound	Solvent*	λ_{max}, nm (log ε)
Ia	a	213 (4,48), 309 (4,49), 462 (3,39)
	b	pl. 270...290 (3,8)
Ic	b	310 (3,73)
Ie	b	258+266 (4,04), 357 (3,66), pl. 466 (2,88)
If	b	254 (3,75), 266 (3,75), pl. 288 (3,37), 365 (4,12), pl. 475 (1,72)
Ig	b	261+268 (4,11), 356 (3,63) pl. 465 (3,30)
IIIc	a	pl. 213 (3,13), 265 (3,19), pl. 290 (2,97), 342 (2,62), 353 (2,57), pl. 409 (2,35)
IIId	a	pl. 225 (2,84), 260 (2,57), 308 (3,27), 350 (2,57), 438 (1,89)
	b	pl. 255...265 (3,55), 305 (4,29), 358 (3,67), 420 (3,28)
IVb	a	215 (3,23), 274 (3,21), 350 (2,77), 360 (2,77), 404 (2,46)
	b	275 (3,95), 360 (3,53), 400 (3,44)
IVd	a	252 (2,97), 316 (3,11), 373 (2,85), 434 (1,85)
	b	252 (4,14), 3,10 (4,32), 365 (4,04), pl. 410 (3,71)
V	a	215 (4,08), 275 (3,82), 326 (3,44)
VIc	a	292 (3,53), pl. 350 (2,93)
VId	a	229 (2,33), 255 (2,57), 292 (2,60), 370 (2,56)
VIIb	a	252 (3,35), 305 (3,41), pl. 340 (3,0)
VIId	a	233 (3,28), 252 (3,09), 316 (3,00), 366 (2,96)

*a) 90% ethanol; b) a 2.5-N solution of KOH in ethanol.

The strong low-field shift (>1 ppm) of the 5-H proton seen in the PMR spectra of the indolizines (IIIc, d) and (IVb, d) induced by the peri-oriented magnetically anisotropic acyl group confirms the formation of the 3-isomers (Tables 1-4). The mass spectral fragmentation of (IIIc, d) and (IVb, d) involves elimination of substituents from the 6(8) position and from the acyl group. The resulting fragment then loses a CO molecules and an H_2CN radical in succession. In the case of the 3-benzoyl-6- and 8-nitroindolizines (IVb, d), cleavage of a hydrogen atom is also seen, while with (IIIc), which contains ortho-oriented CH_3 and NO_2 groups, and HO· radical is also eliminated (the ortho-effect [7, 10, 11]).

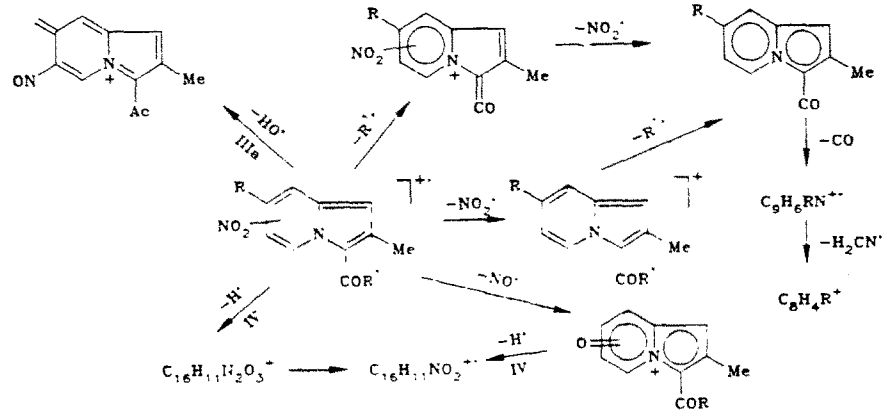


TABLE 3. PMR Spectra of (I), (III), and (IV-VII)

