REACTIONS OF 1,5-DIKETONES

XIII.* STRUCTURES OF PRODUCTS OF THE REACTION OF ALICYCLIC 1,5-DIKETONES WITH o-AMINOPHENOL AND o-PHENYLENEDIAMINE

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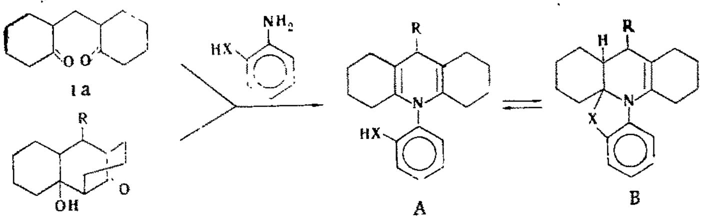
10-(o-Hydroxy- and aminophenyl)decahydroacridines, which are formed from 1,5-diketones and the products of their intramolecular aldol concentration with o-aminophenol and o-phenylenediamine, are cyclized reversibly to give five-ring structures.

We have established that, as in the case of the reaction of these ketones with ethanolamine [2], the decahydroacridines [IIa-f, A) formed in the reaction of 2,2'-methylenedicyclohexanone (Ia) and the products of intramolecular aldolization of other alicyclic 1,5-diketones (Ib, c) with o-aminophenol and o-phenylenediamine are cyclized reversibly to give five-ring structures (IIa-f, B).



Ib R=CH$_3$; c R=C$_6$H$_5$: IIa X=O. R=H; b X=O, R=CH$_3$; c X=O, R=C$_6$H$_5$; d X=NH. R=H; e X=NH. R=CH$_3$; f X=NH. R=C$_6$H$_5$

Instead of the two bands at 1660 and 1690 cm^{-1} characteristic for decahydroacridines [3, 4], the IR spectra of IIa-f contain a single peak at 1670 cm^{-1}, which is peculiar to dodecahydroacridines [3-5]. The spectra of IIa-c do not contain the absorption band of an OH group at 3100-3600 cm^{-1}; instead of the bands at 3500 and 3400 cm^{-1} that are characteristic for a primary amino group, the spectra of IId-f contain only the absorption of a secondary amino group at 3400 cm^{-1}.

The PMR spectra of IIa-f and 9,10-diphenyldecahydroacridine (III) [4] and 9,10-diphenyldodecahydroacridine (IV) [4] contain a multiplet of an o-disubstituted benzene ring (4 H) at 6.6-6.7 ppm; in addition, IIc,f give singlets at 7.3 ppm (5H). Compound III gives a singlet at 7.26 ppm (10H), whereas IV gives a singlet at 7.23 ppm (10H). Signals of olefin protons are absent in the spectra of all of the compounds, and the double bonds therefore are located between the rings. The spectra of IId-f at 3-4 ppm have a broad signal of NH groups (1H), which vanishes when CD$_3$OD is added. The signal of an OH group at 0-15 ppm is not observed in the spectra of IIa-c. In contrast to decahydroacridine III, which gives a singlet at 3.35 ppm (1H), which is related to the proton in the 9 position of the hydroacridine system, IIc has a doublet at 3.28 ppm (J = 10.8 Hz, 1H); a similar doublet is found at 3.0 ppm (J = 10.8 Hz) in the spectrum of dodecahydroacridine IV. Thus it has been shown in the case of IIc that the hydrogen ends up in the 12 position in the

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*See [1] for communication XII.

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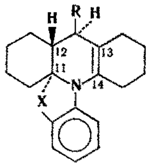
TABLE 1. Hydroacridine Derivatives