Compound	Solvent	δ, ppm						
		1-H (1-Me)	2-Me (substituent)	3-H (substituent)	5-H	6-H (6-Me)	7-H (7-Me)	8-H (4-H)
Ia	CCl_4	(2,35)	(2,35)	7,25	9,10	—	7,25	7,25
	CF_3COOH	(2,30)	(2,15)	5,30	9,80	—	9,00	7,90
Ic	P-p CD_3ONa in CD_3OD	5,7	(2,0)	6,55*	6,7*	—	(2,4)	5,95
IIIc	$CDCl_3$	6,28	(2,6)	(2,6)	10,83	—	(2,6)	7.17
IIId	$CDCl_3$	7,21	(2,60)*	(2,67)*	10,24	6,83	8,15	—
IVb	$CDCl_3$	6,45	(1,97)	(7,5)	10,57	—	7,77	7,37
	P-p CD_3ONa $CDCl_3$	6,1	(1,75)	(7,65)	—**	—	7,3	6,3
IVd	$CDCl_3$	7,20	(2,00)	(7,50)	9,85	6,85	8,20	—
V	CD_2Cl_2		7,00	(2,35)	—	(2,70)	7,15	8,30
VIc	$(CD_3)_2CO$		(2,75)	(2,75)	—	(2,75)	7,45	8,25
VId	$(CD_3)_2CO$		(2,7)	(2,7)	7,2	8,1	—	8,4
VIIb	$(CD_3)_2CO$	11,2	7,60	(2,77)	—	8,17	7,60	8,63
VIId	$(CD_3)_2CO$		7,60	(2,67)	7,30	8,30	—	8,17

*The assignment of the signals could be the reverse.

**Lies in the region of absorption of the solvent.

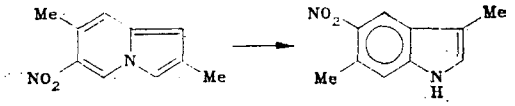
TABLE 4. Mass Spectra of Nitroindolizines (I), (III), (IV) and Nitroindoles (V-VII)*

Compound	m/z (I_{rel}, %)
Ia	190 (100), 189 (35), 145 (20), 144 (64), 143 (63,5), 142 (23), 129 (8), 128 (9), 117 (14,5), 115 (30)
IIIc	232 (100), 217 (40), 215 (67), 202 (1,5), 186 (25,5), 170 (230), 144 (18), 143 (29), 142 (15,5), 115 (11)
IIId	218 (100), 204 (7,5), 203 (71,5), 188 (2,5), 175 (9), 172 (16), 157 (27), 129 (49,5), 128 (12), 101 (13,5)
IVb	280 (100), 279 (126,5), 250 (5), 249 (7,5), 234 (23,5), 233 (57), 204 (42), 203 (21,5), 157 (19,5), 129 (10)
IVd	280 (100), 279 (84), 250 (20), 249 (24,5), 234 (13), 203 (14), 157 (9,5), 129 (34), 128 (8), 101 (18)
V	190 (100), 174 (17,5), 173 (129), 149 (7,5), 145 (44), 144 (45,5), 143 (55), 142 (22), 128 (23,5), 118 (55,5)
VIc	232 (100), 217 (18,5), 215 (118,5), 202 (11), 199 (23), 186 (18,5), 171 (15,5), 166 (17), 143 (43), 116 (24,5)
VId	218 (100), 203 (55,5), 200 (137), 171 (70,5), 170 (122), 157 (52), 142 (37), 129 (40,5), 128 (33,5), 102 (40,5)
VIIb	280 (100), 279 (80,5), 264 (15,5), 262 (9,5), 233 (16,5), 232 (54), 217 (16,5), 204 (28), 158 (14), 129 (21)
VIId	280 (100), 279 (31), 262 (82), 260 (22), 234 (60), 232 (75), 204 (72), 203 (25), 157 (13), 105 (39)

*The ten main peaks are given (intensity of the ions as a percent of the molecular ion given in brackets).

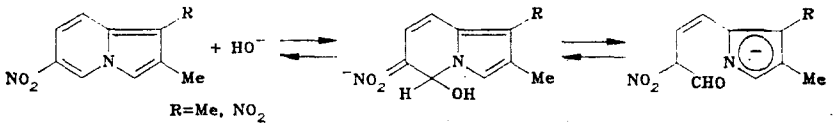
The nitroindolizines obtained were subjected to the recyclization reaction. The first stage of the recyclization, carried out in aqueous-alcoholic alkali, is the formation of the σ-complexes [3]. The UV spectra of these complexes with di- and trimethylindolizines were found to be identical with those of their lower homologs (Table 2). Anionic complexes of acylnitroindolizines absorb at longer wavelengths than the σ-complexes of nitroindolizines with a free 3-position which do not contain auxochromic acyl groups, but at shorter wavelengths than the anionic complexes of dinitroindolidizines (cf. [6]). The structures of the σ-complexes of (Ic) and (IVb) were also confirmed by PMR (Table 3).

2,7-Dimethyl-6-nitroindolizine recyclizes to 3,6-dimethyl-5-nitroindole, whereas the isomeric 2,7-dimethyl- and 2,5-dimethyl-8-nitro, together with 2,5,7-trimethyl-8-nitroindolizine (Ie-g) undergo resinification and do not give the nitroindoles:



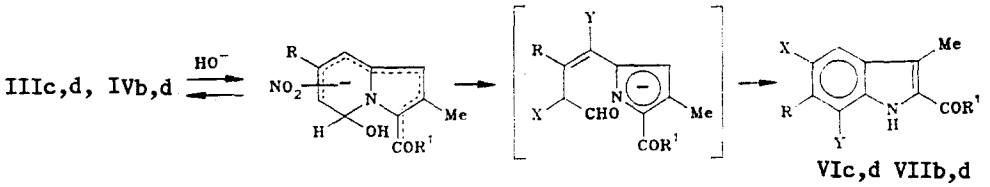
IC V

The 1-substituted nitroindolizines (Ia) and 2-methyl-1,6-dinitroindolizine [6] were recovered unchanged under the recyclization conditions (boiling for many hours in aqueous-alcoholic alkali). Since under these conditions the C_5–N bond must inevitably be ruptured, as in the analogous 1-unsubstituted nitroindolizines, the recovery of the starting indolizines suggests that the stage at which the pyridine ring is opened in the recyclization reaction is reversible.



R=Me, NO_2

The 3-acyl-6- and 8-nitroindolizines (IIIc, d) and (IVb, d) recyclize to the corresponding isomeric 2-acyl-5- and 7-nitroindoles* under milder conditions than are required in the case of nonacylated 6- and 8-nitroindolizines.

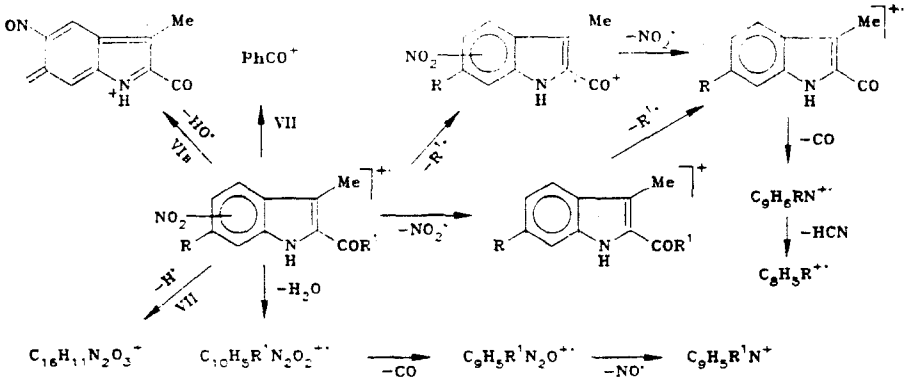


VIc,d VIIb,d

It is worthy of note that multistage procedures have previously been employed for the synthesis of acylnitroindoles, particularly those which are key intermediates for the synthesis of biologically active compounds [13, 14].

The ease of recyclization may be rationalized by participation of the acyl group in the delocalization of the negative charge in the pyrrole moiety of the molecule which remains after rupture of the $C_{(5)}$–N bond in the anionic σ-complex. In contrast to the more electronegative nitro-group (cf. [6]), the $COCH_3$ and COC_6H_5 substituents do not prevent closure of the benzene ring of the indole molecule in the final stages of the S_N ANRORC reaction.

The structures of the indoles (VIc, d) and (VIIb, d) were confirmed spectrally (Tables 2-5). Mass spectral fragmentation involves elimination of the substituent R from the acyl group, and in the case of indoles (VIc) and (VIId), of the NO_2 group (with VIIb), the $[M - H]^+$ ion loses the R and NO_2 groups), together with cleavage of a molecule of water [or the $HO^\cdot$ radical in the case of VIc)]. In addition, the benzoylnitroindoles (VIIb, d) lose an atom of hydrogen and the $PhCO^+$ cation.



These data, with those reported previously [3-6], enable the scope of the isomerizational recyclization of indolizines for the synthesis of indoles to be defined. First, a nitro-group (or a group at least as electronegative) must be present in the 6- or 8-position. Second, a methyl group in the 7-position prevents the recyclization of 8-nitroindolizine, but not of its 6-isomer. Third, a strongly electron-acceptor group (such as NO_2) in the 3-position prevents recyclization, while less-strongly acceptor (acyl) groups facilitate the recyclization.