Compound	mp, °C	Empirical formula	Found, %			Calculated, %			Yield, %
			C	H	N	C	H	N	
IIa	96—97	$C_{19}H_{23}NO$	80,8	8,3	5,1	81,2	8,2	5,0	77
IIb	77—78	$C_{20}H_{25}NO$	81,5	8,7	4,8	81,6	8,5	4,8	73
IIc	144—145	$C_{25}H_{27}NO$	83,9	7,7	4,0	84,0	7,3	3,9	100
IIe	67—68	$C_{20}H_{26}N_2$	81,4	8,9	10,4	81,6	8,8	9,5	50
IId	173—175	$C_{25}H_{28}N_2$	84,1	8,0	8,2	84,3	7,9	7,9	78
Va	217—218	$C_{21}H_{26}N_3O$	75,2	7,6	12,9	75,2	7,5	12,5	85
Vb	199—201	$C_{22}H_{27}N_3O$	76,0	8,2	12,3	75,6	7,8	12,0	100
Vc	226—228	$C_{27}H_{29}N_3O$	78,7	7,1	9,7	78,2	7,1	10,2	79
Ve	220—221	$C_{22}H_{28}N_4$	75,5	8,2	16,0	75,8	8,0	16,1	74
Vf	235—236	$C_{27}H_{30}N_4$	79,0	7,4	13,8	79,0	7,3	13,7	95
VIa	279*	$C_{19}H_{22}ClNO$	72,2	7,5	4,6	72,2	7,0	4,4	50
VIIb	247*	$C_{20}H_{24}ClNO_5$	60,6	6,3	3,7	60,9	6,1	3,6	55
VIIc	250*	$C_{25}H_{26}ClNO_5$	65,4	6,3	3,3	65,8	5,7	3,1	60
VIIe	230*	$C_{20}H_{25}ClN_2O_4$	61,0	6,8	6,7	61,1	6,4	7,1	40
VIIf	274*	$C_{25}H_{27}ClN_2O_4$	65,8	5,8	6,0	65,9	5,8	6,2	45

*With decomposition.

cyclization to form B. From the magnitude of the J value it can be concluded that the coupling protons in the 9 and 12 positions in IIc and IV are oriented diaxially. An examination of models of these compounds shows that cyclization may proceed without steric strain only in the case of an axial orientation of the $X-C_{11}$ bond, i.e., trans-A/B fusion.

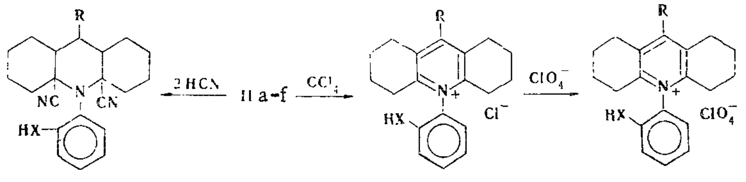


The methylene protons in the spectrum of III give two unresolved multiplets at 1.62 ppm (8H) and 1.43 ppm (8H). A more complex distribution of the intensity of the signals of the methylene protons at 1.0-2.6 ppm is characteristic for the spectra of IIa-f and IV, and a similarity in the forms of the signals is observed for compounds with an identical substituent in the 9 position. In addition, the methyl groups of IIb and IIe have signals with identical chemical shifts (doublets at 0.95 ppm, J = 5.6 Hz). It is known that the various stereoisomers of decalin, perhydroanthracene, and perhydroacridine have characteristic (for each configuration) forms of the multiplet of the methylene protons [6-8]; this makes it possible to assume that IIa-f have a common configuration. The fact that the signal of the proton in the 9 position in the spectrum of IIf is not isolated from the overall multiplet of the methylene protons is apparently associated with the effect of the unshared pair of electrons of the nitrogen atom rather than with cis-A/B fusion.

A structure with a trans-A/B fusion was also assigned to dodecahydroacridine IV. In fact, it is known from an analysis of the PMR spectra of the two isomers of N-phenylperhydroacridines [9] that the isomer in which cis fusion is absent gives a multiplet of the C_{11} and C_{14} protons at 2.18 ppm (2H) and a singlet of aromatic protons at 7.09 ppm. A multiplet of the protons attached to C_{11} and C_{14} is present at 3.42 ppm (2H) in the spectrum of the other isomer, which has at least one cis fusion, whereas the aromatic protons are separated by two groups centered at 7.18 and 6.83 ppm. The PMR spectrum of IV (see above) recalls the spectrum of the isomer without cis fusion.

Compounds IIa-f undergo the reactions characteristic for decahydroacridines, and this indicates the reversible cyclization $A \rightleftharpoons B$. They add 2 moles of HCN to give dicyanides Va-f. The IR spectra of the latter do not contain an absorption band at 1670 cm^{-1}, and a band appears at 2240 cm^{-1} ($C \equiv N$). The absorption band of an OH group appears in the spectra of products Va-c at 3430-3460 cm^{-1}, and the absorption of an NH_2 group is present in the spectra of products Vd-f at 3390 and 3490 cm^{-1}.

Compounds IIa-f are oxidized by carbon tetrachloride at room temperature to give sym-octahydroacridinium salts. Only VIa could be isolated in the individual state from the chlorides; the remaining salts were obtained in the form of the perchlorates (VIIb-f). The IR spectra of the perchlorates contain intense absorption at 1100 cm^{-1} (ClO_4^-). The OH group in the spectra of VIIb, c gives bands at 3600, 3500, and 3100-3300 cm^{-1}. The spectrum of chloride VIa contains a number of broad absorption bands at 2500-2800 cm^{-1}, which indicates strong coupling of the OH group with the quaternary nitrogen atom. The absorption of an NH_2 group at 3370 and 3460 cm^{-1} is present in the IR spectra of perchlorates VIId-f.