The authors thank P. A. Sharbatyan for the mass spectra of (III), (IV), (VI), and (VII).

*Cf. [12].

TABLE 5. Properties of Acylnitroindoles (VIc, d) and (VIIb, d)

Compound	Empirical formula	mp, °C	IR spectrum, ν, cm^{-1}	HRMS* found	HRMS* calc.	Yield, %
VIc	$C_{12}H_{12}N_2O_3$	232...233	3300, 1640	232,0851	232,0848	61
VId	$C_{11}H_{10}N_2O_3$	146...148	3486, 1665, 1640	218,0719	218,0691	90
VIIb	$C_{16}H_{12}N_2O_3$	234...236	3410, 1625	280,0917	280.0848	73
VIId	$C_{16}H_{12}N_2O_3$	158...160	3475, 1650	280,0916	280,0848	30**

*High-resolution mass spectrum.

**Yield not optimized.

EXPERIMENTAL*

The homogeneity of the products was checked on Silufol plates. UV spectra were obtained on Specord M-40 and Cary-219 instruments, and IR spectra on a UR-20 in Vaseline grease. PMR spectra were obtained on a Tesla-467 (60 MHz), internal standard TMS, and mass spectra on a Varian MAT-212 (E = 100 eV) with direct sample introduction, HRMS being obtained on the same instrument (mass reference compound perfluorokerosene), mass measurements being carried out manually.

Diethyl (5-Nitro-2-pyridyl)methylmalonate ($C_{13}H_{16}N_2O_6$). Sodiomethylmalonic ester, obtained by dissolving 0.78 g (34 mmoles) of sodium and 5.6 g (34 mmoles) of methylamionic ester in 70 ml of absolute ether followed by evaporation of the latter, and 4.7 g (33 mmoles) of 5-nitro-2-chloropyridine were stirred in 40 ml of freshly distilled DMF for 1 h at 70°C. After removal of the solvent under reduced pressure, the residue was dissolved in 300 ml of cold water, extracted with chloroform (3 × 200 ml), and the extracts dried over Na_2SO_4 and the solvent removed. The resulting red oil was chromatographed on a column of length 50 cm (SiO_2; $CHCl_3$), followed by distillation to give 5.25 g (50%) of the nitropyridylmethylmalonic ester, bp 180°C (20-22 mm). PMR spectrum (no solvent): 9.25 (1H, d, 6-H, ^4J = 2.5 Hz); 8.46 (1H, d.d, 4-H, ^3J = 8, ^4J = 2.5 Hz); 7.75 (1H, d, 3-H, ^3J = 8 Hz); 4.25 (4H, q, CH_2, ^3J = 7 Hz); 1.90 (3H, s, CH_3–C); 1.25 ppm (6H, t, CH_3 in OEt, ^3J = 7 Hz).

5-Nitropyrid-2-ylmalonic ester was obtained similarly, from 34 mmoles of sodiomalonic ester and 2.3 g (15 mmoles) of 5-nitro-2-chloropyridine, in a yield of 4.0 g (97%), mp 97°C (alcohol; according to [15], mp 97-99°C). The nitroindolizine (Id) was obtained from the ester, as described in [8].

5-Nitro-2-ethylpyridine ($C_7H_8N_2O_2$). A mixture of 4.0 g (13 mmoles) of the nitropyridylmethylmalonic ester and 20 ml of 18% HCl was boiled for 4 h. After cooling, the mixture was neutralized with sodium carbonate to pH 7 and extracted with ether (2 × 200 ml), and the extract dried over $CaCl_2$ and evaporated. The ether was distilled off, and the residue fractionated to give 1.2 g (60%) of the ethylnitropyridine, bp 123-130°C (16-22 mm). PMR spectrum (in CCl_4): 9.30 (1H, d, 6-H, ^4J = 2.5 Hz); 8.45 (1H, d.d, 4-H, ^3J = 8, ^4J = 2.5 Hz); 7.40 (1H, d, 3-H, ^3J = 8 Hz); 2.93 (2H, q, CH_2, ^3J = 7.5 Hz); 1.30 ppm (3H, t, CH_3, ^3J = 7.5 Hz).

1,2-Dimethyl-6-nitroindolizine (Ia, $C_{10}H_{20}N_2O_2$). A mixture of 3.0 g (20 mmoles) of the ethylnitropyridine and 4 ml (40 mmoles) of bromoacetone in 20 ml of acetonitrile was boiled for 20 h. After cooling, the mixture was evaporated to dryness, and the residue heated with 50 ml of 0.1 N HCl in 50% ethanol. The resulting solution was extracted with chloroform (2 × 100 ml) to remove impurities, and the aqueous-alcoholic layer separated and heated with an excess of $NaHCO_3$ for 30 min. After cooling, the solution was extracted with chloroform (3 × 200 ml), and the extract dried over Na_2SO_4 and evaporated. Chromatography on a column of length 50 cm (SiO_2, hexane–ether, 4:1) gave dark red crystals of the nitroindolizine (Ia), mp 132-135°C (hexane); yield 0.28 g (7.3%). When the reaction was carried out in ethyl methyl ketone, the yield was 1.3%.

2,7-Dimethyl-3-acetyl-6-nitroindolizine (IIIc, $C_{11}H_{10}N_2O_3$). A mixture of 0.125 g (0.66 mmoles) of the nitroindolizine (Ic), 6 ml (63 mmoles) of acetic anhydride, and 2 ml of pyridine was boiled in 20 ml of benzene for 20 h. After removal of the solvent under reduced pressure, the residue was chromatographed on a Silufol plate in benzene to give 115 mg (70%) of (IIIc) as an orange-colored powder.

*With the assistance of Yu. Vasil'ev and A. Kossakovskii (students).

Nitroindolizine (IIId, $C_{12}H_{12}N_2O_3$) was obtained similarly from 0.18 g of the indolizine (Id), as brick-red needles, yield 56%.

2-Methyl-3-benzoyl-6-nitroindolizine (IVb, $C_{16}H_{12}N_2O_3$). A mixture of 0.176 g (1 mmole) of the nitroindolizine (Ib), 1.2 ml (10 mmole) of benzoyl chloride, and 1.4 ml of triethylamine was kept for 3 days at 20°C in 10 ml of benzene. The solvent was removed, and the residue treated with 10 ml of 5 N KOH in 50% aqueous alcohol, and extracted with benzene (2 × 100 ml). The solvent was evaporated, and the residue chromatographed with hexane followed by benzene on a column of length 50 cm, packed with SiO_2. The first fraction contained 0.12 g (68%) of the starting (Ib), and the second 75 mg of orange-yellow needles of the indolizine (IVb). Similarly, from 0.108 g (0.61 mmole) of the nitroindolizine (Id), after boiling for 1 h with benzoyl chloride and triethylamine in benzene followed by chromatography, there were obtained 19 mg (17%) of the starting (Id) and 0.88 g of the benzoylnitroindolizine (IVd) as bright orange crystals.

3,6-Dimethyl-5-nitroindole (V, $C_{10}H_{10}N_2O_2$). A mixture of 0.12 g (0.63 mmole) of the nitroindolizine (Ic) and 2.2 g of KOH in 50 ml of 90% aqueous alcohol was boiled under argon for 3 h. The mixture was poured onto 30 g of ice, neutralized with dilute HCl to pH 7, and extracted with chloroform (3 × 50 ml). The extract was dried over Na_2SO_4, evaporated, and the residue chromatographed in a Silpearl plate in benzene to give 0.38 g (31%) of the nitroindole (V) as a yellow powder, R_f 0.35, mp 146°C (benzene). IR spectrum: 3480, 3220 cm^{-1}.

Reaction of 2,7-Dimethyl-8-nitroindolizine with Alkali. The nitroindolizine (Ie) (57 mg, 0.3 mmole) was treated with a solution of 5.6 g of KOH in 20 ml of 80% ethanol. The solution was heated carefully under argon to 60°C, the mixture becoming darker and resinifying. According to TLC, even after 30 min the mixture contained no starting material (Ie), nor were any indoles detected. After working up in the usual way (see preceding preparation), no indoles or indolizines were found in the organic extract.

Reaction of 1,2-Dimethyl-6-nitroindolizine with Alkali. A mixture of 0.19 g (1 mmole) of the indolizine (Ia) and 5.6 g of KOH in 50 ml of 80% ethanol was boiled for 3 h. After cooling, the solution was poured onto 30 g of ice, and neutralized with dilute HCl to pH 7, the solid which separated being filtered off. After chromatography on a column of length 50 cm packed with SiO_2, elution with benzene gave 0.12 g (65%) of unchanged (Ia).