V a-f VI a-f VII a-f

EXPERIMENTAL

The IR spectra of a chloroform solution (for II), mineral oil suspensions (V), and chloroform solutions (VIa and VIIb-f) were recorded with a UR-20 spectrometer. The PMR spectra of CDCl$_3$ solutions were recorded with a ZKR-60 spectrometer. The chemical shifts are given on the scale with an accuracy of 0.03 ppm.

9-R-10-(o-Hydroxyphenyl)decahydroacridines (IIa-c) and 9-R-10-(o-Aminophenyl)decahydroacridines (IId-f). A mixture of 0.1 mole of ketones Ia-f and 0.11 mole of o-aminophenol or o-phenylenediamine in 100 ml of xylene was refluxed in the presence of 0.5 g of p-toluenesulfonic acid with a Dean-Stark trap for 1-2 h until water separation ceased. The solvent was removed by vacuum distillation, and 50 ml of ethanol was added to the residue. After several hours, the crystals of products IIa-f were removed by filtration and crystallized from ethanol or propanol. Compounds IIa-f were colorless crystalline substances that readily turned pink in air, were readily soluble in chloroform, acetone, and dioxane, and less soluble in alcohol. Compound IId was identical to the compound prepared in [3] according to the IR spectra; see the physical data on IIa-c, e, f in Table 1.

9-R-10-(o-Hydroxyphenyl) and 9-R-10-(o-Aminophenyl)-11,14-dicyanoperhydroacridines (Va-f). A 5-mmole sample of IIa-f was added in portions with stirring to a solution of 1.5 g of KCN in 10 ml of water, 10 ml of dioxane, and 20 ml of acetic acid in the course of 30 min, after which the mixture was stirred for 3 h and allowed to stand overnight. Water (100 ml) was then added, and the precipitated dicyanides V were removed by filtration, washed with water, and crystallized from alcohol. Dicyanide Vd was identical to the compound in [3] according to the IR spectra; see Table 1 for information on dicyanides V-c, e, f.

9-R-10-(o-Hydroxyphenyl)-sym-octahydroacridinium Salts (VIa, VIIb, c). A 2-mmole sample of IIa-c was dissolved in 15 ml of CCl$_4$, and the precipitated chlorides VIa-c were removed by filtration after 24 h. Product VIa was recrystallized from ethanol—ethyl acetate (1 : 10), whereas products VIb, c could not the recrystallized. Crude salts VIb, c were dissolved in 50 ml of water, a saturated NH$_4$ClO$_4$ solution was added, and precipitated perchlorates VIIb, c were removed by filtration, washed with water, and crystallized from alcohol.

9-R-10-(o-Aminophenyl)-sym-octahydroacridinium Perchlorates (VIId-f). A 2-mmole sample of IId-f was dissolved in 15 ml of CCl$_4$, and the solution was extracted with water (three 10-ml portions) after 24 h. The aqueous layer was extracted with ether, saturated NH$_4$ClO$_4$ was added, and precipitated perchlorates VIId-f were removed by filtration, washed with water, and crystallized from alcohol. Perchlorate VIId was identical to the compound obtained in [3] according to the IR spectra; see Table 1 for data on the remaining perchlorates and chloride VIa.

LITERATURE CITED

1. V. I. Vysotskii, É. V. Pavlycheva, and M. N. Tilichenko, Zh. Obshch. Khim. (in press).
2. A. N. Saverchenko, Z. R. Bekkerova, V. A. Kaminskii, and M. N. Tilichenko, Khim. Geterotsikl. Soedin., 243 (1974).
3. A. N. Saverchenko, V. A. Kaminskii, and M. N. Tilichenko, Khim. Geterotsikl. Soedin., 1232 (1972).
4. A. N. Saverchenko, V. A. Kaminskii, and M. N. Tilichenko, Khim. Geterotsikl. Soedin., 384 (1972).
5. V. A. Kaminskii, A. N. Saverchenko, and M. N. Tilichenko, Khim. Geterotsikl. Soedin., 1538 (1970).
6. B. L. Clarke, J. Amer. Chem. Soc., 83, 965 (1961).
7. N. Bărbulescu and F. Potmischil, Tetrahedron Lett., 2309 (1969).
8. N. Bărbulescu and F. Potmischil, Tetrahedron Lett., 5275 (1969).
9. B. Bărbulescu and F. Potmischil, Rev. Roum. Chim., 15, 1601 (1970).