Similarly, 2-methyl-1,6-dinitroindolizine (16 mg, 0.07 mmole) was boiled with 5 ml of 5 N KOH in 50% ethanol for 3 h. The deep cherry-colored solution remained unchanged. The usual workup (see above) gave 12 mg (75%) of unchanged dinitroindolizine.

2-Acetyl-3-methyl-7-nitroindole (VId, $C_{11}H_{10}N_2O_3$). A mixture of 0.09 g (0.04 mmole) of the acetylnitroindolizine (IIId) and 15 ml of 3 N KOH in 80% ethanol was heated for 10 min on a boiling water bath. After cooling, the mixture was neutralized with acetic acid to pH 7, and extracted with benzene (3 × 50 ml). The extract was evaporated, and the residue chromatographed on a Silpearl plate in chloroform to give 0.08 g (90%) of the acetylnitroindole (Vd) as yellow crystals.

Similarly, recyclization of the acylnitroindolizines (IIIc) and (IVb, d) (starting amount 0.25 mmole) gave the isomeric acylnitroindoles (VIc) and (VIIb, d) (yellow powder).

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CONDENSATION OF 1,2-HYDROXYLAMINOOXIMES WITH ACETYLACETONE. CONVERSION OF TETRAHYDROIMIDAZO[1,2-*b*]ISOXAZOLES INTO DERIVATIVES OF 2H-IMIDAZOLE, 1-HYDROXYPYRROLE, AND 4-OXOTETRAHYDROPYRIDINE

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Reaction of 1,2-hydroxylaminooximes with acetylacetone gives tetrahydroimidazo[1,2-b]isoxazoles. 4-Phenyltetrahydroimidazo[1,2-b]isoxazole in methanolic HCl forms the corresponding 2-acetonyl-2H-imidazole. Both tetrahydroimidazo[1,2-b]isoxazoles and 2-acetonyl-2H-imidazole on heating in aqueous KOH convert into 4-oxo-1,2,3,4-tetrahydropyridines along with 3-acetyl-1-hydroxypyrroles.

Reaction of 1,2-hydroxylaminooximes with 1,2-dicarbonyls, depending on the reagents and reaction conditions, gives N-oxides of imidazole and pyrazine derivatives [1, 2]. The reaction of 1,2-hydroxylaminooximes with 1,3-dicarbonyls has not yet been studied.* Little data exist for the reaction of N-alkylhydroxylamines with 1,3-dicarbonyls [4].

In the present work, we study the reaction of 1,2-hydroxylaminooximes Ia-e, which contain a hydroxylamino group on a secondary carbon atom, with acetylacetone. Condensation of Ia-d with acetylacetone forms tetrahydroimidazo[1,2-*b*]isoxazoles IIa-d as a mixture of diastereomers. Signals of the two diastereomers A and B are seen in the PMR spectra of IIa-d. The diastereomeric mixtures of IIc and IId were separated by crystallization. The PMR spectra do not unambiguously reveal the stereochemistry of these isomers. We believe that the singlet in the PMR for the protons of the methyl group on the hemiacetal carbon of one of the isomers (isomer B) is seen at weaker field. The A isomers convert into the B isomers on heating IIc and IId in alcohol for 4 h. The reverse conversion is not observed. Multiple crystallization of the mixture of diastereomers of IIa and IIb gave only the A isomers. The C=N stretching band of the aliphatic nitrone group occurs at 1620-1655 cm^{-1} in the IR spectra of IIa, c, and d. Bands at 1570 and 1585 cm^{-1} (C=C and C=N) are seen for A-IIb with the α-phenylnitrone group (Table 1). Compounds IIa, c, and d have similar UV spectra with absorption maxima at 233-238 nm. Compound A-IIb has a long-wavelength maximum at 296 nm. This is characteristic for α-phenylnitrones [5] (see scheme below).

Isoxazole II apparently begins to form with condensation of the hydroxylamino group of compound I with the carbonyl group of the acetylacetone to give the β-oxonitrone III. Intramolecular addition of the N atom of the oxime group to the C atom of the nitrone group forms 2-acetonyl-3-imidazoline (IV). Intramolecular addition of the hydroxyl group to the carbonyl group in IV forms the final products II. The A isomers apparently convert into the B isomers in IIa and IIb through the intermediates IV and III. According to [6], the products of addition of the N-substituted hydroxylamines to mesityl oxide are 5-hydroxyisoxazolidines and not N-substituted 1,3-hydroxylaminoketones.

*For a preliminary communication, see [3].

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